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Proceedings of CTGZMA-2021

CRITICAL THINKING for Gen Z

MULTIDISCIPLINARY APPROACH

Editors

Dr. Jasmine K.S.
Dr. Preethi N. Patil
Dr. S. Anupama Kumar
Dr. M.N. Vijayalakshmi
Dr. Andhe Dharani

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MESSAGE

I am very glad to know that the **Department of Master of Computer Applications, RV College of Engineering, Bengaluru** is hosting a 2-day National Conference **Critical Thinking for GenZ-Multidisciplinary Approach (CTGZMA-2021) on 28th-29th October 2021** in association with Indian Society for Technical Education (ISTE) and the conference is being sponsored by AICTE under the GOC scheme.

The theme of the conference **CTGZMA-2021** is perfectly inline and meeting the requirement of the day, focusing on the core aspect of **NEP-2020.** I hope the conference gives the opportunity to exchange the ideas & thoughts on ways of acquiring and applying the ample knowledge through critical thinking.

I am confident the conference will be touching upon the current topics and provide a platform for the stakeholders to have a discussion and knowledge sharing experience. I wish the two-day national conference to be a great success and will really make an impact in the current education system.

I wish all the delegates and organizers a very happy learning time.

(Prof. Anil D. Sahasrabudhe)

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PROF. PRATAPSINH K. DESAI
President

MESSAGE

I am extremely glad to know that R.V. College of Engineering, Bengaluru is organizing a National Conference on "**Critical Thinking for GenZ-Multidisciplinary Approach (CTGZMA-2021)** during 28-29 October, 2021 and releasing a Souvenir to mark the occasion. The overall holistic development of the student is an essential skill to perform their responsibilities in the community and take the nation to greater heights. This can be achieved only by having a thoughtful mind. The role of a teacher is to ignite the minds to bring out the new ideas in the application area of their choices. The Ministry of Education, Government of India has taken an initiative to reform the Education system by revisiting the ancient teaching learning methods in meeting these requirements through National Education Policy 2020.

I am happy to state that the theme of the conference **Critical Thinking for GenZ-Multidisciplinary Approach (CTGZMA-2021) on 28th-29th Oct, 2021** is in line with our motto of career development of teachers and personality development of students and overall development of Technical Education System.

My best wises to the organizers, **Department of Master of Computer Applications, RV College of Engineering®, Bengaluru**.

08-10-2021 **(PRATAPSINH K. DESAI)**

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Dr. P K Panda
Chief Scientist and Head
Materials Science Division

MESSAGE

I am very glad to know that the Department of Master of Computer Applications, RV College of Engineering, Bengaluru is hosting a 2-day National Conference **Critical Thinking for GenZ-Multidisciplinary Approach (CTGZMA-2021) on 28th-29th Oct, 2021** in association with ISTE and the conference is being sponsored by AICTE under the GOC scheme.

I hope and wish the conference would provide a platform for the discussion on the critical thinking in various application area which is an important aspect in making the students to view any problem in multi-faceted way and to come out with a scientific solution.

I am sure, this conference will help the academicians and researchers to share their experience and expertise in the emerging process of implementing NEP-2021.

PK Panda
29/09/2021

P.K.Panda

AICTE-INAE Distinguished Visiting Professor
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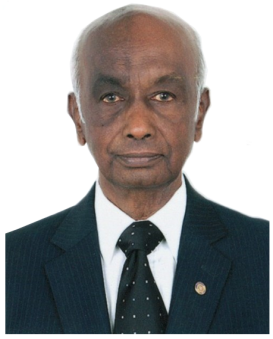

Dr. M. K Panduranga Setty
President - RSST

MESSAGE

It gives me immense pleasure to note that Department of Master of Computer Applications, RV College of Engineering®, Bengaluru in association with ISTE Bengaluru section is organizing AICTE sponsored National Conference on **Critical Thinking for GenZ-Multidisciplinary Approach (CTGZMA-2021)** on 28th - 29th October 2021.

I hope the conference contributes significantly towards the development of critical thinking skills in students to become more independent and self-learners and help teachers to have solid grounding in critical thinking and motivate students with suitable strategies for learning and to align with industry requirements.

I wish the conference "A Grand Success".

(Dr. M. K Panduranga Setty)

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Sri. A. V. S. Murthy
Hon. Secretary- RSST

MESSAGE

It gives me immense pleasure to know that Department of Master of Computer Applications, RV College of Engineering®, Bengaluru in association with ISTE Bengaluru section is organizing AICTE sponsored National Conference on **Critical Thinking for GenZ-Multidisciplinary Approach (CTGZMA-2021)** on 28th - 29th October 2021.

The theme of the conference is appropriate and relevant in the present times. I do hope that the conference will enable academicians, researchers and students to share their knowledge and experience.

I wish all the delegates and organisers the best and hope that the conference will dwell at the length on all the issues related to the themes of CTGZMA-2021.

(Sri. A. V. S. Murthy)

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MESSAGE

Lifelong learning is the requirement of the current day. As the technology change is happening at a very high rate, today's new technology turns obsolete in less than 4 years. To cope up with the challenges lifelong learning is the mantra. To have a mind that thinks in multidiscipline facet is the need of the day.

The theme of the conference is closely inline and I hope it provides the delegates an opportunity to exchange their thought in this regard.

My best wishes to the department of Master of Computer Applications, RV College of Engineering, Bengaluru for organizing a two-day national conference CTGZMA-2021 focusing on the critical thinking – a basic need to have lifelong learning.

Date:22.10.2021

Dr. K.N. Subramanya
Principal

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Go, change the world®

Preface

National conference on '**Critical Thinking for Gen Z: Multidisciplinary Approach (CTGZMA-2021)**' organized by Department of Master of Computer Applications, RV College of Engineering, Bengaluru, Karnataka, India, is a multidisciplinary conference which was sponsored by **All India Council for Technical Education (AICTE) in association with Indian Society of Technical Education (ISTE)**, New Delhi during **28th–29th October, 2021**. To construct multidisciplinary integration in education, cognitive process of critical evaluation of various disciplinary insights and to create a common ground among these various disciplines is essential. Critical thinking is an essential skill in all areas of life. This skill is very important in the new knowledge economy which helps to analyze information and integrate diverse sources of knowledge in solving problems. Critical thinking provides a way to learn from new experiences through the process of continual self-assessment and provides a basis for a 'rational and reasonable' balanced life for an individual. With this skill, one can evaluate the available data and make informed decisions regarding performance in their respective profession. As we look into the topic of conference, it is found that it is relevant topic in personal and professional life, especially in the case of Gen Z. The theme of the conference **CTGZMA-2021** is perfectly inline and meeting the requirement of the day, focusing on the core aspect of **NEP-2020**.

This book covers new emerging works which will be beneficial to Researchers, Academicians, Scientists, Industrial Professionals, Engineers, Scholars and students in the multidisciplinary areas of critical thinking like Science, Engineering, Arts and Humanities, Health care, Research and development, Education, Leadership and administration etc.

Dr. Jasmine K.S.
Dr. Preethi N. Patil
Dr. S. Anupama Kumar
Dr. M.N. Vijayalakshmi
Dr. Andhe Dharani

CTGZMA 2021

About the Conference - CTGZMA 2021

Critical thinking is an essential skill that should be investigated in a multifaceted way. It is a highly desirable skillset and plays an important role in education sector and other sectors. It is best conceived to excel and be successful in all walks of life. Students with critical thinking skills become more independent and self-learners. In the context of NEP 2020, Critical thinking promotes social transformation and diversity in Indian education. This helps teachers to have solid grounding in critical thinking and motivate students with suitable strategies for learning and to align with industry requirements. Critical thinking enables one to develop a deep understanding of the core fundamentals and apply these to solve problems in an innovative way in multidisciplinary areas like Science, Engineering, Humanities, Health Care, Research, Education etc. The two-day National Conference focuses on Critical thinking in the above niche areas for faculty, students, industry professionals and researchers.

The expected outcomes of the conference are:

- To promote in defining and advancing the principles and best practices of critical thinking in education and society
- To enhance teacher's ability to more substantively foster it in the classroom
- To establish rigorous standards of excellence in research findings
- To formulate well-reasoned scientifically feasible solutions

Acknowledgement

It is our pleasure to present this volume consisting of selected papers from oral presentations of the National Conference on **Critical Thinking for Gen-Z Multidisciplinary Approach (CTGZMA-2021**), held on 28-29 October 2021 at the RV College of Engineering®, Bengaluru. CTGZMA-2021 provides a platform for presentation of idea and research on critical thinking in diverse areas of application. Its main objective is to explore, within the procreative framework, different acquisition contexts, across a variety of areas, and between different components of the critical thinking aspect. The theme of this conference grouped presentations based on critical thinking in Education sector, Health Care, R&D, Arts & Humanities, Science & Engineering, Product Development, Management Information Systems, Profession, Leadership and Administration. The inquisitiveness of the main learner population were well addressed by the plenary sessions from eminent speakers Prof. Anil D Sahasrabudhe, Chairman AICTE, Dr. Pratapsinh Kakaso Desai, President ISTE, Dr. Prasanta Kumar Panda, Chief Scientist & Head, Materials Science Division, NAL, Dr. E. Aravind Raj, Associate Professor, National Institute of Mental Health and Neuro Sciences and Mr. Sree Kumar, Founder and Director of Technology, 21North.

We would like to take this opportunity to convey our heartfelt gratitude to the plenary session speakers, presenters and participants. We would also like to extend our indebtedness to the reviewers of the original abstracts and the papers submitted for consideration in this volume for having so generously shared their valuable time and expertise.

The organization of CTGZMA-2021 would not have been possible without the financial support for which we are extremely grateful to AICTE for sponsoring the conference under the Grant for Organizing Conference (GOC) Scheme 20-21 and all other co-sponsors.

A Special mention to the RSST Trust for continuously encouraging us to evolve as a better professional. We would like to thank our beloved Principal, RVCE, Dr. K N Subramanya for his valuable guidance and support throughout the process of preparation and conduction of this event. We also feel immense pleasure to thank our Dean Academics, Dr. Shanmukha Nagaraj, Dean Student Affairs, Dr. Uma BV, Dean Placement and Training, Dr. Ranganath D, Dr. N S Narahari, Chairman HSS Board, Dr. Anand Jatti, Secretary, ISTE-RVCE Chapter and Dr. Andhe Dharani, Director Department of MCA for their valuable suggestions and co-operation in organizing this event.

Finally, we wish to thank our colleagues and students who contributed immensely to the organization and success of the conference.

Contents

Competency Development of Faculty in Higher Educational Institutions

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ABSTRACT

Competency as a concept in institutional development, is which been researched and much discussed world over for many years. Researchers have developed several competency frameworks for different professions and categories. One such category is educational institution, where the competencies of both the teachers and students need to be improved for an exponential growth. Teaching staff members need competencies not only for teaching their subject matter but also to innovate and adapt. Teacher competencies are multifaceted amalgamation of knowledge, skills, understanding, values and attitudes, leading to effective performance in teaching. This article reviews research on competency in educational institutions and the innovative teaching methods to be adopted. The findings and recommendations derived from the review and the future scope are presented.

Keywords: *Competency, Innovative Teaching Methods, Teaching and Learning, Experiential Learning*

1. Introduction

As of late, the nature of educational instruction has fundamentally changed. Assuming, already, the college's significant point was that of furnishing understudies with specific sorts of information hence they are relied upon for later application, colleges now-a-days center fundamentally around 'life abilities'. Here the point is to train the students to get information without anyone else and to work in manners that empower them to think of novel thoughts. Producing novel thoughts is a critical principle of current culture. We need experts who are socially able, capable, inventive and imaginative issue solvers, talented and basic scholars. New advances offer a chance to empower critical reasoning.

Large scale influence of digital and internet enhanced access to information and knowledge is leading to a paradigm shift in teaching-learning process. One of the immediate requirements in the shift towards creating for learning is to adapt to the changing patterns in the learning psychologies of the new generation introduced by the influence of the digital world. Scientific studies and statistical data show that there is a significant shift in learning from the printed and didactic lectures to learning from animated and digital content. Experiential learning coupled with value-based education is becoming even more pertinent in the present-day context. There is a growing acceptance that the success of every professional depends upon the summative application of the human and digital intelligence to arrive at the optimal solutions. Access to the infinite digital intelligence identifying authenticity of information and applying them to chosen problem is a vital skill to be acquired by the students and faculty.

Global research has indicated that the audience can keep their concentration only for a period of maximum 20 minutes at a stretch while listening to lectures/seminars. Therefore, the need for role play and activity-based learning are essential to promote interactive and participatory learning from students' point of view. This experiential and practical learning are also important to build ethical and confident professional minds with an emphasis on better retentively of knowledge acquired and to ignite creativity in their thinking to assimilate into wisdom.

Educational sector will therefore have to be amongst the earliest to introduce new techniques and technologies to aid participatory learning within and outside academic campus. There is need to introduce digital learning and smart campus environment to balance these forces of disruptive technologies and to remain in tune with changing paradigms of education. Hence the innovation in teaching pedagogy is not the complete solution unless otherwise the competency of faculty matches the current and futuristic technologies, presumably those of high industrial relevance. Hence it is therefore important to have a quality framework in place to foresee and introduce emerging technologies to boost both the competency level of teachers and the teaching-learning process.

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2. Literature Review

The study on the competencies involves referring of exhaustive literatures penned by very well-established educators around the globe who have gained practical experience with the education system. The collective information from such sources is given as literature review in this section.

Nessipbayeva, olga *et al.* (2012) have discussed the competency requirement of modern a teacher, in which the authors have discussed the skills required for a 21st century teacher. Hence an educator needs to develop his/her skill using innovation, creativity, critical thinking, problem solving and other pedagogical skills. The authors have also discussed on reflective teaching, student evaluation and other class room techniques required to equip a modern day teacher.

In their work Anguo Xu and Long Ye (2014) have highlighted the irreplaceable role of educational institutions in national as well as social development. To achieve this the quality of teachers as well as teaching has to be improved. Hence the competency on job performance becomes important. The positive and significant roles of a teacher have to be explored and utilized.

Knight, Peter et.al. in their article, stressed the need for structural changes needed in education system. The leadership skills that have to be developed by the teachers, their transformation in line with the transformational leadership and organizational and cultural engineering at local, departmental and national level.

3. Competencies of the Modern Teacher

The importance of competence portrays that it is a term utilized broadly by various individuals in various settings; consequently, it is characterized in an unexpected way. The education and performance of a teacher are the two areas where the term competency is used. Competency comprises of the information, abilities and qualities an educator should exhibit for his/her effective profession [1].

A few qualities of competency are as per the following:

1. A competency ability comprises of at least one ability whose authority would empower the achievement of the capability
2. Competency is connected to every one of the three of the spaces under which execution can be surveyed in particular the knowledge, skills, attitude
3. Competency has an exhibition measurement; subsequently they are noticeable and self-evident
4. Since competence are detectable, they are additionally quantifiable. It is feasible to evaluate an ability from an instructor's presentation. competencies preferably requires equivalent measures of knowledge, skills, attitude, yet essentially not since certain capabilities might include more information than ability or disposition, while, a few skills might be more expertise or execution based

4. Classifications of Competency

Competency can be classified basically in to three types namely

- Academic competency
- Professional competency
- Personal Competency

4.1 Academic Competency

When considering the competencies in academics the studies done on it frequently vary in titles and definitions. At the point when inspected, one can easily observe that they all have comparable implications and allude to a comparative range of abilities. Consequently, the essence of all scholastic competency studies spins around evaluating intellectual and exhaustive skill, scholarly and information capacities.

Academic competency incorporates the ideas, abilities and information on the educators in his/her field of specialization it likewise incorporates the consciousness of the examination techniques related to education sector. Competence in academics is a significant feature related to specific capability essential for educators. It incorporates the educator's substance authority of the subject that they instruct and their intellectual and showing cognizance capabilities [1]. The ideas of exploration capability and deep-rooted learning are additionally considered as essential parts of instructors' scholarly skills [2].

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Attending the competency related to global conclave, symposium gives the worth to the scholarly skill and scholastic settings as a feature of nonexclusive instructor competencies [3]. They weight on the significance of having an expansive information base and comprehension of the instructed subject. The assessment of the academic competency can be done by means of the educator's reactions using survey as well as markers to demonstrate the guidelines [4]

4.2 Professional Competency

The techniques for educating, execution instruments, methods for preparation are incorporated in the professional competence. It relates to the utilization with instruction and knowledge mechanism leading to a circumstantial learning to rise the students' inspiration to get the hang of, empowering them to work and utilizing shifted learning assets dependent with the societal as well as the mental requirements of the students. It has to be noted that the vast majority of research is represented by idea of professional competence regularly represents the vast majority of the research. It is generally referenced by a similar name with same definition and ranges of abilities [5] or simply by posting the abilities hidden professional capability which incorporate genuine educational practices. The Professional competence also alludes to the genuine showing class room based educational practices. The inclusion of instruction handling, information on consolidating innovation with instructing, educational curriculum planning, its execution and working with the students learning measure based on course outcomes. Based on the instructor's obligation to bring understudies in proficient knowledge gathering, set out open doors for the accomplishment of expert information and to ensure understudies have a satisfactory climate for learning [6].

4.3 Personal Competency

Personal or the Individual competency refers to the personal ability of the individual characteristics of an educator/ lecturer. In an higher educational institution this has developed based on Humanistic Based Teacher Education (HBTE) in which, suitable consideration can be coordinated with respect to the student with less emphasis to the educator himself/herself. HBTE comes with the standard of Human mind or psychology-based approach that is presented in the year 1968 by Maslow. Hence core component of Human based psychology depends with poise considering the focal reason that is focused on self-growth.

The way that this development centered consideration on the instructor was of significance to the further advancement of instructor training" [7]. Individual competence incorporates the individual characteristics of an instructor for example actual wellbeing, general insight, great ethics, etymological capacity, capacity to develop, capacity to oversee or to make choices as well as capacity in a way to tell the leaders as well as the learners. Different names suitably fit the Individual Competence such that make it accessible for great educators. Individual skill includes values, mentalities, manners and individual viability of the individual [8].

The point-by-point unmistakable components of individual capability essential to their prosperity incorporate knowing the understudies, school, family, cultural connections, information and growing better associations with individuals from the learning local area and students. Simultaneously, it additionally includes esteeming and really focusing on all understudies and acting in a predetermined way which best suits their inclinations. Going about as good examples, genuinely and morally and having a decent handle on the utilization of information on the understudy's turn of events and development. They ought to see the value in the help and inclusion of families, watchmen and guardians in schools. The competencies discussed above section can be further classified as following:

- Competencies related to core area
- Competencies based on ICT
- Competencies based on environmental factors
- Competencies related to emotional concepts
- Curriculum based Competencies
- Communication Competencies
- Expertise available for life long
- Research Competencies
- Competencies based on societal and cultural inputs

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5. Competency Framework

Competency Framework is what supports Competency Management and typically has 3 different parts. The first part is further sub-divided to multiple groupings internally in each category.

The first part of the competency usually includes Major competence requirements like core competency whereas the last part takes care of highlighted competencies based to highlight the mainly the performance criteria.

To help this competency assessment procedure it can be proposed that this competency Framework shall be assisted by required skill set with the Assessment as well as the database of requirements of the Training. In order for successful implementation of competency development in an institution, the organisation's Competency Framework should reflect its objectives [9].

It is the responsibility of the faculty to assess their level of competence that is required to perform in line with the competency framework related to each area. In case of any shortfalls suitable training should be given and this training requirement should be typically triggered by any of the listed items

- Appointing a new faculty hence he/she shall be trained in specific areas
- The current academic qualifications and/or experience
- To suit the new regulations introduced in the workplace
- Any Change in role of the faculty in the institution
- Any weakness as identified during the review or audit
- When re-training is required due to organizational changes
- Requirement of continuous training for the existing staff to maintain or upgrade their Skills sets as well as their knowledge

The most important thing that has to be considered when training objectives are developed is the 'criteria' which is an essential thing that may be required for training a person to be competent. Hence suggestion is to frame the above said criteria to follow in the line of the acronym SMARTT which is otherwise expanded as the following for each letter as Specific, Measurable, Achievable, Repeatable, Traceable and Time-dependent.

6. Phases of a Competency Framework

The competency framework consists of 5 phases as shown in Fig. 1 and their details are given as below:

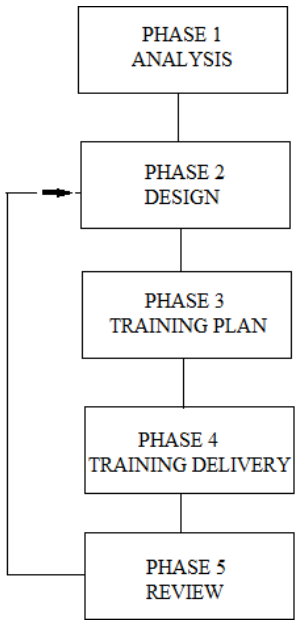

Fig. 1. Phases of a Competency Framework

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In Phase 1 the individual faculty has to perform his/her task in such a way that he/she has to get the necessary information related to the task in order to achieve the required competency which in turn involves few regulatory procedures, essential knowledge and other requirements [10].

In case of Phase 2 it is basically the design phase focusing on the development of a training suitable to get the additional competencies that us based on few shortfalls observed in phase one hence should be properly aimed for achieving.

Phase 2 will lead the faculty/trainee to achieve the required competency for their job directly through suitable design. Thus, the design phase specifies the following:

- Upon whom this is aimed?
- Required skill sets that should be imparted during training?
- Component that has to be used?
- Standards to be followed and constraints?

Phase 3 deals directly with the Training Plan like development of necessary training material like handouts, assessment methods and other things related with the competency assessment.

Phase 4 is where the training is delivered in order to meet the identified requirement. Thus, the training shall be given without any break hence it is reliable to all faculties/trainees.

In Phase 5 all the above said is reviewed.

A Personalized Competency Review (PCR) will be made accessible for every workforce coordinating with the necessities according to their profession advancement, staff inspiration additionally the work fulfillment. At the point when a staff means or moved to different offices there ought to be a handover of all the preparation records with the end goal that it will permit any future skill review to be effectively embraced.

7. Competency in Teaching Learning Practices

As discussed in previous sections competency is something beyond knowledge, abilities and it is inclusive of required satisfaction through some psychosocial assets like specific attitudes and skills. Hence if a teacher has to excel in his/her quest competency is very much required in his/her career.

Any faculty working in a higher education sector needs competencies to encounter the challenges posed in current educational field. Thus, competency in Teaching is an element of an effective training procedure, for the faculty who has an urge for national contribution and development. Hence, teachers here can be found as the central figures in the education sector and their skills as well as their learning curve in getting the required competencies reside on the below:

- Teachers shall have good communication skill with good physical and mental health
- Teachers shall work with the newer generation without any grievance
- They have a good imagination, observation and leadership

Teaching competencies of modern teacher include that [11].

1. They demonstrate leadership through evaluation development of instructional plans, maintenance of safe and orderly class room they also manage the positive behavior of the student. Help them in effective communication, deescalate their disruptive or dangerous behavior with a demonstration of ethical practices
2. They are oriented towards the global educational community and in the world since they maintain high expectation and with consideration of the benefit of the scholars who need special attention hence to assist the special needs required related to the learning curve. They also prepare the educators for a respectful environment aiming the different category of the students and utilise research-based plans to offer an effective teaching learning environment
3. The Teachers realize the substance they show they create and apply exercises by coordinating powerful instructive guidance all through the educational curriculum, across content regions to upgrade the learning skills of the student community. They encourage the scholars to observe the contents and improve their knowledge to satisfy their needs. Educators make their directions pertinent to understudies by their behavior and the teaching learning is done to provide degrees of physical, academic, social, passionate improvement to the scholars. They show their consciousness of the capability of the innovation and use it to upgrade learning by incorporating innovation with their guidance to expand learning skills of the students

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During the career of a teacher, they undergo various levels of expertise development that accomplishes a zenith related with the professional competency as shown in the Fig. 2 among which pedagogical innovation is most important and is the need of the hour. It is discussed in detail in next section.

7.1 Pedagogical Innovations

Development in instructive area has drawn expanded consideration all around the world, currently numerous nations have set out on instructive changes to change both the objectives just as practices in training field. Such advancements can be upheld by joining ICT (Information and Communication Technologies) with instructing and learning measure are broad. Hence, the developments are these days on a very basic level changing the learning experiences of the students.

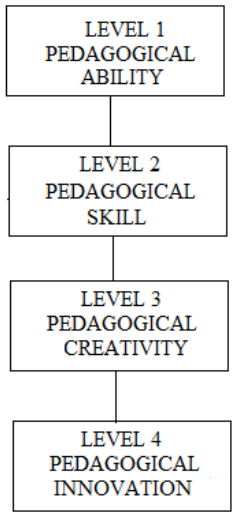

Fig. 2: Pedagogical Levels

As a part of innovation new progressive methods are now-a-days are involved in teaching learning process.

Pedagogical innovations demand the replacement of paradigms in education one such innovation is IILA discussed in next section.

IILA stands for Innovative and Integrated Learning Approach, which assists the teachers of the higher educational institutions to teach, evaluate and hence do the assessment of the level of the understanding achieved by the individual scholars related to a topic of particular interest. The responses for innovative and integrated learning includes quiz, jigsaw, GOIL (Guided and oriented inquiry-based learning), Mapping, game-based learning, Pedagogical approach Learning PAL, group learning, role play and zoom up are the few innovative methods.

These methods help the students in understanding the complex concepts on some advanced topics to keep them interested in the studying process. Internationally acclaimed Flipped class-based learning has successfully proved that this approach where a prerecorded video of the topics that are proposed to be handled is given before itself for the students to learn in advance. After viewing the video, the class begins with a session consisting of interaction between the instructor and the students. Hence, this method of teaching reduces the actual delivery time of the content during the regular class and brings in enhanced learning and knowledge gaining. This method gives rise to overcome the effect of monotonous conventional teaching. It has to be noted that the videos will also help in revision before the examination.

Conclusion

From the discussions in the previous sections, the job of a capable teacher of an educational establishment is not to just focus on his/her self-improvement but to develop their range of abilities and henceforth their reasonable worth, this also causes to redefine their performance in their class room handling skills, increased efficiency, maintaining decorum and discipline, working as a group with spirit and ethics, collaboration, communication, result orientation, assessing progress, and making consistent changes yet in addition incorporates scope of plan and systems that have

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to be utilized to advance positive relationships, participation, and learning with a purpose. Hence the job of a teacher is reworked from simply arranging and relegating against time, space and other needs in order to ensure a fair commitment towards the students in their useful assignments.

In this way the competency framework of an educational institution should reflect the objectives of the institution. The final section which discussed the pedagogical innovations, brings about execution of effective teaching learning practices with contrasting perspectives and speculations including "the methods of knowing" and strategies for request while showing topic ideas. Different educating and learning systems should assist with drawing in the students to an active learning environment that advance the improvement of problem solving, critical thinking, and performance in general while assisting them with accepting accountability for recognizing and utilizing learning assets.

References

[1] Nessipbayeva, Olga. The Competencies of the Modern Teacher. ERIC Speeches/Meeting Papers; Reports, https://eric.ed.gov/?id=ED567059 (2012).

[2] Anguo Xu, Long Ye (2014). Impacts of teacher's competency on job performance in research universities with industry characteristics: Taking academic atmosphere as moderator, *Journal of Industrial Engineering and Management*, 7 (5), 2014.

[3] Dalal A. Alqiawi &Sawsan M. Ezzeldin, A Suggested Model for Developing and Assessing Competence of Prospective Teachers in Faculties of Education, *World Journal of Education*, Vol. 5(6), 2015.

[4] Knight, P.T. and Trowler, *P. Departmental-level Cultures and the Improvement of Learning and Teaching. Studies in Higher Education*, 25(1), pp. 69–83, 2000.

[5] Levander, Lena.et al., Challenges and Opportunities of Teaching Competence Evaluation., http://www.iced2014.se/proceedings/1214_Levander.pdf, 2014.

[6] Hanesova, P. Hanes, Current Trends and Trajectory of Research on Teachers, INTED 2017.

[7] Merkt, Marianne, The importance of academic teaching competence for the career development of university teachers: A comment from higher education pedagogy, *GMS Journal of Medical Education*, 34(4), (2017).

[8] Annierah Maulana Usop, Kamarulzaman Askandar, Maeda Langguyuan-Kadtong, Work Performance and Job Satisfaction among Teachers, *Work Performance and Job Satisfaction among Teachers*, Vol. 3 (5), 2013.

[9] Paloma Julia Velasco et al., Faculty Perspective on Competency Development in Higher Education: An International Study. *High. Learn. Res. Commun.*, Vol. 4(4), (2014).

[10] Peklaj, Cirila, Teacher Competencies through the Prism of Educational Research, *Canter for Educational Policy Studies Journal*, Vol. 5(3), 183–204, 2015.

[11] International Trends in Teacher Competency Research: A Review, *International Journal of Pure and Applied Mathematics*, Vol. 119(7), 2591–2600, 2018.

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Critical Thinking Skills for Mathematics Learning in Engineering Education: State-of-the-Art Review

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ABSTRACT

Engineering problem solving skills involve mathematical thinking and optimum solution development. There is a need of critical thinking (CT) in handling multi-disciplinary nature of the problems. CT is recognized as student's learning quality indicator. Components of CT such as analyzing skills, making inferences, reasoning, decision making are to be inculcated in the students. There is an urge for mathematics teaching community to provide opportunities for collaborative learning and making it learner centric by posing unorganized open-ended, real-life problems which make students overcome memory based thinking. Development of effective critical thinkers can be made possible by incorporating CT into the contents of the curriculum, pedagogical ways by sequencing at every grade levels. This paper is a systematic review of literature, highlighting in engineering education, the need of investigating new approaches on CT skills for mathematics teaching.

Keywords: *Engineering Education, Mathematical Thinking, Critical Thinking*

1. Introduction

Professional engineer is required to possess knowledge as the database. Knowledge can be handled with skills as tools. Engineering education earlier was knowledge transmission, skill development value promotion. Engineering Professionals would choose to work in an industry or be a consultant with a task of routine repeated computations leading to good profit. Faculty reinforcement and noteworthy changes in Engineering curriculum is required to prepare our graduates in facing the recent challenges. Important skills engineers should possess are Creative thinking, critical thinking(CT) and solution to problems to address future challenges. Students as dependent learners entering the college rely on their Professors' presentation and knowledge interpretation. According to ABET Engineering Criteria they should acquire the ability of applying mathematics, science knowledge to engineering and gain managerial skills with a capability of addressing interdisciplinary problems and commitment of lifelong learning [1]. According to the Stanford Encyclopedia of Philosophy Critical thinking is a universally agreed educational goal. CT is identified as one of the necessary skills in making students industry ready.

2. Critical Thinking (CT)

2.1 Definition of CT

Critical thinking as defined philosophically by Socrates is Reasoning debate or process of critical questions. Paul, [2] defines CT as thinking that is self-directed, disciplined which represents perfections appropriate to a particular field or thought mode". Approach of Cognitive psychology considers "strategies of mental processes people making use for decisions, in solving problems for learning different conceptions"[3]. The highest three Bloom's taxonomy levels evaluation, synthesis and analysis represent critical thinking as defined with educational approach [4].

2.2 CT Skills in Education

In education CT skills were analysed by John Dewey (1916) [cited in 5] as beginning with a problem, proceeding with self-interpretation and ending with a solution. Also evoking natural curiosity in students stimulating critical thoughts and learning [6]. With these, one can define CT as a thought process by an individual, beginning in problem solving or answering a question to choose a logical and most suitable option [7].

CT comprises six main skills, evaluation, analysis, interpretation, self-regulation, explanation and inference. Significant questions that arise in CT skills-learning and teaching are: where and what to be taught, how to be assessed and can students' CT skills be promoted by technology? This can be addressed by teaching CT in specific courses and then in

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general courses. Teaching strategies may include Problem-based learning, Reading, Writing exercises, Collaborative learning, Questioning techniques, Discussion methods, Technology to enhance CT, Peer review.

Assessment strategies for CT can be Self-assessment with well defined rubrics, standardized tests. Also Web-based teaching-learning environment, Online discussions, Inquiry-based learning lead to Collaborative learning. In a specific course, focussing on theory, skillset and practice one can teach CT skills.

2.3 A Pedagogical Look of CT in Higher Education

CT is considered to be a universal higher education goal. Higher education requires higher order thinking among students and CT ability becomes important to give evidence for their opinions and for critical evaluation. CT is cultivated through different knowledge areas than taught as an autonomous skill. Allowing students to conclude on their own is the best way of teaching CT to students. CT enhances usage of the right skill in an appropriate context. CT in the classroom should provide good reasoning behavior models, explain methods, purpose, concepts of good reasoning, peer interaction opportunities and feedback. Annotating, previewing and contextualizing are the suggested strategies to develop the CT ability [8].

3. Engineering Education

3.1 CT Impact on Engineering Education

In engineering disciplines there is less explanation on CT definitions. Creating ideas in problem solving using the knowledge gained is important in the real world situation. There is a need in engineering education to engage with educational literature for CT understanding. CT can be studied in engineering from professional disciplines like architecture, law or humanities who explicitly address CT by giving clear guidance to students in becoming critical thinkers.

It is required to design tasks and learning objectives to enable engineering students to become critical thinkers [9].

3.2 CT Skills in Engineering with Math - Orientation

There is a need for the engineering fraternity to research from microscopic to nano level to global mega level to new cyber infrastructure areas by acquiring new skills and knowledge explosion. Many of the technical innovations have fundamental knowledge key-base as mathematics involved in engineering practice. In many engineering aspects sound knowledge of Mathematics and skills are essential. Mathematics fluency is an important weapon for engineering graduates for technological advancement. There is a need for engineering students to acquire math-oriented CT skills upon graduation. Mathematics teaching to the students of first year is a challenging task. During the engineering mathematics class, cooperative learning environment is observed to encourage students in communicating to each other. Illustrations connecting mathematical methods to the respective engineering fields by mathematics educators is necessary with a perspective towards current industrial needs [10].

3.3 Case Study: Mathematically CT in Education - Civil Engineering

Sharifah Osman *et al.*[11] have explained CT elements with thinking mathematically in civil engineering real time practice, pertinent elements of CT - identification for the duration of open coding which is among three stages of process in analysis of grounded theory analytically. Providing empirical information beneficial for curriculum of engineering, students & educators infuse interaction and interrelation for mathematical problem solving.

3.4 CT Through Mathematical Modeling

Acebo *et al.* [12] have proposed classroom experimentation using simulation by modeling real world phenomena reviewing CT ideas. It is shown that in the Mathematics classroom, mathematical modeling help in developing this competency. Defining the problem, strategy identification, proposing solutions, evaluating and implementing results are the rubric to assess competency.

Concluding Remarks

CT and mathematical thinking is crucial to be inculcated to present engineering education. Importance of skills of CT with professional practice should be made understood by students in solving complex engineering problems.

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CT skills benefit the engineering educators to reinforce by having an engineering curriculum representing the real engineering practice. Mathematical Modeling is shown to be an excellent strategy in implementing integrated STEM education. In the field of engineering, training the students CT is considered as one of the most important competencies.

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References

[1] A. Rugarcia, R. M. Felder and D. R. Woods, The future of Engineering education, Chem. Engg. Edn., 2000.

[2] R. W. Paul, CT: What, why, and how? *New Directions for Community Colleges*, 77, 3–4, 1992.

[3] R. J. Sternberg, CT: Its nature, measurement, and improvement, National Inst. Edn, 1986.(http://eric.ed.gov/PDFS/ED272882.pdf).

[4] M. Kennedy, M. B. Fisher and R. H. Ennis, CT: Literature Review and Needed Research, Ednl. In L. Idol & B. F. Jones (Eds) , 11–40, 1991.

[5] D. Kuhn, A Developmental Model of CT. Ednl Reschr., 28(2), 16–46, 1999.

[6] J. Bean, Engaging ideas: Professors's guide to integrating writing, CT and active learning in the classroom (2nd ed), San Francisco: Jossey-Bass, 2011.

[7] N. J. Alsaleh, Teaching CT Skills: Literature Review, TOJET, 19, 21–39, 2020.

[8] M. Fahim, CT in Higher Education: A Pedagogical Look, *Theory and Practice in Language Studie*s, 2, 1370–1375, 2012, ISSN 1799–2591.

[9] A. Aherna, T. O'Connorb, G. McRuaircee, M. McNamarab and D. O'Donnelb, CT in the University Curriculum-Impact on Engineering Education, *Eur. J. Engg. Edn* 37, 125-132, 2012.

[10] N. M. Radzi, M. S. Abu and S. Mohamad, Math-oriented CT skills in engineering, IEEE proc. 2009 Int. Conf. Engg. Edn. ICEED 2009.

[11] S. Osman, M. S. Abu, S. Mohamad and M. Mokhtar, Identifying Pertinent Elements of CT and Mathematical Thinking used in Civil Engg. Practice in Relation to Engg. Edn., T. Qual. Rpt 21, 212–227, 2016.

[12] J. Acebo & R. Rodriguez, Theoretical and Methodogical Proposal on Development of CT through MM in Training Engineers, Proc., 7th Int. Conf. TEEM, 2019.

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Enhance the Critical Thinking Ability among Engineering Students using Problem based Learning

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ABSTRACT

This paper presents how to integrate the knowledge and skills to improve the Critical thinking ability among Engineering students. To realize knowledge and skill integration, the Project based learning (PBL) is needed. The PBL helps the students to achieve the learning outcome and industry ready. In the present situation, the Industries need an engineer who is well accomplished with critical thinking skill, such as real time problem solving and decision making, Analysis and Evaluation. In this direction, the author applied PBL to one of the Undergraduate Course by name Microprocessor and Microcontroller. The result analysis shows that, the students learnt this course with PBL have 7%, 9%, 8% and 12% improvement over the non PBL with respect to Course Outcome (CO) CO1, CO2, CO3, C04 respectively.

Keywords: *Project Based Learning (PBL), Course Outcome (CO), Critical Thinking*

1. Introduction

The Project based learning (PBL) is applied to Undergraduate Course by name Microprocessor and Microcontroller for two academic year. The 8051 microcontroller is the major part of surveillance unit system. It will access all the information from Sensors and camera and manipulate it. The 8051 is a which is used extensively in many industrial applications. The 8051 microcontroller is as chip flash memory permits the program to reprogrammed in systems. Atmel AT89C51 is powerful microcomputer, which offers a especially in embedded control application. The power down mode saves the RAM contents however freezes the oscillator disabling all other chip functions till the next hardware reset.

2. Related Work

In[1] the author presented a continuous fields research using qualitative and quantitative tool for explore pupil progress in affective and cognitive domains. In[2] the involvement program had divided into two parts: First is the pupil document their projects according to creative process. Second is the project were assessed to a creative thinking scale. In[3] founds a little o50 per cent of sample result in completed corroborations and the balance corroborate. In[4] A advanced review of empirical evidences assessing a impact of PBL in academic achievements of nursery school and elementary student and it found many study yield in an inconclusive result.

3. Importance and Outcome of PBL

PBL will encourage the improvement of critical thinking skill, problem solving abilitie, and communication skill. It also provides opportunities for working groups, finding and evaluate research material, and life-long learning's.

Project Based Learning is innovative approach to learning a multitude of strategies to critical for success in 21st century. It also expose students to real world and open an extend inquiry process and it boosts their communications skills and interdisciplinary learning's.

4. ICT Tools Used

The following ICT tools are used in Undergraduate Course by name Microprocessor and Microcontroller.

2.1 Thing Link: it is a invention tool makes easy clickable tags to image on web and shared the tagged image on social network.

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2.2 Jeopardy Lab: it_allows user to create a tailored jeopardy templates without PowerPoint's. It makes students to play online from any part of the world.

2.3 Easy Class: it is a tool which provides unique opportunity for instructor to connect students in a various activities.

5. Microprocessor and Microcontroller

The Course outcome of Under graduate Course Microprocessor and Microcontroller are :

1. Interpret the architecture, instruction set, memory organization and addressing modes of the microprocessors and microcontrollers
2. Analyze pin functions/ports for implementing peripheral interfaces with microprocessors and microcontrollers
3. Apply the knowledge of microprocessor and microcontroller for implementing assembly language/C programming
4. Engage in assignment to understand, formulate, design and analyze problems to be realized on embedded processors

5.1 Program Outcomes

It describes what student are likely to know and would able to do during graduation. It relate to the skill, knowledge, and behaviors and CO attainment process of Microprocessor and Microcontroller is shown in Fig. 1.

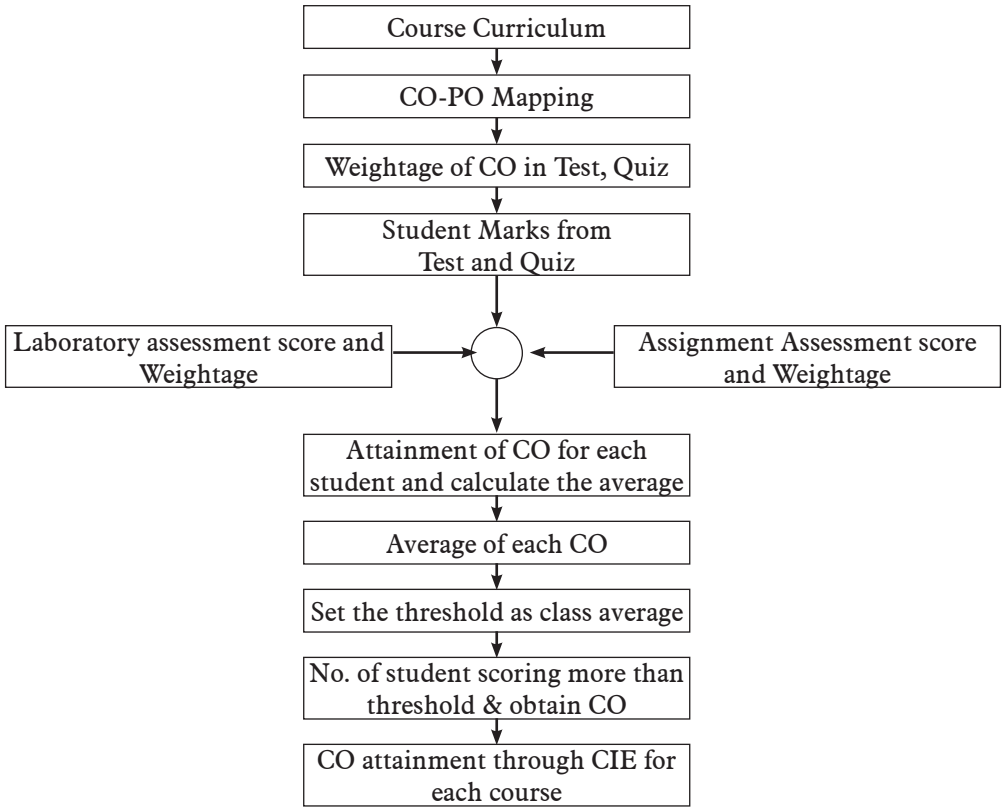

Fig. 1: CO Attainment Process

5.2 Direct CO Attainment Calculation

For direct CO attainment calculation CIE and Quizzes are consider

Enter marks for each student for all the questions,

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CO1 contribution is calculated by

Σ (marks obtained in questions corresponding to CO1)

Σ (maximum marks of all questions corresponding to CO1)

Similarly for CO2, CO3 and CO4 contributions are obtained

- Do for all 2 quizzes and take the Sum of both the quizzes.

For Tests

- Enter marks for each student for all the questions
- CO1 contribution is calculated by

Σ (marks obtained in questions corresponding to CO1)

Σ (maximum marks of all questions corresponding to CO1)

- Similarly for CO2, CO3 and CO4 contributions are obtained
- Do for all 3 tests and take the average of all the 3 tests.

5.3 CO Contribution from Assignment

The CO contribution from assignment is shown in Fig. 2

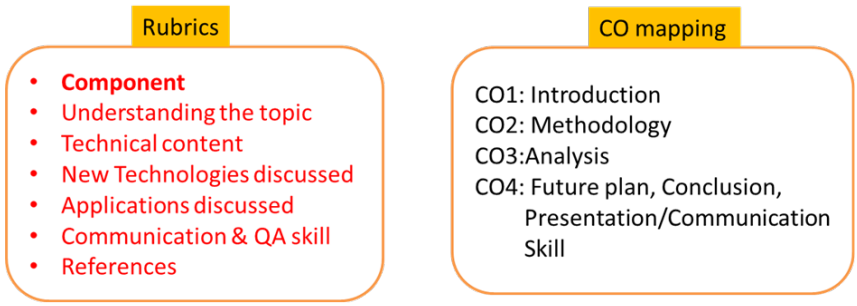

Fig. 2: CO Contribution from Assignment

- CO1 contribution is calculated by
  - Σ(marks obtained in questions corresponding to CO1)
  - Σ(maximum marks of all questions corresponding to CO1)
- Similarly for CO2, CO3 and CO4 contributions are obtained

Contribution of Cos(Q1+T1, Q2+T2, T3) and Assignment
- A sample shown in Table 1

Table 1: CO Calculation

Sl. No.	USN	Unit Quiz, Unit Test & Assignment Name	CO1-1	CO2-1	CO3-1	CO4-1	CO1-2	CO2-2	CO3-2	CO4-2	CO1-3	CO2-3	CO3-3	CO4-3	ACO1	ACO2	ACO3	ACO4
1	1RV18LVS01	Aishwarya H S	95.00	80.00	86.00	75.00	80.00	100.00	68.63	63.89	90	75	52.94	77.78	85.71	87.50	87.50	85.71
2	1RV18LVS02	Arpitha Nagesh K	77.50	33.33	36.11	41.67	80.00	83.33	66.67	33.33	60	100	94.12	66.67	85.71	87.50	100.00	92.86
3	1RV18LVS03	Asha D	75.00	48.33	0.00	41.67	75.00	83.33	51.96	0.00	50	100	94.12	33.33	85.71	87.50	100.00	92.86
4	1RV18LVS04	Ashish BP	65.00	65.00	83.33	41.67	95.00	83.33	83.33	63.89	50	100	64.71	33.33	85.71	87.50	87.50	85.71
5	1RV18LVS05	Basaweshwari	92.50	70.00	66.67	50.00	90.00	83.33	83.33	69.44	70	100	76.47	100	85.50	87.50	87.50	85.71
6	1RV18LVS06	Deepak S Pal	75.00	70.00	55.56	41.67	67.50	100.00	71.57	58.33	90	50	29.41	88.89	100.00	87.50	87.50	85.71

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Results and Discussion

The Jeopardy Lab was developed for Microprocessor and Microcontroller course as shown in Fig. 3.

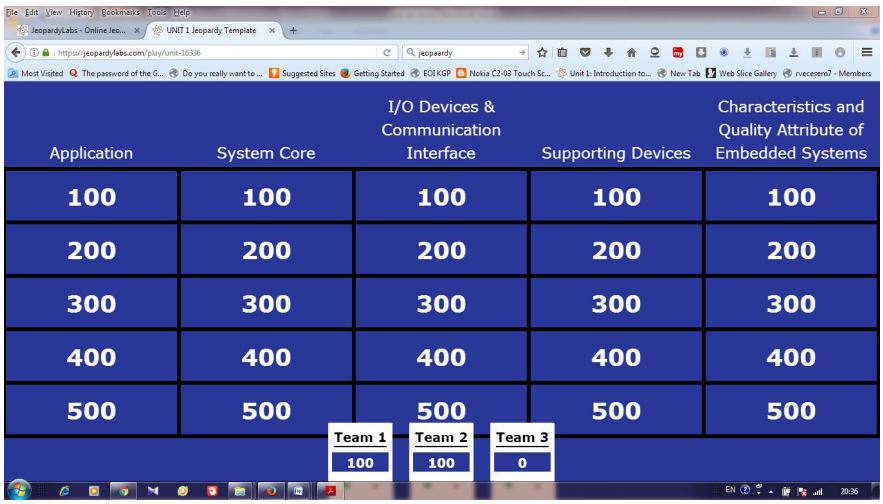

Fig. 3: Jeopardy Lab

Thing Link: ThingLink was developed for Systems block diagram and components were explained using ThingLink tool as shown in Fig. 4.

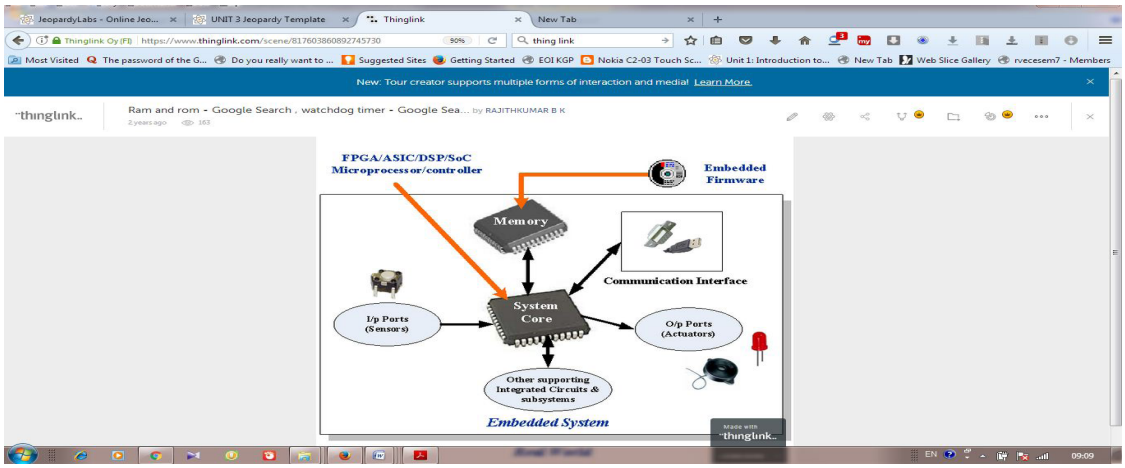

Fig 4: Thing Link

The Course outcome of Microprocessor and Microcontroller for 2019-20 and 2020-21 is shown in table 2.

Table 2 : Course Outcome of Microprocessor and Microcontroller

Sl. No.	Academic Year 2019–2020(in %)	Academic Year 2020–21(in %)
CO1	62.3	69.2
CO2	65.8	74.2
CO3	49.3	57.3
CO4	52.3	64.5

The result analysis shows from Table 1 is the students learnt this course with PBL have 7%, 9%, 8% and 12% improvement

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Conclusion

Project-based learning is student centred pedagogy, it involves a active classroom approach, which it believed that student attain a deeper understanding through dynamic study of real-world challenges. The Students learn about topic by working for extended periods of time to examine and respond to complex question, problem. The Project based learning (PBL) enhance skill and learning capability of students and PBL is very much needed for current engineering education.

References

[1] Doppelt, Y. Implementation and Assessment of Project-Based Learning in a Flexible Environment. *International Journal of Technology and Design Education.*

[2] Barak, M. & Doppelt, Y.: 2000, 'Using Portfolios to Enhance Creative Thinking', *Journal of Technology Studies* 26(2), 16–24.

[3] Gaikwad SS, Baharathi SV. An exploratory study on the application of multiple intelligences to MBA andragogy with particular reference to ERP-controlling configuration course. International. *Journal of Information and Communication Technology Education.* 2018;14:58–71.

[4] Jensen KJ. (2015). A meta-analysis of the effects of problem-and project-based learning on academic achievement in grades 6–12 populations. Education Dissertations. [internet] 2015 Aug [cited 2020 May 28];7.

[5] Angelle S. Project-based and Problem-based Instruction: A Literature Review [dissertation] Western Kentucky University (WKU): Bowling Green, Kentucky; 2018.

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The Influence of Instructional Methods on Critical Thinking: A Comparison of Innovative Learning and Conventional Approach in Education

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ABSTRACT

Critical and creative thinking are closely interconnected and united in developing an effective thinking and problem solving ideas in education and research. But still very less knowledge on the critical thinking is adopted in academics and research. There is a need to implement critical thinking in teaching practices and academic research in order to get better outcome. In the present work, studies made on innovative methods of teaching skills used for innovative learning activities that are to be used to adopt critical thinking in education and research rather than conventional class room education. The few innovative methods considered is namely, design thinking approach, virtual experiments for the academic and research labs, design of innovative experiments and software tools usage. A detailed comparison of innovative learning and conventional learning methods is made. These innovative methods in educational system can further, zero down the gap" in the creative research and teaching practice by creative thinking despite of their limitations.

Keywords: *Academic Research, Critical Thinking, Innovative Learning, Teaching Skills, Classroom Layout*

1 Introduction

Critical thinking in technical education comes in the group of people who acquire knowledge with experience, thought, thorough understanding, innovative thinking and problems solving skills [1]. To produce effective thinking and problem solving capabilities both the critical and creative thinking abilities required [2-3]. Due to change in the teaching practices day by day, adopting critical thinking in teaching the students is key to produce technically strong engineers. Due to this reason, preparing students with good cognitive capabilities like creative and critical thinking capabilities will always at top priority in higher education. Giving knowledge on the critical thinking in the under graduate level and make individual student educated is important [4]. Past evidences suggest that the complex problems can be taught in systematic and simple ways [5]. Therefore, in the developments of learning skills through teaching learning is a innovative way of promoting the students in problem solving through critical thinking ability, virtual experiments and design of innovative experiments. The virtual lab offers the simulation facilities, to use the tools effectively and provides visualization of equipment's, interaction through software platform, learning program languages, feel of reality in experimentation. Experiencing experimental conduction through virtual mode students will be able to repeat the experiments and relearn towards correctness with ease so that their experimental knowledge will improve [6-7].

1.1 Innovative Learning Environments

The novel methods will have excellent implications in knowledge transfer and problem solving capabilities in new situations [8]. Due to need advanced teaching methods there is a trend towards the slight rejection of conventional class room teaching and favouring Innovative Learning Environments (ILEs), which is more dynamic, visually effective that create spaces to open environment for innovative learning [9].

Students are expected to acquire technical skills by experiments conduction through laboratory activities. Students are expected to have practical experience, concepts understanding and equipment operation knowledge along with long-term memory. The existing experiments are to be carried out with the newer technology in order to feel the real experience of the industrial units [10].

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2 Traditional Classroom and Retrofitted ILE Enabled Classroom Layouts

In recent times a traditional classroom or laboratory is retrofitted into ILE to enhance the teaching and learning activities in schools and also in higher education. The nature and limitations of different classroom are presented in sections 2.1 and 2.2.

2.1 The Deficiency of the Traditional Classroom Layout

The survey on student through assessment of data in theoretical, problem based, and practical sessions showed that how student ability to learn and acquiring problem solving skills differed in conventional and ILE classroom. In both between- and within-group analysis of traditional vs ILE on student indicated that such group of students who were come in an ILE mode of learning reported that way teaching was student centric in a way of learning in active environment through group discussion, interactive learning. The analysis indicated the key role of course instructors, able to provide creative teaching skills for the students who were able to explore themselves with affordability of new gadgets for knowledge gain.

Analysis of the data shown that the influence both instructors and students were able to afford the required software and other gadgets in ILE enabled classes for knowledge gain. For such classes, the understanding experiences were of technical higher rubrics assessment of students thoughtful learning along with the emotional attachment in learning engagement. The students underwent ILE based learning compared them with the conventional learning they underwent before and suggested to others that their learning ability was improved. The studies presented here is convincing with the same has been reported by earlier data studies which applied a similar design and methods at this site [11,12,13,14], that build the modern teaching methodologies that make positive impact in higher studies learning skills.

2.2 Innovative Learning Environments Effect on Student

In many countries, the investment is made on the infrastructure of ILEs as one of the necessary, or minimum required level to facilitate the modern education needs [15,16]. There is need to shift from conventional to ILEs and ILEs are better in support from instructors-student centric to student-instructor centric learning. The ILE provides a much larger range of learning skills [17, 18] compared to monotonous single mode of teaching with the more flexibility in teaching and learning.

Studies [17] shows that ILE supports for progressive learning continuously active by individual or group to share idea and learn as well as relearn through activities. Another study [19] proposed that learning environments created by ILE bases classrooms made drastic improvement in class room engagement of learners and thus ILE motivates students in learning.

To understand the potential relationship and how learning and academic environment affected student attitude, the previous studies [20-23] indicated and redefined the quasi-experimental approach in setting academic environment to ILE. The variables inherent in the academic environment setting for higher education are course syllabus, student strength, student background, learning ability. Students improved in the effective utilization and adaptation to technological tools through ILE based activities. Students found alert, active and responsible through their ILE based experiences. But, these studies on few courses were limited within a particular to group of students and not able to eliminate other parameters that affect the ILE.

3. Impact of a Traditional Classroom and a Retrofitted ILE Enabled Classroom

The present study evaluates teaching layouts namely a conventional or formal classroom teaching and a retrofitted ILE class room. Over a particular period of time, among- and between- class groups analysis by comparison and groups are evaluated for student behavioural attitudes in learning and outcome of academic were affected by traditional and ILE class room layout. Therefore the interest of current study is:

- How various classroom layouts teaching affect attitudes of students in their understanding and learning experiences?
- How different classroom teaching models (conventional and retrofitted ILE) affect student attitudes towards their motivation? Comparison and analysis of conventional vs ILE
- To what extent learning outcomes affect student by two layouts, considering their unique higher understanding nature and assessment techniques?

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The study made on two building and each building contained 20 classrooms and each class room had a data projector, boards and network configurations support to connect student digital devices. The conventional classrooms for teaching is as shown in Fig. 1 reflected a traditional arrangement consisted cellular spaces with chairs and desks for fixed seating capacity arranged in rows.

Fig. 1: Photograph of Traditional Classroom Arrangement

The students seating desks are faced towards the teacher teaching position with an arrangement of faculty desk, white board, and data projection at the front side of the room.

The second type of the class room layout was modified into ILE and pictorial arrangement of the class room is shown in Fig. 2. These types of classrooms will be utilised as a combination of existing desks along with new set of furniture and additional boards and modern digital boards with newer technologies to support both teacher and students in order to create and make environment that influence better classroom learning environment.

The main point of this type of class room layout was the multiple front interacting points through creating many instructional points. The multiple instructional points classroom alters the instructional nature due to class arrangement change to encourage learning activities. This way of retrofit to traditional classroom is solution to create different learning experiences and impact on student learning capabilities, interests and academic or research outcomes.

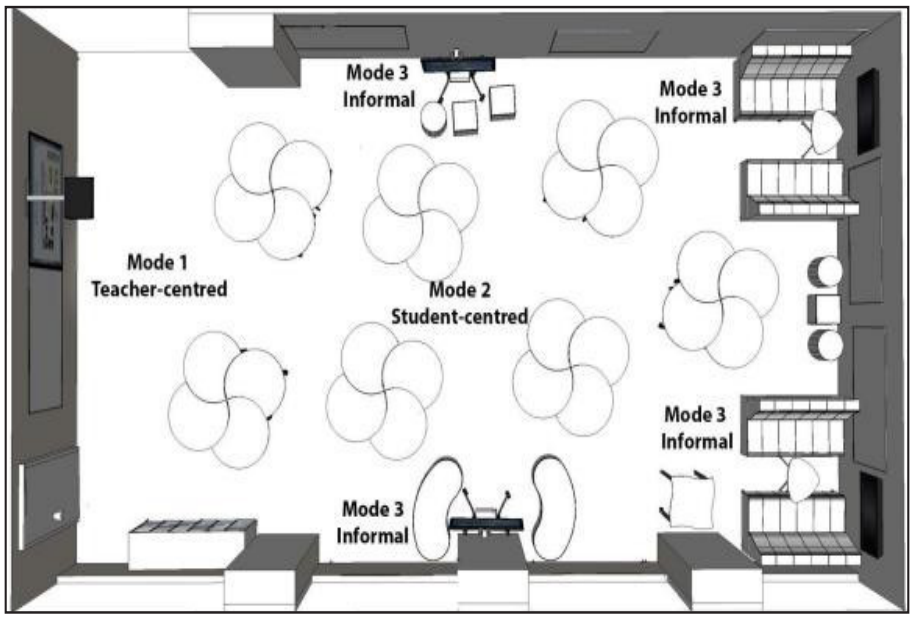

Fig. 2: Schematic of Retrofitted Classroom Layout Arrangement

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The student data included here (n =352) and teachers (n = 9) and encompassed students from 2 classes from year 3 (n = 40), year 2 (n = 40). The overall student participation rate of the study was 64%. These class room layouts were divided as groups based on time table as shown in Table 1.

Table 1: Summary of the Sample Size and Participation

Study Group	Sample Size			Participation Percentage		
	Year 2	Year 3	Year 4	Year 2	Year 3	Year 4
ILE Intervention (IN)	39	42	33	69	74	68
ILE Control (ILC)	39	40	28	67	66	56
Traditional (T)	39	26	24	59	58	53

The ILE intervention group denoted as "IN" focuses the effect of class room layouts of conventional and ILE enabled types by comparative analysis of student learning for the group that attndeded the classes in particular classroom layouts. The ILE control group in the Table 1 is denoted as "IC" as shown in the bracket and this group spent complete one semester in class room. The other set of the students stayed in the class room with conventional teaching environment and this set of group is traditional group and denoted as "T" for entire semester.

From these set of groups, it was observed that the different set of class room layout provides the positive approach in learning and significant effects on teaching learning activities that affected the student learning skills, creativity and active engagement in class sessions. In ILE group, a set of students identified exhibited wider range of software related creative active learning and collaborative skills than that group who were in traditional group. However the ILE group was not changed only because of the classroom environment but also there learning ability in adapting to newer technology was observed and they many factors play a role as these groups themselves were not agents for complete change.

Lab related activities in academic environment plays a major role in creative and critical learning in technical courses. Laboratories conducted with the critical thinking in the conduction and evaluation of the particular experiment creates interest in learning by enhancing the creating the thinking ability of the both teacher and students in the laboratory courses in the design of experiments. The lab was conducted in a conventional mode for two group of student and comparative analysis is made through assessments. The results indicated that the average values of creative thinking ability of the students in that lab not shown average difference.

Virtual lab along with conventional lab experiences will improve students learning motivation in labs, students understanding in the experimental conduction and learning motivation. Because modern generation prefer convenience in learning and ease of accessing and for this reason virtual labs gaining more attention in learning the academic and research. As compared the virtual way of learning the conventional learning needed significant time to complete the tasks and assisting the students in learning activities. In academics the virtual labs will be able play major role in experimental conduction, analysis, visual understanding of concept and refine the modern curriculum in digital learning based subjects.

Conclusions

In the present work the two different classroom layouts that influence the learning activity of the students are considered. By taking into account of class groups, cognitive ability and teaching skills different classroom layouts influenced the student grades in the courses taught. Students who were in the ILE group have tended to perform better as compared to conventional set. This study is conducted for small group of students who have acquired almost same technical ability and it is required to conduct such type of study for large group with different regional back ground. The virtual lab will help in enhancing the student creative thinking and critical thinking with wasting much time in travel and conduction. However technical skill and course knowledge and practical knowledge plays major role along the virtual learning. Therefore in education system virtual labs need to use to improve better learning and quality teaching along with conventional mode of exercises.

References

[1] P A Facione, Critical thinking: a Statement of Expert Consensus for Purposes of Educational Assessment and Instruction, *The Delphi Rep*, 1–19. 1990.

ISBN: 978-93-91355-21-0 (e-Book)

[2] S Bailin, Critical and Creative Thinking, *Informal Logic*, 9 (1), 23–30, 1987.

[3] S. P. Norris, "Synthesis of research on critical thinking," *Educational Leadership*, Vol. 42, no. 8, pp. 40–45, 1985.

[4] L Jianzeng, L Yanbao, C Yi, W Wenxian, Evaluating creative thinking of students and creativity development at southeast University, China, ASEE Proce Frontrs in Edn, 2(4), 223-248, 1997.

[5] R K Scheckler, Virtual labs: a substitute for traditional labs?, Int J. Dev Biol, 47(1), 231- 236, 2003.

[6] Z Tatli, A Ayas, Effect of a virtual chemistry laboratory on students' achievement,
Edu. technol soc, 16, 159-170, 2013.

[7] T Garcia, R Pintrich, Critical thinking and its relationship to motivation, learning strategies, and classroom experience, Report of the Annual Meeting of the American Psychological Association, American Psychological Association, Seattle, Wash, USA, 1992.

[8] L Benade, Is the classroom obsolete in the twenty-first century?. Educ Philos Theory, 2016. https://doi:10.1080/00131857.2016.1269631

[9] C Tüysüz, The effect of the virtual laboratory on students achievement and attitude in chemistry, Int Online J. Educ Sci, 2, 37-53, 2010.

[10] Byers T (2017). What does teaching and learning look like in different classroom environments? Educ Philos Theory, 4, 130-142, 2017.

[11] Byers T, Hartnell-Young E, Imms W, (2018). Empirical evaluation of different classroom spaces on student perceptions of the use and effectiveness of 1 to 1 technology, Br. J. Educ. Technol. Indexing, 49(1), 153–164, 2018.

[12] Byers T, Imms W, Making the space for space: The effect of the classroom layout on teacher and student usage and perception of one-to-one technology, Paper presented at the 26th Australian Computers in Education Conference, Adelaide in 2014.

[13] Byers T, Imms W, Evaluating the change in space in a technology enabled primary years setting, The translation design of schools: An evidence based approach to aligning pedagogy and learning environment design, In K. Fisher, 1, 215-236, 2016.

[14] Dovey K, Fisher K, (2014). Designing for adaptation: The school as socio-spatial assemblage, J. Archit., 19(1), 43-63, 2014.

[15] Mulcahy D, Morrison C, Re-assembling, innovative learning environments: Affective practice and its politics, Educ Philos Theory, 2017, https://doi:10.1080/00131857.2016.1278354

[16] J South, B Blass, The future of modern genomics, Blackwell, London, ISSN, Edition, 2017.

[17] Dumont H, Istance D, Analysing and designing learning environments for the 21st century,
CERI, 2010, https://doi.org/10.1787/9789264086487-3-en

[18] Mulcahy D, Policy matters: de/re/territorialising spaces of learning in Victorian government schools, J Educ. Policy, 31(1), 81-97, 2016.

[19] Ryan A M, Patrick H, The classroom social environment and changes in adolescents motivation and engagement during middle school. Am Educ Res J, 38(2), 437-460, 2001.

[20] Byers T, What does teaching and learning look like in different classroom environments?,
Am Educ Res J, 28(3), 437-460, 2017.

[21] Byers T, Hartnell-Young E, Imms W, Empirical evaluation of different classroom spaces on student perceptions of the use and effectiveness of 1 to 1 technology, Br J Educ Technol, 49(1), 153–164, 2018.

[22] Byers T, Imms W, Making the space for space: The effect of the classroom layout on teacher and student usage and perception of one-to-one technology. Paper presented at the 26th Australian Computers in Education Conference, Adelaide, 2014

[23] Imms W, Byers T, Impact of classroom design on teacher pedagogy and student engagement and performance in mathematics, Learn Environ Res, 19(2), 1-14, 2016.

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Emphasize Critical Thinking on Engineering Students using Think-Pair-Share Technique

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ABSTRACT

In the 21st Century, proactive students are entering to the higher education. To engage and hold their concentration in the class is not that easy. In this scenario, Implementation of Andragogy strategies such as predict-observe-explain, peer instruction and Think-Pair-Share [TPS] techniques are required. The author focuses on TPS Teaching learning Strategy. This process allows the students to think individually, then pair up to share and discuss their thoughts with entire class pertaining to the given problem. This method not only improves the interest and motivation matrix but also enhances the learning capability with critical thinking. This technique has been implemented for one of the Undergraduate courses, "Real Time Operating System". The comparison is done based on student's grades with and without TPS. The result analysis provides a promising sign to use this method in Engineering Education.

Keywords: *Think-Pair-Share, Andragogy, Active Learning, Critical Thinking*

1. Introduction

Teaching and learning are impossible without critical thinking. Knowledge is not only "handed over" or "consumed" in the latter instances. I disagree with the notion that empty vessels should be filled in any learning scenario. Learners should, rather than having their head in the sand, ask questions, challenge assumptions, apply their learning to resolve problems, think carefully about their actions, and utilise many sources of information. Meyer (1986, cited in Jones & Safrait 1994) said it well when he exclaimed, "Learners cannot be simple sponges absorbing the 'knowledge' of a teacher's lecture." Instead, they need to address subjects head-on and use critical thinking in their practise.

According to Jones and Safrait (1994), self-directed learning is fostered by promoting independence in thinking, assessing, and acting in an information society. Considering the fact that we are continuously inundated with information from many sources, social media being one of the most important, I think this is really important. Many people fail to verify the authenticity of claims and reports, and they fail to analyse them in-depth. An further factor is that when others repeat the same error, the situation compounds. However, without personal awareness of the need to study, develop such abilities, and think critically, nothing can be done.

The term pedagogy is one that most of us are familiar with; it refers to the art or science of teaching. Another more precise term is andragogy, which refers to the art or science of adult education. Adults and children learn in very different ways. While much of learning design is focused on creating effective learning experiences for young minds, as the need for reskilling and cross-skilling continues to grow in popularity across industries, exponentially increasing the number of adult learners, learning and instructional designers have been focusing on creating learning experiences tailored to adult learners. This is when andragogy enters the picture.

The theory of adult learning was developed by Malcom Shepherd Shepherd Knowles in the 1980s, and it is based on the idea that as people mature, they become less dependant on others and more self-sufficient. It is predicated on the premise that as a person matures, they have an inclination to acquire knowledge that will assist them in fulfilling existing societal roles.

Think-Pair-Share is an active learning approach meant to enable all students in a classroom to think and discuss about their ideas (Lyman, 1981). The thinking-pair-share was originally proposed in 1981 by Professor Frank Lyman and has been widely promoted by the university as an excellent active learning technique for over 20 years (Sherman, 1991; Cavender and Rutter, 1997; Allen and Tanner, 2002; Tanner, 2009, 2013). When a thought-pair-

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share is used, a teacher asks pupils to think individually about the question and typically encourages them to write down their thoughts.

Then students couple themselves with another student or a small group and discuss the issue. Finally, the teacher invites several students to discuss their opinions with the entire class. To allow the students by asking them to think quietly or scribble their thoughts down on a sheet of paper. Allow all children to speak by having them share their responses/responses and thoughts in a pair or small group conversation with a teacher, classmate, or neighbour. Allow a selected student to share with the entire class by asked them to share what they discussed in their pairs/groups. The thinking and pairing of the think-pair-sharing seems to be very essential in boosting student engagement and learning. Taking time to think about the issue independently improves the complexity of the answers and increases the willingness of students to share their ideas with others (Rowe, 1972; reviewed in Allen and Tanner, 2002). And having students pair up and talk to others offers kids an opportunity to remember, absorb, practise and share what they have learned in a low-stakes context (reviewed in Tanner, 2009). The advantages of the share of this active learning technique are, however, little less evident.

2. Related Work

Hetika, H., *et.al.* [1] proposed, this research is to learn the use of the Think Pair Share (TPS) learning method in the field of Accounting I of Politeknik Harapan Bersama's accounting students. The data gathering method in this study followed the procedure for observation, testing and documenting. The analytical method included qualitative and quantitative descriptive analysis method. The results suggest that the TPS method improves the motivation and achievement of learning.

Ahmad Hamdan [2] did a semi-experimental study in the study consists of (120) students from a third grading student in the Irbid Educational District. The study recommended the (Think–Pair–Share) strategic development within student teaching strategies and the participation of teachers in training courses.

Kaddoura et.al [3] proposed Students' ability to think critically has helped them become better prepared to provide effective and safe patient care. To help students enhance their response quality, think-pair-share is a discussion method that provides them time to reflect before speaking. After 17 weeks of using the TPS teaching/learning technique, findings indicated a significant rise in CT. Educators, nurses, and researchers should take note of the findings.

Florence Karura [4] researchers in Kenya's Nakuru County investigated the motivation and achievement of children using the Think-Pair-Share (TPS) method. Four weeks of conventional instruction followed by four weeks of TPS instruction followed by four weeks of TPS instruction has been used to teach CRE in the experimental groups. The study's findings revealed that TPS enhances CRE performance. Furthermore, the results suggest that pupils' gender has no bearing on their performance.

3. Proposed Model

3.1 The Course Selected for Think Pair Share is Real Time Operating Systems

Proposed Model is with respect to Real Time Operating System (RTOS). The course learning objectives of the course summarizes to develop an understanding of real-time concepts such as semaphores, mutexes, threads, processes, and priorities, and combine them with a command set that can be utilised to operate comfortably in this virtual world. Acquire expertise in the administration of real time memory and master the art of combining commands to perform complex operations.

Real time operating systems course involves the basic skills of data structures for the scheduler are needed. Depending on the technique used to plan processes, several data structures are employed. The most popular round tap algorithm is a queue (FIFO). It also invokes threading and fork/exec, which are not truly dependent on data structure but use a large amount of "sync" programming. Understanding the fundamentals behind resources will be very important for producer consumer problems (live locking, blocking).

In building and constructing the course and curriculum; it is vital to prioritise and to promote the skills needed for performing real time activities. Experience, training, and practise improve skills. skills, such as 'the ability to recognise weaknesses in systems,' would need testing and error and would be used to create skills in high order thinking activities. In a classroom context, analytic, project management capabilities and other soft skills that are

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also necessary for operating systems employment can be promoted through student-to-student interactive, practical activities and real-world examples.

Promoting meaningful relationships and allowing students to engage in high-quality thought activities have been highlighted as crucial to increasing academic success. Many instructors have begun to combine different educational tactics and technologies in the last few years to enhance interaction, student involvement and learning activities that can assist promote a range of abilities in the classroom. Active learning is one of the most popular education strategies for scholars and educators over the years.

Active learning is a teaching strategy that encourages students to take an active role in their education. In order for students to be successful, they must actively participate in higher-level thinking processes including analysis, synthesis and assessment. Students typically work in pairs or small groups on tasks that require them to reflect on and review what they have learned. Students actively participate in the learning process rather than just listening to lectures. They do this by analysing, discussing, and reflecting on the material they are learning. These actions can take various shapes.

Students might be grouped in a small group before starting a new topic together to solve an issue. A quick lesson can help to address the issues that the teachers have observed while addressing problems. At the end of a course, students might work with pairs in short writings or programming projects and then share their views with the class. You can also complete banks of questions and tutorials.

Active learning occurs both inside and beyond the classroom. Students can collaborate outside of class hours and subsequently present their work to the class or publish it on a wiki or other learning platforms. Simply put, when students have the opportunity to "think about what they do", they learn more.

The course was piloted with students at the RV College of Engineering in Bengaluru in 2020 and again in 2021 as an online synchronous course. It was a four-credit course with 42 hours of classroom instruction. The 2020 session lasted 12 weeks. The proposed model implemented for the course is as depicted in Figure 1.

The class met for 60 minutes four times a week. 38 students in 2020, 36 in 2021. Students in both programmes took at least two computer programming courses. A pre-assessment survey revealed that 80% of students had no prior knowledge of operating systems.

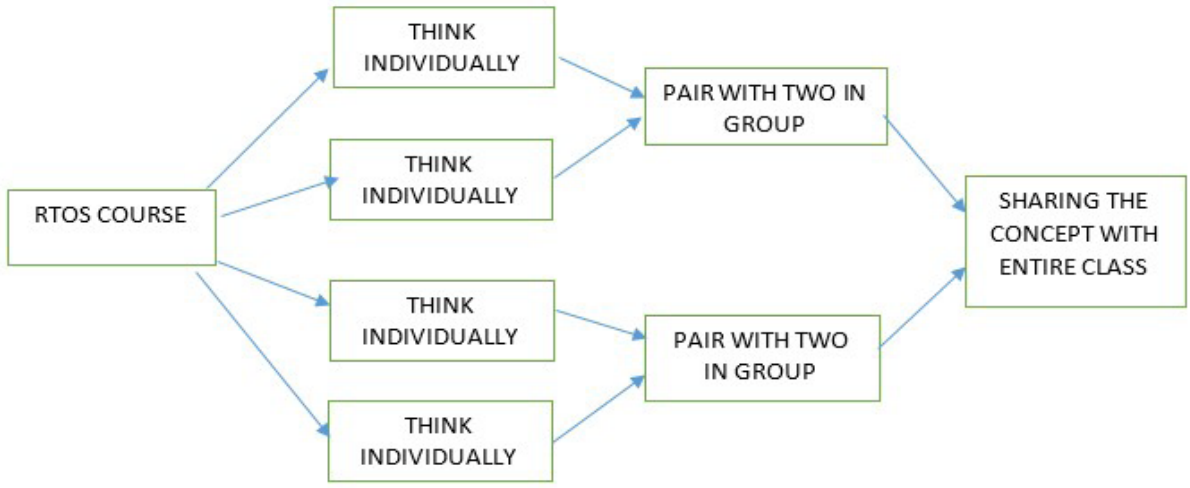

Fig. 1: The Proposed Model Implemented for the Course

3.2 Strategies for Teaching

The classes included lectures, demonstrations, and active learning assignments. It was largely collected and referenced by Google Classroom resources for the classroom.

The lesson usually starts with a 5-minute description of the day's expectations and aims. Instructors demonstrated concepts on (1) risk detection, (2) threat execution, (3) vulnerability removal, and (4) risk mitigation. Then they would actively learn, reflect, and practise what they had learned. The course used active learning methods

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with excellent students. Analytical, problem-solving, and other soft skills may be cultivated. The lesson usually ended with important pickups and student feedback. The course examines students' performance and knowledge using homework assignments, quizzes, and class activities. The next section details the course's active learning activities.

4 Result Analysis

The active learning technique involved a team of two students to indulge in activity and real-world case studies introduced students to key field topics including operating system drawbacks, implementation, case studies in Real-world scenarios assist students to comprehend the importance of the subjects of the course. In contrast to a standard teaching style, students actually "thought" about the events and the repercussions. In the discussion, the instructor played the role of facilitator. Table 1.1. and 1.2 and 1.3 are the analysis for the students done.

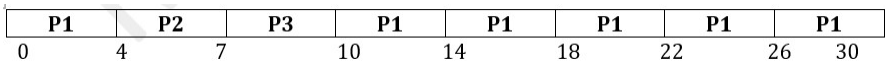
Scheduling using Round Robin (RR) is a preemptive algorithm that relates processes based on how long they have been waiting. There are many advantages to using this algorithm, including its age, simplicity, and wide applicability.

To provide acceptable decent response times and to share the system fairly among all system users, round robin scheduling algorithms are commonly employed in time-sharing and multi-user systems. CPU time is divided into time slices, essentially. There is a limited amount of time allotted to each step, referred to as the quantum.

While other processes are in the ready queue, no process can execute for more than one quantum at a time. When a process runs out of CPU time after using up a quantum of resources, it is moved to the end of the ready queue where it waits for the next allocation to be made available. The Queue of Ready procedure is used to implement RR scheduling using a Queue data structure. At the end of the Queue is a new procedure. For a given period of time, the CPU scheduler allocates a processor to the first process in the ready queue. After that, the CPU scheduler will decide which process is next in line for the ready Queue and assign it to the CPU. Using the milliseconds as a unit of time, consider the following series of operations.

Process Time P1: 24 P2: 3 P3: 3 P4: 3.

Process PI gets the first 4 milliseconds if we use a time quantum of 4 milliseconds. Quantum is pre-empted after the first time because it needs another 20 milliseconds, and the CPU is given to Process P2, the next process in line. Process P2 terminates early since it does not require and milliseconds. Following this, the CPU is handed over to Process P3 for another time quantum before being returned to Process P1 for another time quantum. The Gantt chart will look somewhat like this:



Completed Time	Process Completed	Turnaround Time = t (Process submitted)	Waitting Time= Turnround Time - Processing Time
0	-	-	-
30	P1	30 - 0 = 30	30 - 24 = 6
7	P2	7 - 0 = 7	7 - 3 = 4
10	P3	10 - 0 = 10	10 - 3 = 7

4.1 Think-Pair-Share

After the course information was presented, various activities were carried out. First, pupils work alone and "think" about how to tackle the problems. In order to develop collaboration, critical thought and communication skills, they were then 'matched' with another student. Teachers would then ask some of the students, which stimulates debate and a meaningful approach to a joint conclusion, to share their review.

Table 1.1: With Respect to Grade

Academic Year	No. of Students
2020 (WTPS)	38
2021 (TPS)	36

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Table 1.2: With Respect to Grade

No. of Students	S	A	B	C
TPS	3	17	15	1
WTPS	1	15	15	5

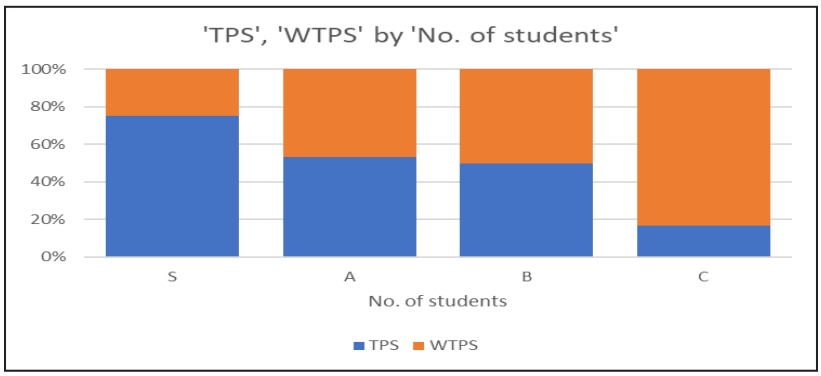

Fig. 1.2: Results of Improvement Shown with TPS and WTPS

Table 1.3: With Respect to CO% Attainment

	TPS	WTPS
CO1	80%	72%
CO2	86%	77%
CO3	83%	73%
CO4	87%	70%

The ability to demonstrate progress toward the course outcome will be enhanced by utilising the TPS andragogy technique. To get the most out of the think-pair-share activity, prepare ahead of time. Before creating an activity, the instructor should know what the students will learn from it. Therefore, a backward design is beneficial when developing questions for think-pair-share, in order to support the desired learning goal through the questions they support. Unless follow-up summative assessments incorporate prompts from the think-pair-share activity, the think-pair-share technique may not be the optimal way if the learning aim is just to have students obtain basic, factual information for them. Questions with multiple possible answers are the most conducive to in-depth debate. There should be a balance between the topic and the focus of the conversation questions used in think-pair-share activities.

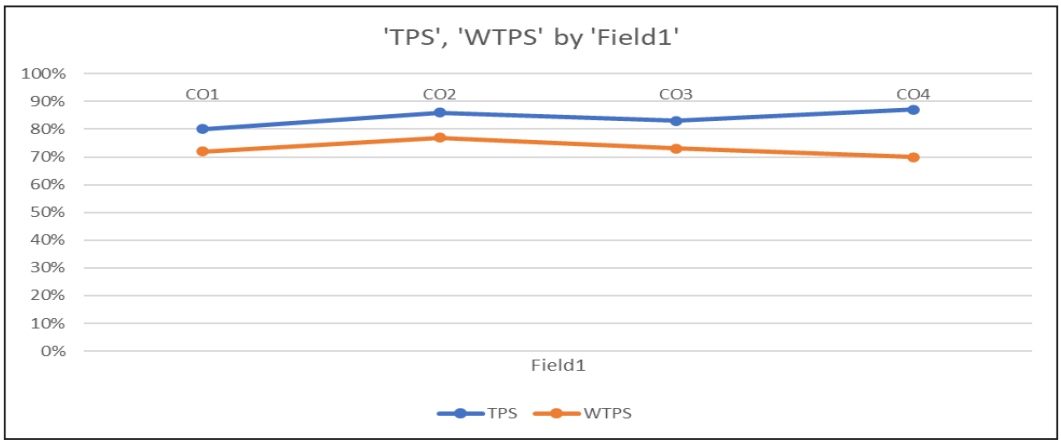

Fig 1.3: Strategy of Improvement Shown with TPS and WTPS

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Conclusion

Active learning was the appropriate method for delivering a real-time operating systems education. We used class activities to connect course information to application, feedback, and reflection. Active learning helped students build transferable skills like communication, problem-solving, threat detection and prevention, and software penetration testing. Active learning encourages deeper proficiency and engagement by allowing students to grow and refine their skills. This course taught students the value of ongoing real-time system case studies in addressing important priorities and improving operating system knowledge.

Limited by low enrolment and the COVID-19 epidemic's possible impact on students' learning experiences, more study is needed on the effectiveness of active learning in higher education.

References

[1] Hetika, H., Farida, I., & Sari, Y. P. (2017, December 1). Think Pair Share (TPS) As Method To Improve Students Learning Motivation And Learning Achievement | Hetika | Dinamika Pendidikan. Think Pair Share (TPS) as Method to Improve Students Learning Motivation and Learning Achievement | Hetika | Dinamika Pendidikan. https://journal.unnes.ac.id/nju/index.php/DP/article/view/13561.

[2] Ahmad Hamdan, R. K. (n.d.). ERIC - EJ1139082 - The Effect of (Think-Pair-Share) Strategy On the Achievement Of Third Grade Student In Sciences In the Educational District of Irbid, Journal of Education And Practice, 2017. ERIC - EJ1139082 - The Effect of (Think-Pair-Share) Strategy on the Achievement of Third Grade Student in Sciences in the Educational District of Irbid, *Journal of Education and Practice,* 2017. https://eric.ed.gov/?id=EJ1139082.

[3] Kaddoura, M. (n.d.). ERIC - EJ1061947 - Think Pair Share: A Teaching Learning Strategy To Enhance Students' Critical Thinking, Educational Research Quarterly, 2013-Jun. ERIC - EJ1061947 - Think Pair Share: A Teaching Learning Strategy to Enhance Students' Critical Thinking, Educational Research Quarterly, 2013-Jun. https://eric.ed.gov/?id=EJ1061947.

[4] Florence Karura, Dr. Esther Kimosop, Dr. William Orora, "Effect of Think-Pair-Share Strategy on student achievement and motivation in C.R.E", IOSR Journal of Humanities And Social Science (IOSR-JHSS) Volume 26, Issue 3, Series 10 (March. 2021) 25-33 e-ISSN: 2279-0837, p-ISSN: 2279-0845.

[5] Awid, Faleh Abdal_husn; and Abood, Suhad, Abdul Ameer. (2014). the effect of (Think-pair-share) strategy on the students' achievement and the improvement of students' attitude toward chemistry, Journal of alfatih.10 (58) 149–168.

[6] https://www.wgu.edu/heyteach/article/how-think-pair-share-activity-can-improve-your-classroom-discussions1704.html

[7] https://www.adlit.org/in-the-classroom/strategies/think-pair-share

[8] https://teaching.utoronto.ca/teaching-support/active-learning-pedagogies/active-learning-adapting-techniques/think-pair-share/

[9] Chen-Hong Li, Min-Hua Wu & Wen-Ling Lin (2019) The Use of a "Think-Pair-Share" Brainstorming Advance Organizer to Prepare Learners to Listen in the L2 Classroom, International Journal of Listening, 33:2, 114-127, DOI: 10.1080/10904018.2017.1394193

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Strategies for Enhancing Critical Thinking of 21st Century Learners

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ABSTRACT

Critical thinking develops intellectual abilities rather than technical or professional skills and gives potential for exponential thinking. It helps in the development of both parts of the brain i.e creative and analytical. Enhancement of critical thinking in engineering education creates a perfect environment for aspiring engineers. The potential to analyze complex problems, examine different techniques, and design solutions requires the skills of critical thinking. Musicians and artists are born with the finest sense of imagination. It's easy to teach artists how to use software and graphics tools, but it's far more difficult to turn engineers into artists. Visualization in education encourages students to view the world from various perspectives. If anyone says academics and sports don't go together the best answer to this is Anna Kiesenhofer, who won the Olympic-2021 gold medal in cycling. She has completed her PhD in mathematics and is currently pursuing her post doctorate in France. Not only sports, even arts, logic can be related. It is beneficial to understand the relationship of critical thinking with academics. In this study, certain techniques are discussed related to puzzle solving, problem based learning, design thinking, image analysis and experiential learning which enhances critical thinking and the real world problem solving capabilities.

Keywords: *Critical Thinking, Higher Education, Lifelong Learning, Problem Based Learning, Experiential Learning*

1. Introduction

Critical thinking [1] is the ability to check information rationally and make reasonable judgments based on your analysis. Critical thinkers refuse to accept problems as it is and are aware of their cognitive biases so that they can draw objective conclusions. Higher-order thinking skills, such as critical thinking, allow us to actively learn rather than passively absorb the information presented.

It is no longer adequate to specialize on a particular topic of engineering in this age of globalization [2], students must become scholars. They must broaden their abilities and carve themselves a niche in the engineering industry. Engineers who work for international corporations need more than just technical skills to succeed. Even the creation of a small product necessitates a diverse set of talents, including design thinking to better understand and improve the user experience, interpersonal skills to better understand end customers, and adaptability and problem-solving skills, which are critical for products.

All of these key skills are rarely included in engineering courses. Without such capabilities, modern engineers are doomed to fail. Our students should master the skills needed to succeed in the modern workplace. A novel strategy is required that provides a holistic engineering approach. Holistic education must be adapted in the modern curriculum.

Need to create a perfect combination of science, technology, engineering and mathematics (STEM)and general education. All organizations seeking to shape "modern" engineers need a comprehensive education model.

Because novelty is at the forefront of all industries, it is necessary to establish equilibrium between technical expertise and social abilities. Key talents such as innovation, interpersonal skills, management, inquisitiveness, critical thinking and collaboration must be developed through educational institutions. Students can get essential abilities to investigate numerous academic subjects while establishing interdisciplinary views of human experience from multiple viewpoints by incorporating liberal arts courses into engineering curricula. This will go beyond technical education's boundaries, resulting in individuals who contribute to society and become life-long learners.

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A well-trained critical thinker[3] raises important concerns and issues by stating them concisely and specifically, collects and evaluates important data, applies abstract ideas to effectively understand, and arrives at ingenious conclusions that are then tested against applicable criteria and standards.

Liberal arts involve different types of thinking that are difficult to measure, but are implicit for critical thinking. Although logic and linear thinking are easy to measure, they are only one aspect of critical thinking. Creativity, innovation and inspiration, as well as the ability to look at things as a whole (Holistic thinking) are the qualities of a good thinker. They are difficult to measure, but they are an integral part of liberal arts training. Logic and linear thinking will help to improve existing skills, whereas Innovative thinking helps to discover new things.

The study of liberal arts allows broadening new horizons and looking at careers beyond consideration. Critical thinking skills may be the most basic skills for making judgments and solving problems that can be continuously improved.

The following section describes various impactful ways of promoting critical thinking skills.

2. Techniques to Promote Critical Thinking

2.1 Puzzle Solving

To shape the minds of higher education students, the teaching and learning processes are designed to incorporate diverse, intuitive, imaginative approaches and unravel the hidden creative ideas [4]. Puzzles are classified into different categories such as logical, visual, numerical, mechanical and verbal puzzles. Puzzles are not only entertaining but also educational, engaging, thought provoking problem-solving ideas [5]. Reasoning involved in solving puzzles is the key concepts in computer science [6]. To understand concepts in STEM puzzles are used [7]. Sometimes puzzles help to solve real life problems and vice versa. One such example is the Königsberg bridge problem. An old puzzle to find a path over every one of seven bridges without crossing any bridge twice, that spread over a river flowing past an island. Euler solved the solution to the Konigsberg bridge problem. Euler addressed both the specific and generic solution.

There are four areas of the town labelled as A, B, C and D - on the mainland north and south of the river along with on the island and on the peninsula as shown in fig 1

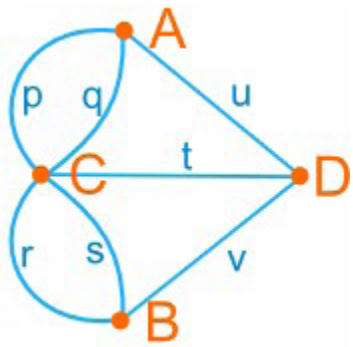

Fig. 1: Konigsberg Bridge Problem Represented as Graph

In Fig. 1 it is observed that the long walks through the town can be drawn using lines by pencil. This is the famous puzzle "for drawing each line p, q, r, s, t, u and v only one time, without lifting the pencil from the paper (starting point can be any point on the graph)". This gave birth to Graph Theory, a subdivision of mathematics. Ideas based on graph theory are extensively used by computer science applications. For example a tree is represented as a combination of vertices and edges to represent data structure, traveling salesman problems, database design concepts, resource networking. Using graph concept network topologies are modeled. One of the most important concepts of graph coloring is used in resource allocation. This pushed for the development of new algorithms required in many applications.

Graph theoretical concepts are used to study different applications. Few such areas are study of chemical molecules, formation of bonds, study of nature of atoms, Sociology, Biology, Operations Research, Modeling transport networks, activity networks, games and Computational biochemistry.

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2.2 *Experiential Learning*

With the increasing competition of technological development, there is a need for a skilled worker. Industries can increase their productivity and quality of product with the right skills of employees. Employers are expecting soft and hard skills from their employees to carry out complex tasks dynamically. Skilled employees for industries are essential as it influences the nation's economic growth. Developing skilled workers can be done by upgrading the standards of the existing education system through experiential learning, as it is a crucial indicator for the development of the nation through industrial development [8]. "Knowledge is created through the transformation of experience" is the concept of experiential learning theory [9]. Universities, educational institutions adopt different teaching learning methods to enhance the learning outcomes. Few of these methods are collaborative, experiential, project/problem/active based learning. In all these approaches the focus is on students to make the education system more student centric [10]. The six propositions[11] under theory of experiential learning are given below:

1. Process of learning is accompanied by feedback
2. Learning always includes relearning and it is challenged/verified with new ideas
3. Learning process continuity is done by resolving issues and misconceptions
4. Learning is adopted by a particular way (thinking or feeling or perceiving etc.)
5. Learning happens by adding new knowledge to existing knowledge and vice versa
6. New knowledge is created by learners

In experiential learning theory, the two type of learning experience are Concrete Experience (CE) and Abstract Conceptualization (AC). The two types of transforming experience are Reflective Observation (RO) and Active Experimentation (AE). Concrete experience leads to reflective observation and covert reflections to abstract concepts from which new ideas are generated for new experience [12]. In online classes, experiential learning is incorporated to enhance skills and competences, which act as a bridge between experience and communication technologies [13-14].

To develop meaningful learning for 1st year engineering students the learning ways adopted at RV College of Engineering, Bengaluru are video based seminar, virtual experiments, industrial problem solving, survey on a topic, literature review, e-poster presentation, open ended experiments, use of software tools, physical experimentation and innovative methods. Verification of critical thinking in assessment is carried out using proper rubrics. The five different skills needed to be considered for evaluation of critical thinking skills are observation, analysis, interference, communication and problem solving. Higher education system is focused on bringing development to the nation by inculcating knowledge and skills student's minds to make them valuable resources. Several transformations towards this have taken place in the educational system. Challenges could be addressed in adopting experiential learning techniques through brainstorming and right implementation by the institutions. Qualitatively [15] it is observed that students need a paradigm shift from the traditional system to 21st century learning space that fosters critical thinking.

2.3 *Image Analysis (IA)*

Image/picture analysis are more impactful than text, more memorable and more engaging [16]. To help lifelong learners, inspiring critical thinking skills in relation to visuals has become a major educational commitment. The current global context, with its continual shifts in knowledge, necessitates the development of a new educational paradigm. In the twenty-first century [17], where ideas are mostly transmitted through images, there is a desire for fresh goals and methodologies in visual arts education.

Fig. 2: Source: https://www.123rf.com/photo_113639422_hands-holding-plants-with-dirt.html

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Looking at the picture in Fig. 2, people can interpret it in different perspectives as each one's point is different. Some of the inferences are highlighted:

1. "Our planet's ecological future is in the hands of children all over the world."
2. "For the benefit of the children of the globe, humanity must be cognizant of our planet's ecological future."

Inferring from the image, varies from person to person, and it's very perplexing to write the implication of the picture in one sentence, but the steps below will not only help to write the inference precisely but also develop/write short analysis essays from images.

Steps for image analysis: [18]

Step 1: Spot/ identify the Components.

Step 2: Identify Symbols and Connections need to comprehend what the author or artist is trying to portray when analyzing an image. Locate Relationships and Connections.

Step 3: Develop the Thesis. The main objective in this step is to construct an argument that will support in writing the essay. Goal of writing a visual analysis is determining the image's inner meaning and revealing it to the reader. The picture could be interpreted in a number of ways.

Step 4: Complete the Thesis Statement.

Step 5: Compose Your Essay's Body.

Step 6: Write an introduction and a conclusion to your paper. Conclusion should be a concise restatement of the main points. end the essay in a variety of ways, but this is the most fundamental and efficient method.

2.4 Design Thinking (DT)

It's a process of creative problem solving and a human-centered approach to innovation that combines people's needs, technology possibilities, and commercial success requirements using the designer's toolkit. Decisions are made based on what customers require, rather than on past facts or intuition. The difference between science and engineering is oversimplified. It is necessary to comprehend. One needs to understand the world to solve problems and build new things, hence science and engineering are symbiotic twins. Science and technology are built on three pillars:

- Invention
- Creativity
- Innovation

Creativity: The act of transforming new and innovative thoughts into reality. Strong drive to solve a problem in a new and better way.

Invention: Inventing a fresh concept or idea.

Innovation: Turning a new notion into a commercial success or widespread use is what innovation is all about. For instance: Wheel is the invention whereas the car or jeep is the innovation.

DT is a trans- disciplinary framework for thinking about difficult problems that can be applied to almost anything. It isn't limited to art or technology. Design thinking has five phases-empathy, define problem (Point of View), ideation, prototyping and validation. At RVCE, DT is practiced for 2nd year students. Students are given the themes. Students need to identify the problem, identify the stakeholders and empathize with them physically or online. After empathizing, they draw the empathy maps depicting persona's likes, dislikes, gains/pain points etc.

Next, they have to formulate the problem i.e., point of view (POV) and also frame the how might we questions.

The next is Ideation stage, where students write different ideas, then classify these ideas and pick out the best ideas and they need to work on these ideas. They can use tools like mind map, storyboard, scamper, know how wow matrix etc.

Prototype: It is the culmination of all previous techniques and ideas. Is the process of putting ideas to the test and making quick changes to meet the needs of our consumers?

Testing: is the process of gathering user input for the prototype in order to obtain a better knowledge of the users. The testing stage of a project can feed into almost every stage of the Design Thinking's main goal is to instill creative confidence in people. Rather than simply absorbing information in a classroom, it is critical to use it in our daily lives in order to make a difference. Despite possessing a wealth of knowledge, it becomes evident early on in

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the journey that application can be a time-consuming process. Design Thinking is not just a benchmark for future projects, is a tool for capturing practical information with societal concerns.

2.5 Problem Based Learning (PBL)

PBL is a teaching style in which students participate actively in real-world projects. PBL encourages students to think critically, reflect, and share their knowledge. This inspires students and teaches them how to ask the suitable questions in order to tackle complex situations. PBL is a teaching method in which students learn through doing [19]. Students should be questioned on how they can apply what was learnt in class -to a new situation and other class projects.

Steps to be followed for practicing PBL

Step 1: Determine the desired learning outcomes,

Step 2: Create the Scenario — that includes an embedded problem that is a real, complex issue relevant to the course material. Scenarios should be motivational, engaging, and spark lively debate. Create a scenario that will test different forms of thinking and prompt the necessary discussion, investigation, and learning to accomplish the learning objectives,

Step 3: Incorporate PBL – Allowing them to practice with an "easy problem" will help them understand it and gain confidence,

Step 4: Research and Inquiry —Small-group brain walk sessions in which participants come up with ideas to kick off PBL research,

Step 5: Product Performance - Presentation on product based on expertise and research data analysis,

Step 6: Evaluation - Assessment and reflection of own products/performance using rubrics.

One day one problem PBL model is used at RVCE, Computer Science and Engineering department. In the Logic design course, students are grouped into different teams. Students are challenged with problems, need to identify the appropriate tools /components to use and they survey the whole week about the given problem. On the last day of the week, all the teams have to prepare the prototype on the spot for presentation. Validation and evaluation is done with appropriate rubrics. Students get to work with one problem the whole day in teams, they can completely concentrate and get indulged in solving problems.

Inference

Table 1 depicts the correlation of liberal arts techniques with different attributes responsible for critical thinking skill enhancement.

Table 1: Mapping of Techniques with Skills Enhancement

Sl. No.	Techniques	Attributes Contributing to Critical Thinking Skills
1	Image analysis	Communication, problem solving, computational thinking, imagination and thinking with different perspectives
2	Puzzle Solving	Logical thinking and reasoning, application to the real world problems, networking
3	Experiential Learning	Lifelong learning, collaborative learning, leadership, communication skills, Self-directed education
4	Design thinking	Viewing the world from multiple perspectives, empathy, team dynamics, problem formulation and unique solutions
5	Problem based learning	Self-awareness and group process evaluation, Analytical and critical thinking, interdisciplinary problem-solving, pitching ideas, Imagination and reflection.

Conclusion

Inclusion of liberal arts into the curriculum enhances student's life learning experience. It makes potential learners think exponentially from multiple perspectives. Stimulates students' critical thinking. The active participation of students in the learning process enables to think critically by presenting arguments or perspectives, articulating difficulties, practicing to induce, deduce, and evaluate. Students Collaborate in groups, develop Self-awareness,

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analytical and critical thinking, Self-directed learning, applying course content to real-life scenarios. Some of the advantages of practicing and inculcating liberal Arts techniques like Puzzle solving, EL, IA, DT and PBL in the curriculum are interdisciplinary research, complex problem-solving, presenting concepts, Imagination and reflection, multidisciplinary and holistic education. In this paper an attempt was made to showcase qualitatively some of the liberal arts techniques practiced in engineering education for the enhancement of critical thinking. More studies in future are required with case studies for the quantification and validation of the acquired knowledge. This study will encourage the educationalists to include liberal arts implicitly or explicitly in the engineering curriculum. The strategies discussed here will act as a bridge for the paradigm shift from traditional teaching to 21st century skills for adopting National education policy 2020.

References

[1] https://www.masterclass.com/articles/guide-to-critical-thinking#what-is-critical-thinking

[2] https://www.educationtimes.com/article/careers-science/80003909/portal-exclusive-how-liberal-arts-and-critical-thinking-are-important-for-engineers

[3] Richard Paul and Linda Elder, The Miniature Guide to Critical Thinking Concepts and Tools, Foundation for Critical Thinking Press, 2008

[4] Garcia Lazo, Veronica. (2012). The visual as a thinking tool: Developing students' critical thinking skills through images.

[5] Slocum, J. (2001). Tangram: The World's First Puzzle Craze, http://www.indiana.edu/~liblilly/collections/overview/puzzle docs/TangramWorlds First Puzz Craze.pdf, p. 43-53 (Accessed 16 August 2016).

[6] Michalewicz, Z., & Michalewicz, M. (2007). Puzzle-Based Learning. In Proceedings of the 2007 AaeE Conference [Accessed 12 February 2016]. https://cs.adelaide.edu.au/~zbyszek/Papers/PBL.pdf

[7] Falkner, N., Sooriamurthi, R., & Michalewicz, Z. (2012). Teaching Puzzle-based Learning: Development of Basic Concepts. Teaching Mathematics and Computer Science, 183–204 [Accessed 15 March 2016].

[8] Moursund, D. (2006). Introduction to Using Games in Education: A Guide for Teachers andParents,https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/3177/Games.pdf?sequence=1%20Free%20Manual (Accessed 12 February 2016).

[9] https://www.hays-index.com, [Accessed on: 10/09/2019]

[10] Kolb, D. A. 1984. Experiential learning: Experience as the source of learning and development. New Jersey: Prentice-Hall.

[11] José P. Queiroz-Neto, Diego C. Sales, Hayanne S. Pinheiro and Benjamin O. Neto (2015) "Using Modern Pedagogical Tools to Improve Learning in Technological Contents", IEEE Frontiers in Education Conference (FIE).

[12] Sternberg, R. J. &. Zhang, L. F (Eds.) (2000), Perspectives on cognitive, learning, and thinking styles. NJ: Lawrence Er

[13] Baasanjav, U. (2013). Incorporating the experiential learning cycle into online classes. Journal of Online Learning and Teaching, 9, 575–589. Bell

[14] Association for Experiential Education, Available at: http://www.aee.org/

[15] Emmison, M. and Smith, P. (2000), Researching the Visual: Images, Objects, Contexts and Interactions in Social and Cultural Inquiry, London, UK: Sage.

[16] Garcia Lazo, Veronica. (2012). The visual as a thinking tool: Developing students' critical thinking skills through images.

[17] Freedman, K. and Sthur, P. (2004), 'Curriculum change for the 21st century: Visual culture in art education', in E. W. Eisner and M. D. Day (eds), Handbook of Research and Policy in Art Education, Mahwah, NJ: Lawrence Erlbaum Associates, pp. 815–828.

[18] https://www.tutorphil.com/blog/how-to-write-analysis [accessed on 12/9/21]

[19] https://www.pblworks.org [accessed on 12/9/21]

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The Role of Critical Thinking in National Education Policy

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ABSTRACT

National Education Policy (NEP) 2020 is initiated by Indian Government with the belief that it will bring new reforms in the education sector. The policy focuses on passion, practicality and performance of each student with an emphasis on learning, instead of studying with critical thinking aspects. It is a highly desirable skill and plays an important role in education sector. Critical thinking is an essential skill that should be looked into a multifaceted way. It should be best conceived to excel and to be successful in any walks of life. Students with critical thinking skills become more independent and self-directed learners. In the context of NEP 2020, critical thinking can promote social transformation and democracy in Indian education. Critical Thinking is very important in the new knowledge economy which can help to analyze information and integrate diverse sources of knowledge in solving problems. In order to develop a deep understanding of the foundations of critical thinking, a long-term approach to learning and applying those foundations in multidisciplinary areas is necessary. To construct multidisciplinary integration, cognitive process of critical evaluation of various disciplinary insights and to create a common ground among these various disciplines is essential. The teachers also should have solid grounding in critical thinking to separate facts from opinions, how to examine an issue from all sides and also how to make rational inferences. In this context, the study investigates its relevance in multidisciplinary areas like Science, Engineering, Humanities, Health care, Research, education etc in a best possible way.

Keywords: *Critical Thinking, Multidisciplinary, 21st Century Skills, National Education Policy, Indian Education*

1 Introduction

1.1 About NEP 2020

The New Education policy (NEP) was approved by Union Cabinet of India in the year 2020[1]. This policy aims at revolutionizing the education system and makes India a global knowledge super power by introducing vocational course at primary schooling to having multidisciplinary universities at higher and professional education. It also proposes to reform the traditional examination system followed in the country in the last 34 years [2]. Critical thinking is a process where the intellectual minds perceive, observe, analyze and arrives at a conclusion. NEP 2020 is one such outcome of the observations made and their critical analysis and evaluation of the education process that is currently followed in the nation.

Under this policy the department of Ministry of Human Resource Development (MHRD) will be renamed as Ministry of Education (MoE). This policy will have a functional impact on approximately 1000+ universities, 45,000+ degree colleges, 15,00,000+ schools.

1.2 Relevance of NEP in the Education System

In India, the education system is categorized into public (government) sector and private sector. The functioning of schools and colleges belonging to these sectors varied. The public sectors offered schooling to the students starting at age of 5years with class 1. But in the private sector the schooling starts at the age of 2.5 years with Montessori, pre kinder garden and upper kinder garden as pre-schooling. As per the guidelines of NEP now, even the public sector is required to off the pre-schooling to the children.

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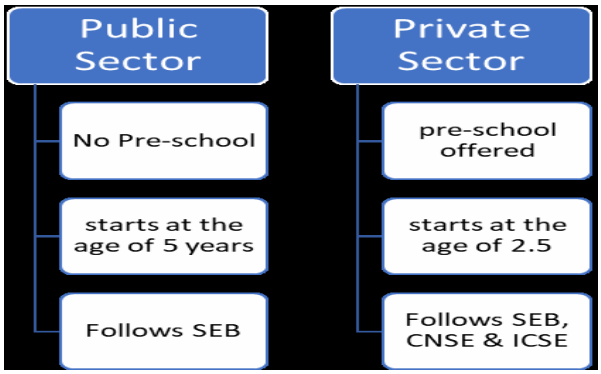

Fig. 1: Sector in Indian Education System

Since, past 34 years India followed 10+2 formula for streamlining the study into three major categories as Arts, Commerce and Science. According to this formula the students studied common courses belonging to all the three major streams under various boards classified as State Education Board (SEB), Central Board (CBSE) and Indian Certificate of Secondary Education (ICSE) till their class 10. It opts to study the courses belonging to one stream for class 11 and class 12 also known as pre-university educations. As per the old formula the students once started with a stream from class 11 onwards had limited or no scope to shift to the other streams. This pre-university education played as a bench mark for the students of the country in selecting their professional career-oriented courses at the university levels for both graduation and post-graduation [3].

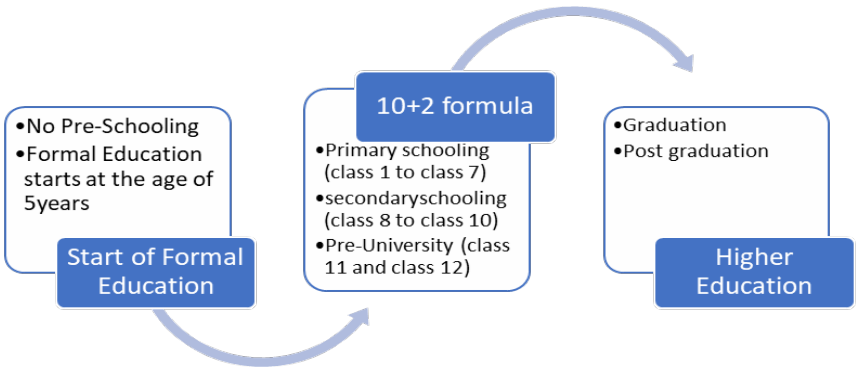

Fig. 2a: Existing Policy

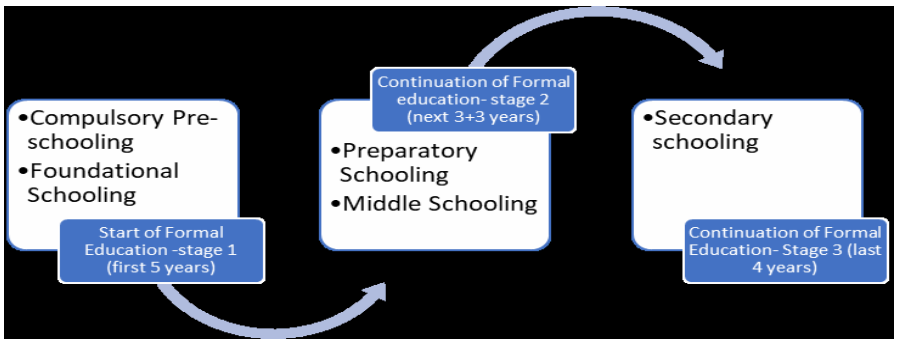

Fig. 2b: New Education Policy

The NEP-2020 proposes to replace the 10+2 formula with 5+3+3+4 rule. According to it, the students between the age group of 3—8 years will be introduced to the pre-schooling from Montessori to class 2 which will be the Foundational School. The children of age group 8 to 11 years will be given the class 3 to class 5 learnings as a part of Preparatory School. Similarly, the Middle School education will be imparted to the children of the age group of 11

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to 14 years. Finally, the secondary school education starts at an age of 14 and continues till they are 18 years of age, where class 9 to class 12 learning is given to the students.

1.3 Relevance of Critical Thinking in NEP

In the present world the skill set required to lead a happy and successful life is continuously changing. The existing education system provided the skills to achieve a successful life but never focused on happiness quotient, an integral and important criterion of human life. This very need of shifting the focus of education system towards happiness and still be able to balance it with the success is critical in nature. The happiness in education system can defined to be the containment and pleasure of learning the course of one's choice and not by completion. The NEP -2020 is an outcome of the analysis flows of existing system in fulfilling the requirements of present day by fulfilling individual's passion with education [4].

1.4 Key Features of Critical Thinking

Critical thinking is all about making one's thinking better, skillful and responsible [5,6]. Following are the key features used to promote ones thinking to a critical thinking.

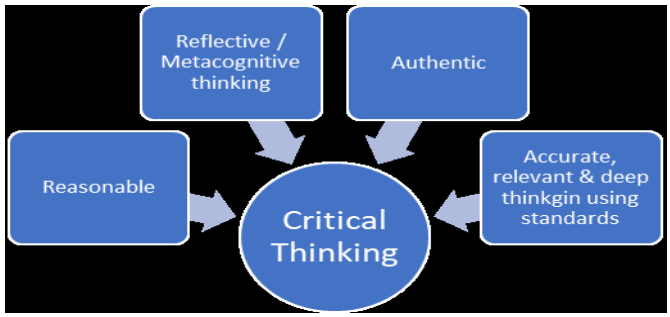

Fig. 3: Key Features of Critical Thinking

1.5 Critical Thinking Skills

Critical thinking is requiring a mind to be equipped with following abilities. A critical mind should be able to:

1. Observe and evaluate the issue
2. Interrogate the respondents involved in the issue
3. Infer and analyze the issue
4. Imagine and conceptualize idea
5. Conduct experiment
6. Decide and conclude

1.6 Critical Vs Creative Thinking

Critical thinking is considered to be a process which is analytical in nature in comparison to creative thinking which generates a new concept or product. Critical thinking is a guided thinking involving reasoning and logical inference whereas creative thinking is boundless and involves use of soft skills to discover a solution.

2. Importance of Critical Thinking in Multidisciplinary Integration

The study of critical thinking requires an interdisciplinary perspective such as philosophical psychological and educational. To construct multidisciplinary integration, cognitive process of critical evaluation of various disciplinary insights and to create a common ground among these various disciplines is essential. This is an essential skill in all areas of life. Critical thinking is very important in the new knowledge economy which helps to analyze information and integrate diverse sources of knowledge in solving problems. Critical thinking provides a way to learn from new experiences through the process of continual self-assessment and provides a basis for a 'Rational and Reasonable' balanced life for an individual.

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2.1 Critical Thinking in Science and Technology

2.1.1 Role of critical thinking in ccience education

Critical thinking is the core of scientific enquiry. A true scientist is a person who by no means stops asking why matters happen, or how matters happen. Science makes development whilst we discover statistics that contradicts our cutting-edge ideas. Critical questioning may be evolved thru focused studying activities.

Steps in scientific critical thinking

The following steps are followed in scientific critical thinking process:

Step 1: Gather and structure the information

Step 2: Support reasoning with rationale map

Step 3: Consider the evidence for Claims

Step 4: Examine the logical structure of arguments for valid assumptions

Step 5: Evaluate and justify the arguments

Step 6: Communicate the claims

2.2 Critical Thinking in Engineering and Technology Education

Engineers are professionals in technical information. As the complexities of issues increase, there was a growing demand for Engineers to use critical thinking in the context of problem solving [7]. The following section deals with critical thinking in various Engineering disciplines like Civil Engineering, Mechanical Engineering, and Software Engineering etc. In addition to that, there is also a discussion on critical thinking in Arts and humanities, social sciences, Healthcare, Research and education etc.

2.2.1 Critical thinking in civil engineering

In Civil engineering, Construction plays an important role. In Construction, employees' ability to analyze risk is essential to create a safe work place.

2.2.2 Critical thinking in mechanical engineering

Critical thinking is an important aspect in the field of Mechanical Engineering which leads to various new ideas for the development and innovation. The fields of study in mechanical engineering spreads across Engineering mechanics, thermodynamics, Acoustics, Fluid mechanics, manufacturing, system design and control etc. Critical thinking emphasizes the critical thought that underlies the discipline of mechanics. With critical thinking, one can avoid the situations like overlooking or under evaluating designs and missing out important features derived from the data collected. Visual literacy is a critical skill for investigating, thinking, imparting physical ideas and for understanding the concept. This is very much essential in the design process of machines. Through representation, benefits of the incredible human visual framework can be utilized to work with critical thinking of configuration issues, where visual portrayals assume shifted parts as intuition drawings which involve introducing an applied or visual thought, changes of the fundamental thoughts and the thoughts are continually attracted conversation with others.

2.2.3 Critical thinking in software engineering

The purpose of software is to serve its customers and make the customer experience better. Since each issues come across is unique, there is no common solution. The planning and the upfront thought process before developing code will be able to provide solutions to some extent. With the critical thinking mindset, the developers can think which is the best possible way to do the things instead of focusing on what has to be done. So the suggested approaches towards it are:

- Thinking 'why' before 'what'
- Involvement of product owner as part of the project team
- Avoid the silos between development and operations
- Sensible selection of technological choices
- Going beyond the concept of software is 'the code' than it is the delivered service to customers
- Better designed system architecture
- Delivery of services in stages

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So how to evaluate evidence and make rational choices among the alternatives available is the path to be followed in the way of critical thinking in Software Engineering.

Eg: A vendor intention towards incentives and financial benefits than quality of the products delivered.

2.3 Why is Critical Thinking Important in Social Sciences?

Critical thinking is important in both individual and social aspects. Since the critical thinking helps an individual to decide about one's way of life, it is very important in both individual and societal aspects. In everyday life, one should have a high power of selectivity to face different situations in life. Many issues cover in the social sciences require fact based reasoning which facilitate to have a choice from controversial opinions by investigating them without preconditioned notions. So critical thinking provides:

- Explore ideas deeply
- To live in information age in effective way
- Helps to manage practical problems related to social sciences such as peer pressure, dealing with relationships, a person's intention etc
- Critical thinkers can identify biases and assumptions before taking one's decision

So a social scientist views the world as a complicated place of causes and effect with the possibility of having logical reason in his evidences.

2.3.1 Arts and humanities as a source of critical thinking development

With critical thinking in humanities, one can expand the knowledge of human cultures and help to understand what binds individuals together and what differentiates one from another. Critical thinking facilitates the observation and analysis process of the numeric details that constitute the works of art. Following are the few skills one can acquire from humanities:

- Analyzing capability
- Teamwork
- Thinking skills
- Interpersonal and leadership skills
- Communication skills

The study of humanities helps to develop communication skill with repeated practice. It makes one an active listener and to be open to other ideas. With the knowledge they hold, they have confidence in what they speak. Humanities involve extensive writing, opportunities to debate and learning foreign languages, thereby strengthening one's ability to communicate globally.

Arts and humanities help the societies to improve the quality of life and facilitate societies' capability for transformation.

2.4 Critical thinking in Education Sector

It is widely accepted that higher education is based on academic values and principles, as it will provide not only professional skills, but also general skills such as critical thinking. Critical thinking can be mapped with learning outcomes as a skill to 'criticize', to more elusive descriptions of 'analyzing' or even 'understanding' and is dependent on judgements and systematic scrutiny of complex problems.

The expected outcomes of fostering a substantive conception of critical thinking in Academics are:

- To promote in defining and advancing the principles and best practices of critical thinking in education and society
- To enhance teachers' ability to more substantively foster it in the classroom
- To conduce educational standards, abilities, and traits and provide practice to students in thinking analytically and critically, reasoning from information to plausible interpretations and judgements in their areas of study

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2.4.1 Benefit to the students

The critical thinking skill benefits the students' community in the following aspects:

- Promotes creativity and problem-solving skills
- Helps to become a good citizen capable of making informed decisions on social. Political, economic issues
- Facilitates to analyze individual dogmas
- Helps to meet basic purpose of education by training the mind to think than simply learning facts

2.4.2 Benefit to the teachers

Critical thinking is part of lifelong learning. It helps in developing teachers' judgement on evaluation and problem-solving abilities of students. A teacher with critical thinking skills knows how to separate facts from opinions, how to examine an issue from all sides and also how to make rational inferences. Critical thinking goes beyond memorization, encouraging students to connect the dots between concepts, solve problems, think creatively, and apply knowledge in new ways. This approach of teaching will provide a healthy and promising environment for teaching fraternity. Also, the teachers having grounding in critical thinking skill, can promote the same among students, able to think in structured way and can make the teaching- learning process a joyful at the same time productive process.

2.4.3 Benefits to society

Critical thinking helps people better understand the source of the evidence and the relationship between facts. Thinking critically allows an individual to identify bias, motivations and goals thereby one can deduce information to apply those to one's own life. This approach helps in promoting personal growth and overall happiness of the society.

2.5 Critical Thinking in Healthcare and Education

Critical thinking in healthcare systems play a vital role in order to make better decisions in dealing with different phenomena and situations [8]. Today, it is emphasized that the critical thinking, as a vital skill in the diagnostic and therapeutic decision-making, should be considered in the best possible way.

With critical thinking, one can adopt the following habits:

When confronted with a problem or situation, seek out the truth by actively examining a problem or situation by suspending the judgment. So the ability to identify and analyze problems as well as evaluate relevant information in order to reach an appropriate conclusion is the associated skill. Eg: Contact the physician when the patient's blood pressure is below an acceptable level.

The various industries coming under Healthcare sector include pharmaceuticals, biotechnology, equipment, distribution, facilities etc. Health services to serve society cover emergency, rehabilitative, hospital, diagnostic, primary, palliative, and home care services etc. We can see that with critical thinking, each and every sector listed can serve or contribute in a better way to society.

2.6 Research and Critical Thinking

Critical thinking is an essential skill which helps to reflect on any knowledge or idea or information presented to us or we come across. This is a core skill required for students working on assignments, performing research, working on projects etc. It is also a vital skill for success in any workplace scenarios.

2.7 Critical Thinking Skills in Research

Critical thinking is a core competency and as a precursor to research. Since the research demands new ideas and the critical thinking skill improves comprehension abilities and think creatively, researchers can analyze their ideas and come out with promising solutions to existing problems. Researcher with critical thinking skills have the ability to revisit their ideas, seek new information when necessary and reconsider and refine the research approach. This facilitates constant reflection and revision in the problem domain and better contribution to society.

The application of the critical thinking skill in Research and the expected outcomes are:

- To establish rigorous standards of excellence in research findings
- To construct well-reasoned solutions by synthesizing multiple perspectives
- To formulate and propose practically and scientifically feasible solutions

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Conclusion

From our discussion and the facts demonstrated as part of the paper, it is evident that critical thinking helps to think beyond, not being judgmental, cultural norms and learn how to understand other factors that can influence decision-making, and it is the crucial skill each and every citizen should possess for the well-being and overall growth of individual, society and the nation as a whole. So as we know New Education Policy 2020 focuses on learning one's own passion and practically implements to achieve performance excellence with the critical thinking ability.

References

[1] Kapur, Radhika. (2018). Problems in the Indian Education System. https://www.researchgate.net/publication/323700593_Problems_in_the_Indian_ Education_System.

[2] Aithal, P. S., & Aithal, Shubhrajyotsna (2020). Analysis of the Indian National Education Policy 2020 towards Achieving its Objectives. *International Journal of Management, Technology, and Social Sciences* (IJMTS), 5(2), 19–41. DOI: http://doi.org/10.5281/zenodo.3988767.

[3] National Education Policy 2020. https://www.education.gov.in

[4] Rajesh Sharma, 2020. Review of National Education Policy 2020, With Specific Reference to Teacher Education, Working papers 2020-35-04, Voice of Research.

[5] Hitchcock, David, "Critical Thinking", The Stanford Encyclopedia of Philosophy (Fall 2020 Edition), Edward N. Zalta (ed.), URL: <https://plato.stanford.edu/archives/fall2020/entries/critical-thinking/>.

[6] Aoife Ahern, Caroline Dominguez, Ciaran McNally, John J. O'Sullivan, Daniela Pedrosa, "A literature review of critical thinking in engineering education, Critical thinking in higher education", pp. 816–828, Volume 44, issue 5, 2019.

[7] Alias Masek, Sulaiman Yamin., The Impact of Instructional Methods on Critical Thinking: A Comparison of Problem-Based Learning and Conventional Approach in Engineering Education, Volume 2012, Article ID 759241 | https://doi.org/10.5402/2012/759241

[8] Jonathan M Sharples, Iain Chalmers, Astrid Austvoll-Dahlgren, Critical thinking in healthcare and education, BMJ 2017; 357 doi: https://doi.org/10.1136/bmj.j2234

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Critical Thinking Development through Online Education: Student's Dispositions

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ABSTRACT

The normal functioning of educational institutions is affected by the COVID-19 pandemic. This makes a shift in the entire educational process to online mode. The development of various skills and educational outcomes during online education is the focus of many studies during this pandemic period. This study is examining the disposition towards critical thinking of higher secondary students through the online class. Critical thinking involves a meta-cognitive process that involves purposeful and reflective judgment, good analytical skills, evaluative and inferential skills. Critical thinking plays a vital role in academic achievement, continuous career and professional development, and social and interpersonal relationships where decision-making and problem-solving are necessary. The study found that online learning is also helpful for the development of critical thinking. The students are more inclined towards online learning for the development of critical thinking. There is a significant difference between the disposition towards critical thinking of higher secondary students through online learning.

Keywords: *Critical Thinking, Online Education, E-learning*

1. Introduction

Critical thinking is an important part of the field of education and the development of critical thinking skills is one of the basic needs of individuals in the [1] 21st century because the individual in the present century must capable of identifying problems, thinking successfully, and creating an effective solution. The development of science and technology makes the life of individuals very easy and at the same time very complex. To adjust to the complex situation and to make the right decision the critical thinking is very useful. The education system prevailing in our country gives importance to impart knowledge and necessary thinking skills to students. Providing education makes the individual access knowledge, solve problems and develop critical thinking. Implementation of the constructivist approach in education increases the importance of critical thinking in education because the constructivist approach increases the individual's constructive, creative, and scientific thinking [2]. Critical thinking is an important tool that helps an individual to take correct decisions based on comparing different options. To compare the different options an individual must analyse the various aspects, synthesis ideas from the observation, and evaluate the different components. This analysis, synthesis, and evaluation are involved in critical thinking [3]. Critical thinkers are creators of knowledge. They are thinking differently from others in a particular situation. The different way of thinking must be in a constructive way only such an individual can produce knowledge which results in the development of society. Education must enable the students to think differently rather than the mere repeaters or consumers of knowledge. As the life of humans becomes complex the need and importance to think differently and to solve difficulties is increasing gradually all over the world [4]. An individual whit good critical thinking ability can solve problems successfully.

The world health organisation has declared the pandemic of novel SARS Corona virus infection early in the year 2020. The silent and fast-spreading nature of the virus affected the whole world and it is one of the major public health issues. To reduce the spreading of the virus physical distancing or social distancing is adopted as a strategy that compels different nations to lockdown. This strategy affected the education sector as closures of universities, colleges schools, and other educational institutions enforced the educational institutions to cancel the face-to-face method of teaching and to search for a new strategy to continue the educational process in an interrupted way [5]. The government of India also declared a nationwide lockdown and closure of educational institutions. As a part

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of continuing the education process, the entire system of teaching and learning is shifted to the online mode or E-learning mode [6].

E-learning is also known as online learning or distance learning. It uses various technological tools and web-based services for imparting education. In online learning, teachers provide study materials and learning resources through the internet, and live interactions are conducted with students. In online learning, the teacher can provide the teaching-learning material at any time and can interact with students at any time so it provides flexibility to students and teachers in providing the content. Students get the advantage of accessing the materials posted by the teachers at any time. Teaching-learning materials can be accessed from everywhere with the help of the internet and now it is cost-effective also [7]. Several E-learning applications such as google meet, Zoom, Webex, etc provide an interactive platform for students and teachers through this teachers can present the learning materials to the students and students can collaboratively work together and it can make the students active, independent self-reflective, and collaborative [8]. In online teaching, the teaching and learning process gets the advantage of information and communication technology in the field of enhancing knowledge, skills, and performance [9]. In the emergency Covid 19 the shifting of the entire educational process into online makes a dilemma in students and teachers and whether the students must cope up with the situation is a big question. [10]

1.1 Critical Thinking

Critical thinking can be seen in the dialogues of Socrates about 2500 years ago. Later different philosophers contributed to it ad reached critical thinking in the present form. Critical thinkers can put their knowledge into practice by changing their current knowledge based on their valuable thoughts [11]. Critical thinking is disciplined, self-directed learning exemplifying the perfections of thinking [12]. To gain accurate results for a problem, an individual must identify and analyse the problem where critical thinking is adopted [13]. Decision-making is possible for an individual by adopting purposeful and logical thinking where everyone is using critical thinking [14]. Critical thinking can be considered as a process as well as an outcome. As a process, it means the application of analytical, synthesis, and evaluative procedures in the thinking process. As an outcome, it means the acquisition of thorough understanding, meaningful linkage with the existing knowledge, and specific inquiry skills related to the particular content. [15]. Critical thinking involves analysis, synthesis, and evaluating the information obtained through observation, experience, and reflection where skillful and intellectually disciplined processes are involved [16]. It can be considered as a skill that helps an individual to think rationally and thoroughly when deciding what is doing by an individual and it involves mental and analytical thinking activity of individuals [17]

Some studies show that the critical thinking level of students is at an insufficient level due to various reasons such as overcrowded classrooms, usage of traditional teaching methods, the inability of teachers to time management, isolation of teachers, asking questions by students are not promoted by teachers, textbook lacking provision for critical thinking. Lack of training for teachers, the presence of superficial and large lesson content, not establishing the discussion environment, not allocating time for creative and critical thinking[18]. Teachers hold a key position in developing skills related to critical thinking and this is possible only when teachers are capable of think critically. Teachers with deep and thorough content knowledge can think critically which makes an impact on students thinking [19]. In certain situations, it is necessary to view different events from different angles or from multiple perspectives where the teachers must think creatively and critically. So Teachers with high critical thinking ability can see the different aspects of an event.

Student's performance and knowledge gain in online learning or e-learning is found to be equivalent to the face method but the skill development in online learning is a big question. In this study, the investigators examine the critical thinking skill disposition of higher secondary students in online teaching and learning.

2. The Objectives of the Study

1. To find out the perspective of higher secondary students about learning critical thinking in the online class
2. To analyze the learning critical thinking disposition of higher secondary students towards online class
3. To compare the learning critical thinking disposition of higher secondary students towards online class
4. To suggest ways to improve critical thinking during online class

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3. Hypotheses

1. The higher secondary students possess different levels of learning critical thinking
2. The higher secondary students show a positive disposition towards learning critical thinking through the online class

4. Methodology

The research focused on gaining a perspective on the critical thinking of higher secondary students during online classes. This study was carried out for comparing the critical thinking development of higher secondary students those who got classes on online mode. The framework of the survey method is adopted for the study. A survey is carried out by sending a google form to the participants and the data were collected. The data obtained were analysed by statistic techniques such as percentage analysis and graphical representation and ANOVA.

4.1 Sample

The present study is intended to conduct among higher secondary students in Thrissur district of Kerala state. The sample selected for the study comprised of 180 students from higher secondary schools in Thrissur district Kerala state. The sample consists of students studying plus two science. The volunteer sampling method is adopted for the study.

4.2 Data Collection Tools

In accordance with the research problem, the learning Critical Thinking inventory developed by Michaeal A, *et al.* (2013) was modified by the investigators for measuring critical thinking of the higher secondary students who got classes by online mode. This scale was a 5-point and included 11 items.

5. Analysis and Interpretation

The response obtained for the learning critical thinking inventory is analysed and their response wise distribution for different statements are given in Table 1.

Table 1: Response of Higher Secondary Students Towards Learning Critical Thinking

Sl. No.	Perceived nature of Learning Critical Thinking	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Thinking about my thinking	11	18	36	17	16
2	Knowing about questions are when learning	7	27	36	20	8
3	Identifying specific examples to illustrate the reasoning	9	27	34	21	7
4	Consider multiple perspectives in subject matter	9	25	37	18	9
5	Making logical connections in the subject of study	7	25	42	15	9
6	Self prejudices or biases influence my thinking	6	23	41	22	6
7	To work through complexities in issues without giving up	11	21	44	14	8
8	Show good thinking in online	9	27	40	16	6
9	Asking questions that helping think carefully	10	31	37	15	5
10	To apply our insights into new or other situations	9	23	42	19	5
11	Feel engaged in class and learning	10	26	36	17	9

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Objective 1

To find out the perspective on learning critical thinking of higher secondary students in the online class.

From table 1 it is clear that the higher secondary students possess a different level of perceptions towards learning critical thinking in online classes. From the table, it is clear that students equal percentage of students are showing the same disposition towards the online mode of teaching and learning and the offline mode of teaching. Nearly 40% of students have no clear idea about the development of critical thinking through the two modes of teaching.

Objective 2

Comparison of critical thinking disposition of higher secondary students. The percentage-wise disposition towards learning critical thinking in online classes is given in Fig. 1.

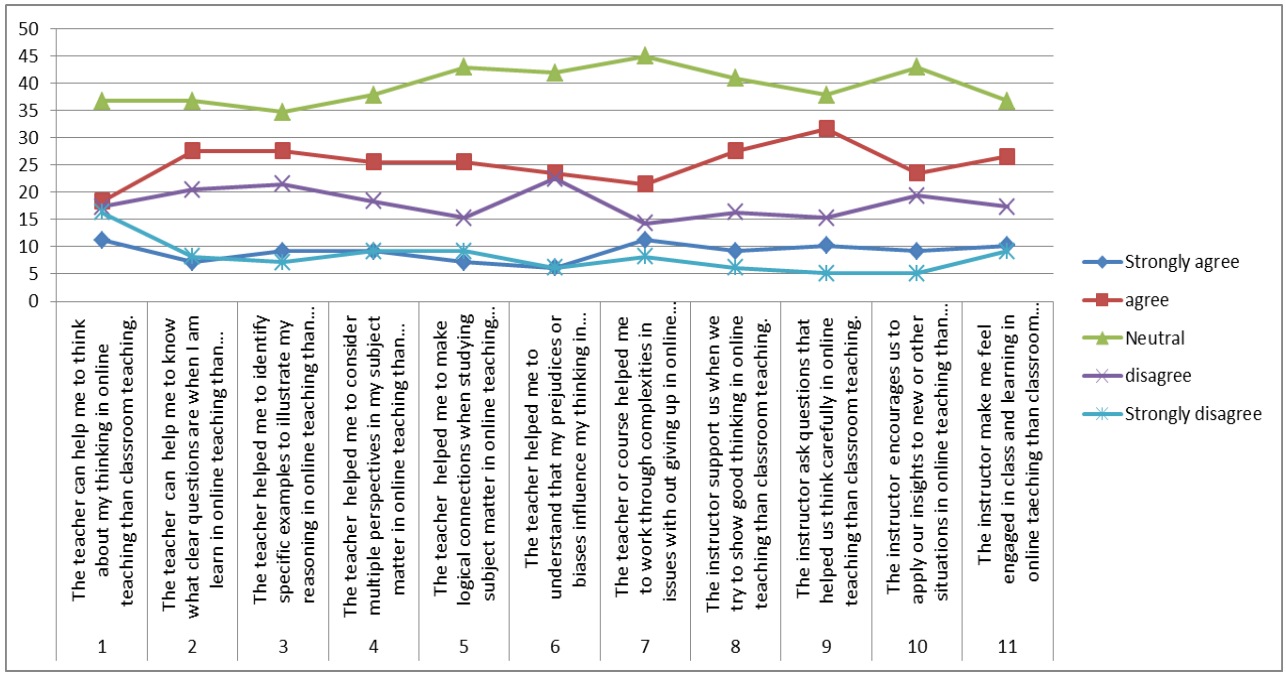

Fig. 1: Percentage-wise Distribution of Learning Critical Thinking Disposition

From Fig. 1, it is clear that 5 to 10% of students are strongly agreed that online teaching is effective in developing critical thinking dispositions in students. In the same manner, 5 to 10% of students strongly disagree with the statement that is critical thinking skills can be developed through offline mode. 35% to 45% of students are exhibiting neutral dispositions towards learning critical thinking through the online class. 25 to 30% of students agree that the online mode is suitable for developing critical thinking skills. 15 to 20% of students disagree that the online mode of the class is not suitable for developing learning critical thinking. This shows their preference for the online mode for developing the skill of critical thinking. So hypothesis 2 is accepted that is higher secondary students show a positive disposition towards learning critical thinking in online mode.

Objective 3

Comparison of the learning critical thinking disposition of higher secondary students towards online class

The responses were scored in such a way that in an assumption that critical thinking is development is more possible through offline mode of teaching and learning. So the students showing strong disagreement to statement is given a score of 5, then for disagreeing the score as 4, 3 to neutral, 2 to agree, and 1 to strongly agree. After scoring the responses the investigators categorized the whole sample used for the study into low, moderate, and high scores based on learning critical thinking scores. The low disposition group has scored below $\overline{x}$–σ, the high disposition group has scores$\overline{x}$+ σ and the rest of them belong to the moderate disposition group. The frequency of student teachers belong to each group, sum scores, average, and their variance are given in Table 2.

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Table 2: Frequency of Higher Secondary Students in a Different Group

Summary

Groups	Count	Sum	Average	Variance
Low	16	315	19.6875	20.09583
Moderate	62	2063	33.27419	18.399
High	20	955	47.75	17.67105

By using ANOVA, the significant difference between the different groups can be determined. The results of ANOVA are given in Table 3

Table 3: Analysis of Variance Different Students Groups

ANOVA

Source of Variation	SS	df	MS	F	E value	F Critical
Between groups	7091.464	2	3545.732	191.4405	.72E-34	3.092217
Within groups	1759.526	95	18.52133			
Total	8850.99	97				

The F value obtained by ANOVA 191.44 shows that it is higher than the F critical Value 3.09 at 0.05 level of significance indicate that the research hypothesis is accepted and which means there exists a significant difference between the high, average, and low disposition group of higher secondary students.

Objective 4

To suggest ways to improve critical thinking during online class

Critical thinking development of students is not always at the desired level due to various reasons, Akinoglu [18] lists some of these reasons as the overcrowded classroom, lack of teacher education in the environment of critical thinking, adopting conventional teaching methods, inability to plan a lesson in accordance with the development of critical thinking, divergent questions from the students are not expecting by teachers, textbooks are not suitable for developing critical thinking, lack of in-depth, education is considered as the only transfer of knowledge, lack of interactive environment in classroom with peers, and usage of rote memorising techniques by students to get high marks without focussing on creative and critical thinking. To improve critical thinking

1. Provide the chance to analysing questions, subjects in terms of the above components
2. Develop an understanding of the logic of how they adapt to each other
3. Develop the thinking about what we do with a purpose
4. Provide problems for in-depth thinking
5. Enhance the capability to develop the implications and consequences of thinking
6. Provide a chance to link the concepts related to ideas and at the end of our thinking, we achieve and interpret the results
7. Reflective thinking should meet high standards
8. In the online mode of teaching the teacher can interact with the students at any time by pausing a question or giving an incident to observe. At the same time, students can communicate with the teacher also. This enhances critical thinking. This is not possible in the offline mode of education

6. Findings

1. Higher secondary students slightly positive disposition towards the development of critical thinking through online. This is because they are digital native students
2. The percentage of higher secondary students showing strong agreement and strong disagreement to learning critical thinking disposition through on-line class are nearly same. But the percentage of

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students showing agreement to learning critical thinking is more disagreement students. This shows that students agree that critical thinking developed is possible through online mode

3. The questions asked by the instructor in online mode help think carefully than off-line mode
4. There exist a significant difference in the disposition towards learning critical thinking of higher secondary students
5. On-line mode teaching is suitable for the development of learning critical thinking in higher secondary students

Conclusion

The skill of critical thinking is a necessary skill that must be developed by the education process and it is one of the goals of education. It gains more attention the today's world and critical thinking skills prepare the students to advance in their area of study or specialisation. Critical thinking development shifts the students from the passive listener state to active learners and processors which will lead to knowledge construction. While designing the curriculum steps must be taken for the development of critical thinking. Critical thinking can be developed by incorporating it into the curriculum. The present curriculum is focussing on the development of knowledge and skill through face-to-face teaching. The curriculum must be modified to accord with the characteristic of online education. The teacher should be themselves as critical thinkers, teachers must get more training on critical thinking development This study examines that whether critical thinking can be developed by online mode of education and it is found that the strategies used in online mode are effective in the development of critical thinking skill.

References

[1] Ekci, G. *et. al.* Analysis of data sources of 21st-century skills. *Journal Education and Training Research.* 6, 124–134. 2017.

[2] Arisoy, B. & Aybek, B. The effects of subject-based critical thinking education in mathematics on student's critical thinking skills and virtues. *Eurasian Journal of Educational Research*, 92, 99–120.2020.

[3] Moore, K.D. Classroom Teaching Skills, Boston, USA: Mcgraw-Hill. 2001.

[4] Demir, S. Evaluation of critical thinking and reflective thinking skills among science teacher candidates. *Journal of Education and Practice*. V.6, n 18.2015.

[5] Wang, C. Horby, P.W. Hayden, F.G. & Gao, G.F. A novel coronavirus outbreak of global health concern . The Lancet. 395(10223), 470-473. 2020. https://doi.org/10.1016/S0140-6736(20)30185-9.

[6] Naik,G.L. Deshpande, M. Shivananada, D.C. Ajey, C.P. Manjunath Patel, G.C. Online teaching and learning of higher education in India during Covid-19 Emergency lockdown. *Pedagogical Research*. Vol. 6(1). 2021

[7] Alqahtani, A.Y. &rajkhan, A.A. Elearning critical success factors during the COVID-19 pandemics: A comprehensive analysis of E-learning managerial perspectives. Education sciences. Vol 10. 2020.

[8] Widyanti, A. Hasudungan, S. & Park, J. E-learning readiness and perceived learning workload among students in an Indonesian university. *Knowledge Management & Learning*. Vol 12, No. 1. 2020.

[9] Rosenberg, M.J. E-learning strategies for delivering knowledge in the digital age. New York: Mc Graw Hill.2001

[10] Bao, W. COVID-19 and online teaching in higher education: A case study of Peking University. Human Behaviour and Emerging Technologies. 2920,113–115. 2020. https://doi.org/10.1002/hbe2.191

[11] Norris, P.S. Synthesis of Research on critical Thinking. *Educational Leadership*, 42 (8), 40–45. 1985.

[12] Paul, R. Critical thinking: How to prepare students for rapidly changing the world. Santa Rosa, CA: Foundation for Critical Thinking. 1995.

[13] Watson, G. & Glaser, E.M. Watson, and Glaser Critical thinking appraisal user guide and technical manual USA: Pearson Education. 2012.

[14] Rudd, R.D. Defining Critical Thinking. *Techniques: Connecting Education and Carriers*. 87(2) :46–49. 2007.

[15] Garrison, R.Anderson, T. & Archer, W. Critical thinking, cognitive presence and computer conferencing in distance education. *American Journal of Distance Education*. 15:17-23.2001. DOI:10.1080/08923640109527071

ISBN: 978-93-91355-21-0 (e-Book)

[16] Scriven, M. & Paul, R. Defining critical thinking: A draft statement for the national council for excellence in critical thinking. Retrieved from. http://www.criticalthinking.org/University/univlibrary/library.nclk

[17] Akar, C. & Kara, C. Critical thinking attitude and some other variables in predicting students democratic studies. *International Journal of Contemporary Research*, 7(2), 226–245.2020. DOI: https://doi.org/10.33200/ijcer.686662

[18] Akinoglu, O. The effect of science Teaching based on critical thinking skills on learning products. Unpublished Doctoral Thesis. 2001.

[19] Besoluk, S. & Ondor, I. investigation of pre-service teachers learning approaches, learning styles and critical thinking skills. Llkogretim online.9(2):679-693. 2010.

[20] Nosich. The elements of reasoning. New Jersy. Foundation of a critical thinker.

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Experiential Learning Model for Gen Z Student's Engagement in Engineering Education: A Case Study

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ABSTRACT

Understanding the Gen Z student propensity helps in better visualizing their learning needs, expectations and guiding for future prospects. Critical thinking involves gathering information, identifying evaluating criterions, drawing inferences and segregating facts from opinions in order to draw conclusions. Critical thinking is a crucial distinguishing factor among students. For the digital natives who have access to information at their fingertips, it would be helpful if learning and creative thinking ecosystem is envisaged including internet and smart phones. With social media playing important role in influencing students, it is necessary to make students think critically gains emphasis in engineering education and in tune with NEP 2020.

In this study, student's creativity was explored through the product design and development course using technology. Methodology adopted involved creation of open-ended exercises by students as part of experiential learning. The challenge is further extended while teaching design related courses where data collection happens through observation and interviews with lead users. The methods explored showcase immediate validation of problem identified through appropriate use of social media using questionnaire design. The result show enhanced engagement and students showcasing deeper understanding of course outcomes. Data suggests that more explorations can be done in this field of study leading to more immersive learning.

Keywords: *Social Media, Critical Thinking, Product Design, Gen Z, Experiential Learning*

1. Introduction

Generation Z is the new generation which includes the individuals who are born between 1996 and 2012 who have witnessed internet and technology create significant transformations in every field. They possess unique characteristics such as individualized, adaptive and connected by technology. GenZ students work best in relaxed environment, enjoy social interaction and autonomy. As rightly said by John Holt, "learning is not the product of teaching but it is the product of activity of the learners". In line with the previous statement and the outcome of 5Why and conflict of interest analysis, it is clear that students immerse more when an activity demands them to be creative and make original contribution.

With the advent of smart devices a lot changes have happened in every field, also it reflects in the field of teaching and learning process. Teaching methodology is moving towards Learner-Centric Teaching Methodology (LCTM). To make all the students attentive and interest to learn, faculty must engage the students with different active learning strategies. Collaborative learning (CL) is directed towards a common goal among a group of students in a class. Logical and innovative processes are used to present the learners views and solutions for a given problem. By working with the collaborative learning activity learners can maintain a good relationship by working with groups. Types of collaborative learning are Course components and Voluntary student initiatives. A course component is divided into two categories: assessed compulsory and non-assessed voluntary. Course component is assessed compulsory with tutorials and lab sessions by making students work with groups and the outcome of this is a group product. A voluntary student initiative includes acknowledged one-to-one support and study groups and the outcome of this is an individual product.

Experiential learning plays a significant role in learning process leading to greater gratification. Providing reflection points allows students to connect and correlate between theoretical and practical knowledge. The course in purview for this work is product design and development offered for higher semester of Industrial Engineering and Management which comprises of 100 marks for theory component and 50 marks for lab component as part of

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continuous internal evaluation (CIE). 10 marks is earmarked for experiential learning (EL) in the theory component. The course is an amalgamation of knowledge, skill, approach and customer understanding. The EL for this course was conceived to utilize best of theoretical knowledge and lab skills to create new lab exercises and thus taking a step towards critical thinking. Well-planned open- ended exercises as part of EL have the ability to involve students actively in original content creation.

2. Literature Review

There are enormous researches on behaviors and attitudes of students have conducted using collaborative learning. Collaborative learning is getting to know category that encourages the participation of a group of inexperienced persons to work and learn collectively on problems of essential concerns to yield an effective solution [1][2]. Learners are required to form groups for working, and the group formation should be designed to suggest positive interdependence, suitable use of collaborative skills, group processing, and individual accountability. While operating as a group, the learners plan, manage, acquire and correlate, interpret, examine apply, and create [3]. The impact on collaborative learning in mathematics education [4], Information systems course [5], Chemistry [6], management accounting course [7] and foundational engineering course [8] are conducted and published recently. There are works on collaborative learning in cyber security course which deals the soft skills [9] and pilot study on collaborative learning – information security course [10]. Literature has revealed that collaborative learning is effective tool for learning enhancement.

Engineering educators can effectively enhance critical thinking and problem-solving skills through appropriate Instructional strategies [11]. It is also observed that Open Ended type projects that students worked on in teams, clearly enhanced their analytical and communication skills enhancing their employability [12]. Teachers need to bring in the element of innovation and creativity in their teaching and encourage students to use their imagination and build associations. There is no standard or well-defined methodologies to measure the outcomes of the laboratory in terms of creativity. Hence, a sensible mechanism is needed to enhance their creativity and to assess the same [13] [14]. Most of the literature available focusses on exploring experiential learning in language or in basic science courses and for courses which involve higher orders thinking as per blooms taxonomy (L4, L5) needs focus.

3. Methodology

The broad goal for this work was to enhance critical thinking among students through effective experiential learning. EL modules can be best suited to immerse students in collaborative learning which is important graduate attribute for an engineering student. The role of faculty coordinators was to involve students in discussion, identify the needs from student's perspective and correlate with the course requirement. The needs analysis involved understanding the reasons for diminishing curiosity and setting expected outcome of EL.

Further, 5Why analysis was carried out to identify the root cause and conflict of interest analysis to obtain insights on desired outcomes. The problem statement provided to students was to create open ended platform as part of experiential learning and utilize instruction based approach to involve students in creating original content for ensuing batch of design. This was followed by evaluation of the student and further grouping them to form effective groups. The actual activity/ task of the experiential learning was performed by the student groups. The methodology followed is as shown in Fig 1.

3.1 Conflict of Interest and 5Why Analysis

Conflict of interest analysis is used to understand what the conflicts are at the initial stage of design from the user point of view and it also helps in establishing the desired outcome as shown in Fig 2. The multiple why or 5Why analysis is used as a predecessor to conflict of interest analysis which throws light on root cause why the issue exists. Curiosity is a fundamental human motivation that influences learning, the acquisition of knowledge. Curiosity to learn through practical experience and problem solving can be referred to as backbone of engineering education. Lack of curiosity and interest stem from several factors for students. 5Why Analysis was conducted to identity the root cause of students not showing interest & excitement in experiential learning. Curiosity being the key to creativity, it was important to decipher the root cause for the lack of it. The outcomes of 5Why analysis is drafted in Table 1.

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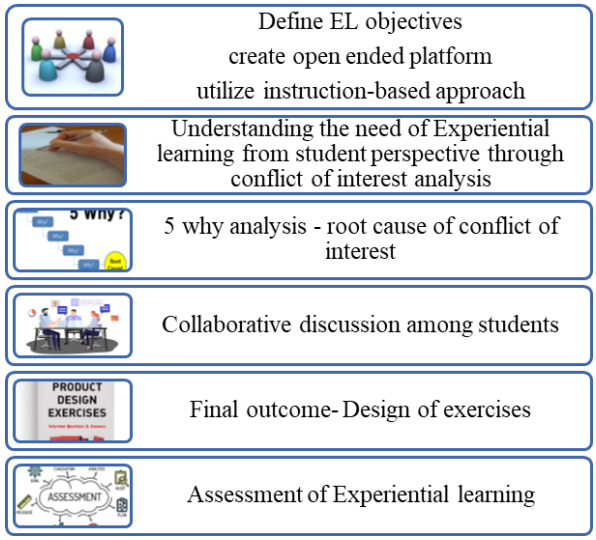


Fig. 1: Methodology Adopted

Table 1: Multiple Why or 5Why Analysis

Sl. No.	Problem: There is Lack of Curiosity for Students to Immerse in Experiential Learning Goal: Create Interest and Excitement in Experiential Learning	
1	Why	Student involvement performance low in experiential learning
2	Why	Last minute duplication of work can be done
3	Why	Don't pose any challenge
4	Why	Exploration is less
5	Why	Poor documentation

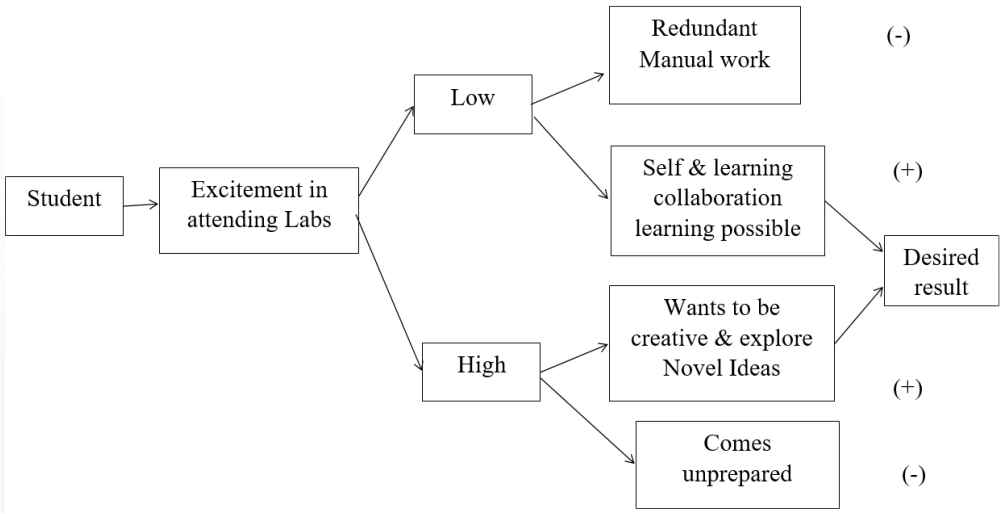


Fig. 2: Conflict of Interest Analysis

3.2 Design of Exercises

Students were given freedom to choose topics, discuss among their subordinates and extend it as an exercise. The instructions along with template were provided along with evaluation criteria. Students had to furnish the

particulars like aim, Introduction to the topic and related video links from YouTube or any video repository along with evaluation criteria or rubrics which would place students to put themselves in the position of faculty. Other considerations included that the users of the document had to use this to complete the work in a time bound environment (Approx. 2.5 hours). Social media pages related to product design were compiled and used as enhancers.

3.3 Assessment of Experiential Learning

Any new strategy adopted in Teaching Learning Process (TLP) will require planning for assessment in terms of time, thought and effort. A deeper understanding of Bloom's taxonomy had to be obtained as shown in Fig 3. Segregation of Bloom's taxonomy with regard to lower order thinking skills (LOTS) and higher order thinking skills (HOTS) was considered as shown in Fig 4. Involving the end users i.e, Students at the initial stages of designing for course execution helped in better outcomes.

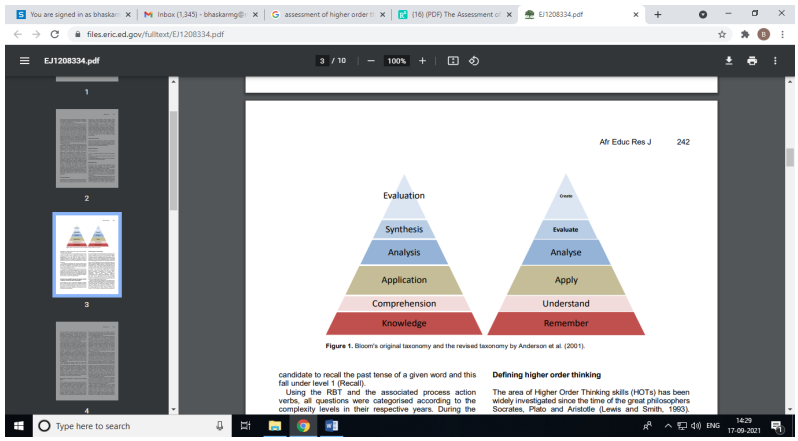
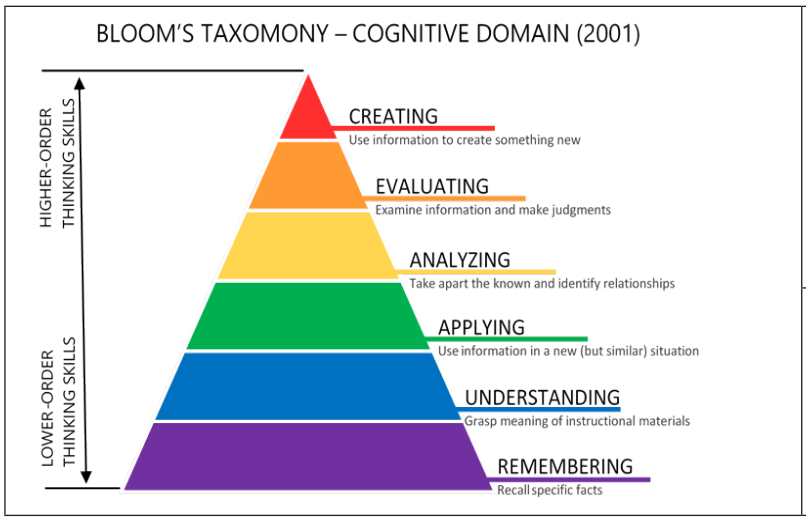


Fig. 3: Bloom's Original Taxonomy and the Revised Taxonomy by Anderson *et. al.* (2001).



Higher Order Thinking Skills	Involves in creating lab exercises keeping user's perspective and gains higher order skills
Lower Order Thinking Skills	Involves executing lab exercise instructions and gaining associated skills

Fig. 4: Mapping of Thinking Skills

Results and Discussions

The topics chosen by students included product specification, Design For Assembly (DFA), retrospective thinking for idea generation, Scamper technique, PDD from Operations perspective, Representing customer needs using user stories, Bio-inspired product design, work breakdown structure and environment impact assessment. Out of 65 students to which this open ended challenge was extended to, 4 students got 10 on 10, 9 students submitted late, 8

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students did not submit. The emphasis was placed on originality of work content which a vast majority of students were able to adhere to (>90%) and the remaining were honest enough to accept that the work was an improvement of existing work and hence can be termed as inspired work. In today's day and age, honouring integrity of students takes prime importance. It was also observed that students were able to utilize their learnings from elective courses and create exercises for product design courses which was noteworthy.

Conclusion

Product design and development is a unique course which requires certain degree of imagination at numerous fronts including customer end and at the designers end. Students will appreciate the emphasis put on experiential learning in engineering education if it is associated with creativity as we are dealing with a generation of students who like to learn more through self-experience and students who place high weight on sharing their own perspectives.

References

[1] Laal, M., & Laal, M., Collaborative learning: what is it?. *Procedia-Social And Behavioral Sciences*, 31, 491–495, 2012.

[2] Laal, M., Laal, M., and Kermanshahi, Z. K., 21st century learning; Learning in Collaboration, *Procedia - Social and Behavioural Sciences*, 47, 1696–1701, 2012.

[3] Zambrano, J., Kirschner, F., Sweller, J., and Kirschner, P. A., *Effects of Group Experience and Information Distribution on Collaborative Learning, Instructional Science*, 47, 531–55, 2019

[4] Lahann P., Lambdin D.V., Collaborative Learning in Mathematics Education. In: *Lerman S. (eds) Encyclopedia of Mathematics Education. Springer*, Cham. https://doi.org/10.1007/978-3-030-15789-0_23, 2020

[5] Spruell, James A. and Le Blanc, Louis A., A Course Planning Method to Incorporate Collaborative Learning in Information Systems Courses, *Journal of Information Systems Education*: Vol. 4(2), 6–11, 1992.

[6] Philipp M. Gemmel, McKenna K. Goetz, Nicole M. James, Kate A. Jesse, and Britni J. Ratliff, Collaborative Learning in Chemistry: Impact of COVID-19, *Journal of Chemical Education* 97 (9), 2899-2904 DOI: 10.1021/acs.jchemed.0c00713, 2020

[7] Hwee Cheng Tan, Using a structured collaborative learning approach in a case-based management accounting course, *Journal of Accounting Education*, Volume 49, 2019, 100638, ISSN 0748-5751, https://doi.org/10.1016/j.jaccedu.2019.100638.

[8] Fox, W. H., & Docherty, P. D. Student perspectives of independent and collaborative learning in a flipped foundational engineering course. *Australasian Journal of Educational Technology*, 35(5), 79–94, 2019. https://doi.org/10.14742/ajet.3804

[9] X. Yuan *et. al.*, Teaching Cybersecurity Using Guided Inquiry Collaborative Learning, 2019 *IEEE Frontiers in Education Conference (FIE),* Covington, KY, USA, 2019, pp. 1-6, doi: 10.1109/FIE43999.2019.9028408.

[10] Tian, Xin and Li, Zhigang,, Collaborative Learning for Information Security Topics: A Pilot Study" (2020). *AMCIS 2020 Proceedings*. https://aisel.aisnet.org/amcis2020/is_education/is_education/13

[11] Magrabi, S. A. R., Pasha, M. I., & Pasha, M. Y., Classroom Teaching to Enhance Critical Thinking and Problem-Solving Skills for Developing IOT Applications. *Journal of Engineering Education Transformations*, 31(3), 152-157, 2018.

[12] Kapadia, R. J. (2008, October). Teaching and Learning Styles in Engineering Education. In 2008 38th Annual Frontiers in Education Conference (pp. T4B-1). IEEE, 2008

[13] Anitha, D., Jeyamala, C., & Kavitha, D. Assessing and Enhancing Creativity in a Laboratory Course with Project Based Learning. *Journal of Engineering Education Transformations*, 32(2), 67–74, 2018.

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Critical Thinking in Education Sector

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ABSTRACT

The process of conceptualizing, analysing and synthesizing the information which is collected by observation, reasoning as a guide to belief and action is called critical thinking. It is developed on the basis of universally accepted values that transcend subject matter divisions and comprises of the examination of those ideas in all reasoning and conclusions. This way of thinking is clubbed with conventional ways of thinking. The way we live is a reflection of our thoughts.

Keywords: *Thinking, Skill, Logically, Analytically, Pedagogy*

1. Introduction

The ability of thinking leads to the production of thoughts. Human beings think every moment and about everything they come across. But thinking about 'thinking' is called critical thinking. Thus it's an in depth way of thinking about any issue before any action. Unlike the conventional way of thinking, critical thinking is not mere acquisition of information and developing skills. A person with the ability to think critically raises relevant questions and thereby gathers required information and then comes to a feasible conclusion. In this process, the person is open minded and broadminded to consider any alternative solutions if any available.

Though it is difficult to induce any way of thinking, but by rigorous practice it should be possible to inculcate the habit of critical thinking in somebody. For this, one has to be observant and should try to understand how the things work. That is to say that, it is not confined to finding the solution but knowing the fundamentals behind the working phenomenon. The education must teach the students to define and analyse the problems, but while doing so the fallacies and cognitive biases must be avoided.

There are many hindrances to critical thinking. To list a few, a blind reliance on emotions, self-centric, established dogmas, unconscious bias and selective perception. Unlike critical thinking, analytical thinking breaks down the complex information into smaller steps .Again, the critical thinking considers external knowledge available while evaluating the information. The teachings of Socrates recorded by Plato can be considered as pioneers on the way to critical thinking [1].

2. Education System

Any development of civilization to a great extent depends on education. Basically education enables the acquisition of knowledge through teaching and learning process at some school or college. The earliest education methods aimed at sharing information about gathering food, shelter, making weapons, learning language and religious rites of a given culture. Prior to the invention of the art of writing and reading, people lived in an environment in which the struggle was about the survival against natural calamities, animals and other humans. In fact today's cultural and educational patterns have their origin in the skills developed by the preliterate people.

Today, we face innumerable problems which are created by us only in our interactions with the social echo system. Also, these problems are becoming more complicated as the Human life is in regular confrontation with their surroundings, be it his fellow beings or societal institutions. Only the person with the required knowledge and skills can face the circumstances with self-confidence. Education thus is expected to prepare the learners such that they can overcome any problem and dilemma so that they can lead a successful life. Today, life is very dynamic and highly unpredictable which indicates that the students should pick up the art of winning over all these challenges during their formative years. Hence, education must impart skills and attitudes of life so the the student becomes an active member of the society. This is the foundation for the critical thinking [2].

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3. Critical Thinking in Education Sector

The skills that the students imbibe during their educational years form the foundation of the critical thinking. Unless a student masters the elementary skills of critical thinking he will not be able to overcome simple obstacles in their lives. Every day we come across a plethora of problems which may have their origin in different fields of life. Next question is how to win over these?. Solution is possible if the basic causes of these problems are known. A person with a sound critical thinking background can come to a sensible conclusion and act intelligently. The following model in Fig. 1 is to be part of any education system to inculcate the concepts of critical thinking among the students.

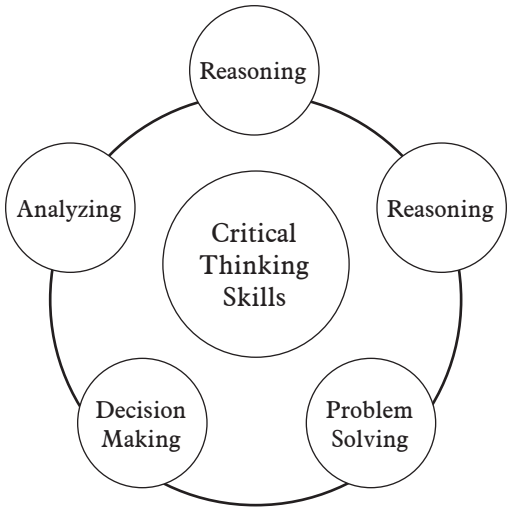

Fig. 1: Model of Critical Thinking

Every child by birth will have an inquisitive mind towards everything around him/her. That is to say, critical thinking is an inborn talent of every person. Conventional schooling is losing its relevance in today's highly competitive world. The age-old method of teaching from a book and asking the students to reproduce like parrots is totally outdated. Instead, students are required to be made to think actively about any new concept being discussed in the class. So urgent need of the hour is to inculcate the culture of critical thinking among the students through the means of education. Education has to undergo metamorphosis for a better world.

Nature has provided us the brains but we create the mind. A person is identified by his thoughts or he is made of them. With a generation of students moulded in the new way of thinking can definitely make the world better. With this new attitude, the children can judge better about any issue rather than blindly accepting what has been told to them. This also improves their learning skills and their interaction with the society. Smart thinking enhances one's responsibility which in turn makes them successful in life. Critical thinking is more about exploring the possibilities.

Due to rapid strides in technology, a mountain of knowledge is available to students just a clique away. Teachers have become just facilitators. At the same time, there is an accompanying risk that all that knowledge available in the web may not be entirely authentic. This is where again, the critical thinking comes into picture. It is proven by many surveys that students show little progress in critical thinking when they are at graduate level. Hence the process has to start very early. But the challenge is how to incorporate the concepts of critical thinking in curriculum.

As our lives revolve around technology, there is an urgent need for the critical thinkers to convert the oral and written words into statements so that they could be built into logical structures which then forma the basis for reasoning. With sustained efforts by experts in the field of education, a consensus has emerged about the definition of critical thinking and also the methods of teaching it in the school and colleges [3].

4. How to Develop Critical Thinking in Schools?

Now it is a bygone conclusion that school curriculum must stress on critical thinking. But unfortunately the school education has utterly failed in this objective. The reason for this fiasco lies in the way how the critical thinking

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is conceptualized. A detailed analysis of today's examination results shows that students do not answer well those questions which require not just mere reproduction of knowledge. Also they fail miserably while facing the tasks which require critical review, inputs from different fields of knowledge or solving a problem in a new context. Many efforts are being made to stress on the need to develop higher order thinking skills. Even the new education policy (NEP) touches these issues. But sad part is that all the efforts in this direction have not brought in any drastic change in the education echo system and also the battle against the century old system of factual teaching was lost.

There are various arguments about the purpose of skills for critical thinking. Any how they may vary : it can range from enabling students to be ready for the demands of the global market and safeguarding the existing culture and societal relationships and to prepare them to take part in the democratic setup. Based on the experience so far, few experts are of the firm belief that the approach to developing the skills of critical thinking among students have to be through the implementation of specially designed programs and only will come into effect when this type of education receives its due place in pertinent documents like curriculum, achievement standards and professional standards for the tutors. Thus development of critical thinking is hence greatly associated with pedagogical teaching-of-thinking strategies, and it is presumed as possible within the existing curriculum and ways leading to them [4].

5. Education for Critical Thinking from the Perspective of Critical Pedagogy

As of now, there are lot of debates going around regarding how to make education relevant in the efforts to inculcate the habit of critical thinking among students. Many experts in this field feel that the idea of critical thinking has a fundamental role in every field of knowledge as well as in all spheres of life where every human being has to interact with all segments of society, be it work space, education, family, friends or community as a whole. The path bearers in this field identify various approaches to the topic. The concern is about developing the skills of critical thinking among the learners. The different fields like Philosophy and Psychology will also help in this task. Critical thinking is closely related to the other personality traits like observation and behavioural attitude [5].

6. Role of Higher Education in Developing Critical Thinking Skills

The educationalists throughout the globe are intrigued about the task of enhancing the skills of critical thinking among the students at every stage of their education. Tough this process can happen at any stage of education but the level of engagement varies. It will be more sensible to continue it till the tertiary level as the students will be in a position to appreciate the efforts.

Then comes the core task of methodology to be used. Critical thinking is highly significant to learning. Usually we split the learning content into two phases. The mental construction of the principles present in the content forms the process of internalization. The second phase occurs when the learners use the principles which they are already familiar in their day to day lives and it is called as Application phase. Teachers trained in this field impart their skills to theirs students by stimulating them with various queries which is a meaningful way to lay a foundation of knowledge in any new field. Every branch of learning has to take inputs from the field of critical thinking. The foundations of it are built into each subject. The crucial stage is when the students learn the concepts and intellectually engage. After all these steps, it could be presumed that the students are in a position to think independently and develop their own knowledge. Experts in this field firmly believe that critical thinking is an important part of cognitive abilities [6].

7. Curriculum and Critical Thinking

The ongoing pandemic has tested our abilities to face the adversaries. The situation would have been different if the young generation has been groomed with the art of critical thinking. Many global bodies have declared that that these skills are inevitable for today's tumultuous times. But unfortunately the learners are not exposed to these things. Today's education is turning the students into parrots so that they reproduce the information available in the curriculum. Students coming out of this system lack the life skills and they utterly lag in inquiry, questioning and reasoning [7].

8. An Inquisitive Pedagogy

The traditional teaching methods have to change for better. Need of the hour is to develop the reasoning skills among students. Most of the problems are solved by right questions. Educationalists must try to bring the advanced

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methods of contemporary teaching to subcontinent. Once the students are taught the fundamentals of alphabets and numerals, next level should be project based learning activity which automatically develops the culture of active learning among students.

9. Alternative Way of Functioning

If we decide to make the critical thinking part of our lives, the existing system has to be totally revamped. The stereotypes are to be abandoned. The methods applied in the institutions are very crucial. The process starts with planning for curriculum and content development leading to the implementation stage.

Conclusion

As we are living in an information age life is becoming very complex and highly dynamic. There is no scope for lethargy in decisions. With the abundance of information, the students can compare the contradictory views and then come to their own conclusion. Of course the authenticity of the information available on the web needs to be critically evaluated. There is a need for rational decisions. In these circumstances, critical thinker can make his own decisions based on real facts. It is time for the individuals and institutions to take lead in the efforts to infuse new blood in the education sector ensuring that younger generation is exposed to the skills of critical thinking.

References

[1] https://www.criticalthinking.org/pages/defining-critical-thinking/766

[2] https://sites.tufts.edu/eeseniordesignhandbook/2013/an-engineers-path-to-critical-thinking/

[3] https://www.edsys.in/10-ways-critical-thinking-plays-an-important-role-in-education/

[4] https://www.linkedin.com/pulse/what-importance-benefits-critical-thinking-skills-islam/

[5] https://files.eric.ed.gov/fulltext/EJ1156618.pdf

[6] https://www.thehindu.com/education/why-critical-thinking-is-a-crucial-skill-for-Students/article32569128.ece

[7] https://en.wikipedia.org/wiki/Critical_thinking

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Development of Critical Thinking among the Students of Higher Education Inculcating 21st Century Skills in Online Mode through DALHAM e-Learning

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ABSTRACT

Learning to ask appropriate questions and reasoning develops the connection in deeper understanding of the environment in which the individual reciprocates. The critical thinking in 21st century skills mainly focuses on different facts, concepts, beautiful arguments, memoriosing and thought developed during their education. The Critical thinking involves the process of analysing a topic or a problem carefully, also aimed at achieving the best possible outcome in any situation. It thus, guides informed decision making in not just personal but also professional environment by allowing one to recognize limitations in their thinking and cultivate a growth mindset. The online platform is quite essential for the students during this pandemic situation that is uncertain till date. The video- based learning make more interactive than the text content to the memorize the contents in a much easier way and more effective to comprehend the content through a moving object and helps in an effective memorizing of the content. Critical Thinking engages students to develop a clear, rational and reflective method of thinking by asking questions based on logic and reason. It covers concepts such as argumentation, logic, reasoning, premises and inference. Critical thinking should not be confused with being critical of other people. Although these skills can be used in exposing fallacies and poor reasoning. Critical thinking can also play an important role in cooperative reasoning and constructive tasks. Critical thinking can also be used to enhance work processes and improve efficiency. The Dalham e- learning platform is the 21st Century Micro-Learning Programme coursework encourages students to apply neo-millennial workplace skills in their learning to develop a holistic understanding of the purpose of their education.

***Keywords**: Critical Thinking, 21st Century Skills, Micro-Learning, Holistic Understanding*

1. How do We Understand Critical Thinking?

Critical thinking is the ability to think clearly and rationally, understanding the logical connection between ideas and as the ability to engage in reflective and independent thinking. In essence, critical thinking requires you to use your ability to reason. It is about being an active learner rather than a passive recipient of information. Critical thinkers rigorously question ideas and assumptions rather than accepting them at face value. They will always seek to determine whether the ideas, arguments and findings represent the entire picture and are open to finding that they do not. Critical thinkers will identify analyses and solve problems systematically rather than by intuition or instinct.

Critical thinking is thinking about things in certain ways so as to arrive at the best possible solution in the circumstances that the thinker is aware of. In more everyday language, it is a way of thinking about whatever is presently occupying your mind so that you come to the best possible conclusion.

2. The DALHAM e-Learning

The DALHAM Learning Integrated Liberal Education Programme has been engineered to elevate the education system by introducing an array of Liberal arts within the curriculum of professional technical courses designed in line with the National Education Policy 2020. The integrated module offers students the perfect avenue to gain technical knowledge and develop essential skills such as critical thinking. It provides a system that promotes skill development and individual thought, rather than facilitate knowledge retention. DALHAM Learning is an e-learning platform of integrated liberal education programs for Undergraduate and Postgraduate students.

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2.1 Objectives

- To prepare young minds to develop a dynamic and critical thought process, which is essential to thrive in the 21st century workspace and also make then lifelong learners
- Students are encouraged to apply their knowledge beyond their areas of specialization
- Helps them to utilize their skills and capabilities to design promising tomorrow for all
- Provides every student the opportunity to experience education in its full potential
- Platform that views education through holistic lens of critical thinking, understanding and application of every concept

2.2 Courses Offered

- Design Thinking – A human centered approach to solve complex problems
- Media Literacy – Broaden one's own perspective and consume information
- Critical Thinking – Leverage augmentation, logic and reasoning to formulate
- Creativity and Problem Solving– discover how creativity helps solve problems
- Other courses – Productivity and Accountability, Creative writing, Communication
- Skills and Collaboration, Cross-cultural skills

2.3 How does Video Based Learning Help Engineering Students Improvise Their Cognitive Abilities?

The course has been well designed and it addresses every possible aspect of critical thinking process with real life examples at every stage. The contents of the Course were very well delivered; the course outlined the important points backed with an experience which makes the course much more interactive and Hands On. This course went through all the necessary thought processes needed to master the skill of critical thinking. All of the videos provide insights about a given situation and also provide alternate ways to deal with a scenario. While hands on learning provide experience to the students, video based learning can help in situation based simulation which also counts as experience for the student. Their cognitive abilities can also be improved with examples of situations. Cognitive abilities are definitely at a decline with video based learning; however it is important to focus on the positives of the situation in hand. Projects and forums help the students improve their reasoning sense.

2.4 Significance of Video Based Learning in Development of Critical Thinking Skills among Engineering Students

Video based learning involves citing real world examples and also simulating scenarios which provide crucial experience (pseudo experience) to the student. They also have a more colorful way of conveying concepts to students, which might not be the case in classroom learning. Critical thinking is the objective analysis and evaluation of an issue in order to form a judgment. Videos are capable of providing in depths analysis and helps breakdown the problem. Finally these video based learning will help in honing the decision making process of the student.

Critical thinking module helped to analyze facts to form judgments. It provided a platform to assess arguments to determine their validity. This course went through all the necessary thought processes needed to master the skill of critical thinking. With the help of wonderful teachers Dr. Kit Patrick and Dr. Shamik Chakravarty the students were able to learn the subtopics and lessons under critical thinking. Since critical thinking is a complex topic, video based learning really helped students to follow the teachers and their innovative teaching styles; video based learning broadens the scope of how something can be taught.

2.5 *Critical Thinking in a form of Video-based Learning through DALHAM e-Learning Platform*

The Dalham e-learning online platform provides two sectors of Critical Thinking which involves the more of brain storming skills.

In the first part of the critical thinking course, the students learned regarding the actual sense of thinking critically along with understanding the validation of an argument i.e. when is the argument valid? How to actually make

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a valid argument/ and also learn different logics for validation of arguments such as evidence and probabilistic approach. For Example: The session focuses on delivering the meaning of Bayesianism and using examples to evaluate instances where Bayesianism is extremely effective. Simply put, Bayesianism is a mathematical procedure that applies probabilities and logic to statistical problems. The video provides 4 different cases and explains how Bayesianism is valid in those situations or parameters (such as a population mean) based on experience or best guess before experimentation and data collection and that apply Bayes' theorem to revise the probabilities. Some of the arguments seem valid, while the rest invalid. It gives us an idea on how to judge the arguments and reasoning and also provides a rough blueprint of what a good argument looks like.

In the second part of the critical thinking course, it focused on Inductive and Deductive kinds of arguments as well as reasoning. Also, it also gave glimpses about different components of arguments and Logical connectives such as conditional, Biconditionals, truth tables, and equivalence relations. Also, course explained on a different kind of inference and fallacies which gave an overall insight into the essence of Critical thinking.

This session focuses upon using beauty, or put clearly, using beautiful explanation to challenge a premise and its conclusion. There also instances where the conclusion to premise is beautiful. This focuses on the positive aspects of the premise while also trying to convey the flaws in their inference. There are also instances where the inferences are perfect and one must not try to correct it.

Course contains a series of self-assessments and case studies to apply leanings to real-life situations, hence providing hands-on experience in such critical skills. It is emphasized in different domains like Business, Market, and Industry and gives us a broad perspective of the thinking process. It clearly displays Pros and Cons of every decision that we make, possible impacts it can have, etc. It gives students multi view scope of looking at things, and it highly promotes students to try out entrepreneurship and other tasks where student's real caliber is tested. Course helped the students to Leverage creativity to find solutions, Have different perspectives in solving problems, Have multi-disciplinary approach in innovation, and lot more. This course mainly helped on inculcating Logical and critical decision-making skills in the budding and the future engineers.

3. Outcome of DALHAM Learning

- Dalham learning's inter disciplinary courses offers for future readiness will help learners to adapt to new workspaces of the 21st century and develop key skills to drive creative and innovative solutions
- The various themes of the programmes will help make individuals lifer-long learners by instilling curiosity
- It helps the learners to develop a comprehensive understanding of various subjects under liberal education to grow as a dynamic professional

References

[1] Dalham e-learning online platform https://www.dalhamlearning.com/

[2] https://www.dalhamlearning.com/course

[3] https://www.dalhamlearning.com/course-details/3/Critical%20Thinking

[4] https://www.dalhamlearning.com/blogs

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Critical Thinking and its Importance in Teaching and Learning in Secondary Education

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ABSTRACT

Critical thinking is the capability of an individual to think about anything and all the possibilities. It is considered as an activity that involves collection, interpretation, and analysis of the collected information thereby evaluating them with specific skills and involvement.

It enables anyone to think broadly, identify problems and arrive at innovative solutions for them. Critical thinking requires one to use their reasoning ability for analysing and evaluating the available solutions. Its abilities also inculcate planning and strategic thinking.

At every stage of one's life, critical thinking should be enormously encouraged. Particularly, for students undergoing secondary education it paves way for thinking actively and learning new things besides passively learning textbooks. In this article the objectives of critical thinking are analyzed, benefits of critical thinking in earlier stages of education are discussed, role of teachers in encouraging critical thinking is studied, role of critical thinking in meeting various challenges in life are elaborated.

Keywords: *Reflection, Justification, HOTS, Socratic Questioning, Bloom's Taxonomy*

1. Introduction

A sound mind is one that thinks of all the possibilities rather than the one that accepts everything given. By virtue of dealing with humans their thoughts are dealt with as well.

It is in a way a thirst for understanding through reasoning rationally with enough justification.

Cultivating critical thinking among students enables the younger generation with a better thinking capability that helps the society.

Critical Thinking is a definitive way for understanding; to have a reasonably open-minded and convenient approach to find out ideas. It essentially involves the ability to work upon the information gained to come up with clear conclusions based on the proof available at hand.

Reflection and justification are the two primary concepts to be taught on critical thinking. Reflexion involves guiding students to reflect them through asking them open questions viz. upon something read or heard without including closed questions that require a yes/no answer. It is also a way of asking, what makes one think that a particular article is from a reliable source, rather than asking a question to make sure whether an article is from a reliable source. Such ways help the students get encouraged to reflect on their answer rather than guessing/taking a momentary decision. Such things encourage students to think more carefully on the arguments through putting the question 'Why?'. [6]

Justification occurs due to Reflection. For an open question, students should search and use the evidence found out to make a decision about their answer. They are led to apply logical reasoning skills to ask themselves 'Wh-' questions, such as 'when?', 'where?' and 'what?' finding out supporting facts. As the students complete collecting all the supporting facts , they compare and work and based on that, a conclusion will be arrived at. They again use the supporting facts that led them to their conclusion as justification for their answer.

1.1 Critical Thinking in Secondary Education

Critical thinking is essential among the emerging students to think effectively with an open mindedness, approach situations by formulating questions with clarity, to think individually, to relate situations with different phases of life, to substantiate their views with proper evidence.

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In secondary education the teachers inculcating critical thinking should have adequate knowledge to help the students with the aspects of critical thinking. There should be open endedness among them to accept the thought process of students, and should not consider them as the lonely source of critical thinking content. Proper encouragement should be vested on the students to look upon the overall picture of critical thinking, and they should be involved in processes related to critical thinking that goes over and above the classroom activities.

The responses given by the students in a way of sharing their personal thoughts in the classroom could be used to evaluate the thought process and their inclination towards health and physical education. They are also useful in evaluation of the students' to whether their decision making capabilities towards individual well being and community are acceptable. It is also necessary to the students to understand their participation in movement culture and understand their impact upon the day today activities of them and the other people in their proximity.

The critical thinking capability of the students also help them to meet challenges and not to depend upon them as the entire sources of information besides helping them to look into the larger volume of the society beyond their classroom. The study focuses on the multi sided requirements of the students to think critically and contribute to their own self and the society in terms of their participation and the behavioural aspects. It also examines the background of critical thinking and the role played by it in the classroom and beyond that to the workplace.

Critical thinking should be thrust forward and included purposefully as part of the courses and design or redesign all aspects of the course.

Many students are unaware of this approach and are inclined upon a simple quest for correct answers, so the teachers would spend class time to talk with students on the need to think critically and creatively in the course; find out what critical thinking covers, what it appears to be, and how the assessment process is carried out.

1.2 Objectives of Critical Thinking

Critical thinking is considered as HOTS (Higher Order Thinking Skill). It goes beyond memorization and knowledge of basic facts. This means arguments upon critical thinking are criteria-based and the criteria requires distinguishing fact from fiction; synthesizing and evaluating information; to clearly communicate with others, solving problems and discovering truths. The basic goal is to improve thinking skills from lower order to higher order following Bloom's taxonomy of thinking skills, that moves upward from knowledge to comprehension, comprehension to application, application to analysis, analysis to evaluation, and evaluation to creation.

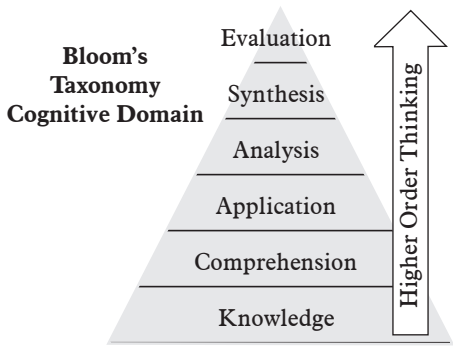

Fig. 1: Higher Order Thinking Skills [1]

Using Bloom's Taxonomy for establishing learning outcomes prevents unclear and expectations that cannot be evaluated. It leads the evaluators to think about what is learning; and how to know that the students are learning. Socratic questioning is a procedure to encourage critical thinking. It is a systematic way of organized questioning applied to find out complex ideas, to understand truth of things, to cover issues and problems, to remove assumptions, to compare and contrast concepts, to differentiate what one knows from what we know, and to get through logical results of thought" (Paul and Elder 2007) [11]

The objectives of critical thinking are always tied up with the objectives of courses imparted as part of teaching and learning. The syllabus for each course should be designed in such a way that the critical thinking component is embedded in it. Thus, all the activities, assignments and assessments aligned with the core learning objectives of the course should assess critical thinking aspects also.

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The learning objectives will cover the knowledge, skills, abilities and values the student will be able to demonstrate upon completion of the course. The activities component will include the necessary class activities and content of the syllabus that scaffold the learning outcomes of the course. The assessment process finds out how the learning or demonstration progresses towards attaining the learning outcomes of the course.

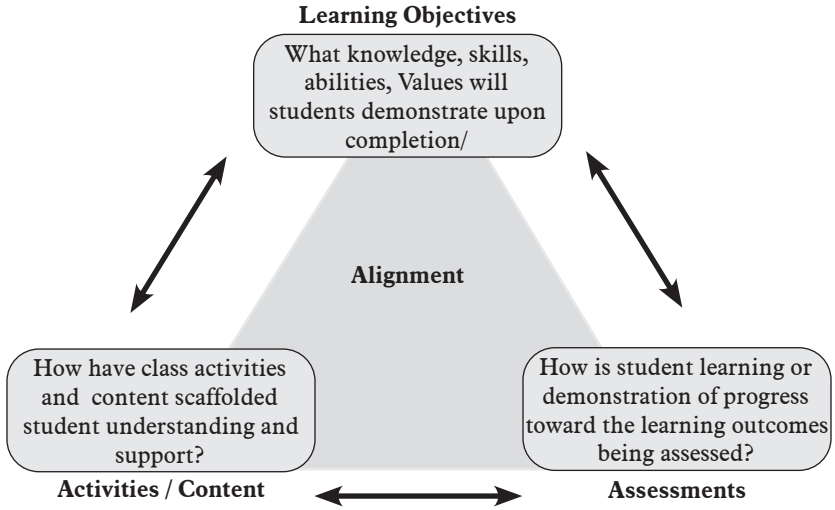

Fig. 2: Course Design Alignment [1]

The careful design of courses around student-learning outcomes upon having a strong critical-thinking component, the final assessment of students' success at reaching the outcomes will be a support of their ability to think critically. An objective type exam will be sufficient to assess lower-order levels of knowledge, whereas a project or demonstration can be required to judge synthesis of knowledge or creation of new concepts. [6]

2. Benefits of Critical Thinking in Higher Education

Critical thinking is important to the future of the aspiring students that they develop the capability to be able analyze a problem and think in all the possible angles.

The art of critical thinking can be developed due to the multitude of benefits. It improves attention and observation on and off the classroom. The capability of getting the point across and analyzing in complex situations is gained. The scores on standardized tests could be improved. Improved student understanding and thought process could be gained. The ability to transfer the skills gained to new applications could be developed among the student community. Decision making and problem solving skills could be improved among the students. The art of making wise choices in establishing human relationships is developed among secondary school students. Interrogative skills in different levels could be developed in the areas of Knowledge, Comprehension and Application. [9] [10]

The Other aspects that are also considered for learning life skills in the student life are encouragement of curiosity, enhancing creativity skills, and improvisation of problem solving ability.

Curiosity results in gaining an inner understanding of the world around us, objects that interest our experience of that world. It relates to the topics learned in school, and also the relevant things in our daily lives. [13]

Critical thinking students are basically curious in nature and expect chances to apply critical thinking capability all around them always. They stay ready for chances to apply the thinking habits gained to any situation. The inherent interest in thinking critically about even the simplest problems and activities indicates a thirst for constructive outcomes. To conclude the aspect of curiosity, critically thinking students keep on asking productive questions such as What is going on? What do they look at? What is the importance? Who is impacted by that? What is missed out? What's being hidden and how important is that? Where is the source they come from? How do they know for sure? Who delivers it? Why should they give ears to that person? What can they gain from? What else can be considered? [7]

Enhancing creativity is achieved through educators for the students to achieve excellence beyond school. Encouragement given to the students to nurture creativity is given the utmost priority. Effective critical thinkers are also considered as largely creative thinkers. Creativity is defined itself as a required skill for having a coupled

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modern workforce. Creativity is considered as a limitless strength, that one is unlimited as a creative person. If creativity is within the students, then they are also considered limitless. [8]

Students who think critically tend to be excellent problem-solvers. This is considered as the most required skill one can build upon. The children of today are the prominent people tomorrow, and come out of complex challenges applying critical thinking ability to build effective solutions. The art of patience and earnestness to truly understanding a problem is an indicator of a genuine critical thinker. This happens to be the primary reason for critical thinking ability to be considered essential to being an intelligent problem-solver. Imparting solid critical thinking skills develops our students to withstand complex problems of the real world. The most common issues such as global warming, population explosion, pollution, health care needs, water shortage, managing electronic waste and energy related issues can be tackled effectively by a capable problem solver. [5]

3. Role of Teachers in Encouraging Critical Thinking

Critical thinking has to be taught explicitly, rather than assuming to come along itself when efficient teachers teach complex stuff with students. All teachers prioritize developing their students' critical-thinking abilities, but to move from thought to advancement, teachers must bring out priority to practices that change critical-thinking instruction directly within a discipline.

Teaching critical thinking can be accomplished through carefully framed exercises and assignments that offer students openings to implement critical-thinking principles for answering queries and solving cases specific to academic stuff. [10]

Teachers can also use real life examples and purposeful practice exercises to demonstrate students upon applying critical-thinking techniques to problems outside class, such as making right decisions relating to college or work or how to avoid fiddling done by political people and advertisers. [3]

4. Role of Critical Thinking in Meeting Challenges

Critical thinking aids in making rational choices in real life. As an instance to choose a career path one faces unstable situations at some point or the other. All the options come with its pros and cons and it's important to choose carefully applying critical thinking. It helps considering the professional, financial and social aspects in the form of some critical thinking instances in real life. In such situations one should be clear about their interest and skill set, and need to answer questions such as What is important and Why is that important. Understanding the impact of the path taken will have in the next series of years is also essential, and accordingly, the career path chosen could be reworked with. To implement these aspects, some level of critical thinking is required. [4]

Critical thinking materializes intellectual self-development processes. It helps to look inwards in finding out rational explanations of decision-making processes. This brings the focus on facts and evidence rather than emotional moments and allows one to keep aside ego for assessing one's performance to step the overall performance.

Critical thinking facilitates becoming flexible in the approach towards a problem, and an effective listener and productive team member in a group set up to solve it. Also, the focus is towards facts rather than emotions or ego, one's collaboration within the team improves and helps establish one as a valuable member of the team. [2]

People thinking can handle stressful conditions much better than others. Applying logic to get through life's challenges is of immense help, and critical thinkers always have a say over non-critical thinkers in implementing it.

Whether in a school set up or at the workspot, critical thinking when combined with active listening, applying logic and getting rid of emotional decision making helps to see links that otherwise go without getting focussed. This aspect adds a lot of academic and professional weightage to the career. [12]

Conclusion

The multi sided aspects of critical thinking are discussed in detail. The importance of critical thinking during secondary education, benefits of critical thinking process in early education, inherent role of critical thinking in meeting challenges are discussed in detail, and the role of teachers in imparting critical thinking skills in the earlier stage of study is analyzed and the necessity of critical thinking process is studied and analysed all through the article highlighting the necessity of the capability.

 ISBN: 978-93-91355-21-0 (e-Book)

References

[1] Critical Thinking and other Higher-Order Thinking Skills. https://cetl.uconn.edu/resources/design-your-course/teaching-and-learning-techniques/critical-thinking-and-other-higher-order-thinking-skills/#

[2] Barell, John. Teaching for Thoughtfulness: Classroom Strategies to Enhance Intellectual Development. Longman, 1991.

[3] Brookfield, Stephen D. Teaching for Critical Thinking: Tools and Techniques to Help Students Question Their Assumptions. Jossey-Bass, 2012.

[4] Elder, Linda and Richard Paul. 30 Days to Better Thinking and Better Living through Critical Thinking. FT Press, 2012.

[5] Fasko, Jr., Daniel, ed. Critical Thinking and Reasoning: Current Research, Theory, and Practice. Hampton Press, 2003.

[6] Fisher, Alec. Critical Thinking: An Introduction. Cambridge University Press, 2011.

[7] Paul, Richard and Linda Elder. Critical Thinking: Learn the Tools the Best Thinkers Use. Pearson Prentice Hall, 2006.

[8] Critical Thinking: A Short Introduction,(2014, April), Carolyn Westbrook, https://www.cambridge.org/elt/blog/2014/04/09/critical-thinking-short-introduction/.

[9] A.K. Alwali, BENEFITS OF USING CRITICAL THINKING IN HIGH EDUCATION, 5th International Technology, Education and Development Conference, 7-9 March, 2011, Valencia, Spain.

[10] 6 Benefits of critical thinking and why they matter, (2021, September), Lee Crockett,https://blog.futurefocusedlearning.net/critical-thinking-benefits.

[11] It's Time to Get Serious About Teaching Critical Thinking, (2020,March), Jonathan Haber https://www.insidehighered.com/views/2020/03/02/teaching-students-think-critically-opinion.

[12] Examples of Critical Thinking At The Workplace & In Real Life, (2020, September), https://harappa.education/harappa-diaries/examples-of-critical-thinking/.

[13] What is critical thinking & its importance in your success, (2017, January), Priyanka Madhusudan,https://www.peoplematters.in/article/campus-recruitment/what-is-critical-thinking-its-importance-in-your-success-14793.

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Understanding Critical Thinking (CT) to Create Better Healthcare Professional

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ABSTRACT

Healthcare professionals master a huge body of data, but sometimes lack systematic problem solving ability, effective clinical decision-making. Thinking critically is an important skill, both for college kids and for the fashionable , evidence-based, healthcare practitioner. Currently, status medical reports have involved reforms in medical education to make a far better generation of doctors who can deal with the system based problems and that they would encounter in an interdisciplinary and collaborative environment and make holistic reasoned decisions for quality patient care. lately, admitting a patient to hospital means observation under a medical supervision and largely hooking the patient up to expensive monitors and watching the readouts, but that ignores the largely human aspect of patient assessments. Nursing professionals were trained to use a uniform practice of care that covers assessment, diagnosis, outcomes and also planning, implementation, evaluation etc., By using critical thinking aspect, one can dig deep and spot signs of degradation , pain or complications early, nurses can actually save lives with this critical knowledge. Academics and practitioners in medical field have raised concerns about the low levels of critical thinking and stress the necessity for fostering critical thinking among medical practitioners. This study attempts to supply a conceptual analysis of critical thinking with regard to medical education and practices along side measures to foster critical thinking during this field. Critical thinking is an important process for safe, efficient and skilful practice. The medical education schemes should adopt attitudes that promote critical thinking and mobilize the talents of critical reasoning in patient care. Critical thinking skills for healthcare professional are an important resource in training in medical community.

Keywords: *Critical Thinking, Healthcare, Medical Education, Medical Professional, Quality Patient Care, Nursing, Critical Assessment*

1. Introduction

At present, students must think during a way through dynamism, abstract problems, working in teams, distinguish good information from bad, be multilingual and global environmentally sensitive in order that they will be simpler in their disciplines. These are an equivalent attributes expected from today's medical students. [1] Doctors are expected to require effective decisions in well-defined and ill-defined medical emergency. However, in medical emergencies they're unable to form effective clinical decisions which results in untoward incidents. one of the various reasons for this is often often a scarcity of critical thinking skills among doctors. It's been reported that critical thinking should be fostered at grassroots level among the medical students which may promote better deciding once they eventually practice. The absence of an apprenticeship model of education, scarcity of emphasis on critical thinking and on acquisition of skills, and competencies have resulted in producing doctors who are incapable of independent practice. [2]

Healthcare sector can't be spared because it is fallible, susceptible to diagnostic and management errors. Every third patient faces problems thanks to diagnostic errors. the answer lies in improving the critical thinking abilities of physicians as they progress through school of medicine and internship. [1] The medical colleges must teach the scientific principle methods and evidence-based medicine, including analytical and important thinking, throughout the curriculum of medicos. [3]

For quite 50 years, Healthcare education has emphasized critical thinking as an important skill. [4] Critical thinkers without surprise have in them, confidence, contextual perspective, creativity, flexibility, inquisitiveness, intellectual integrity, intuition, open mindedness, perseverance, and reflections as their habits of mind. the worldwide standards

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for medical education at minimum level puts forward the essential components of medical education which lists critical thinking and research as a crucial component. [5] This research paper attempts to depict a conceptual analysis of critical thinking with regard to physicians.

For anyone to become a successful physician, you'll got to find out how a physician thinks on the work. In medical colleges during practice in hospitals, a physician will find out how to approach, diagnose and treat a patient and save lives, but there's more to being a critical thinker as a physician than simply having good old habits of treatment regime. Standard treatment protocols will work repeatedly , but what that just one occasion which won't work and that's when you're critical thinking skills can either save or cost a life. it's how effectively the physician uses his critical thinking skills in treating the patient and checking out the issues in minimal time. A physician with critical thinking abilities requires to handle the present situation available , content of medical knowledge, including ideas, theories, and ideas in treatment. It is also important to develop his/her intelligence and skills in order that one can become highly proficient critical thinkers in patient treatment. A physician with critical thinking ability got to be precise, complete, logical, clear and fair in his approach. of these attributes must be true, whether the physician is talking or treating. Physicians got to get obviate inconsistent, irrelevant and illogical thinking as they believe patient treatment.

2. What is Critical Thinking?

According to The American Philosophical Association (APA), critical thinking may be a purposeful, self-regulated judgment that uses cognitive tools like interpretation, analysis, evaluation, inference, and explanation to a conceptual, methodical or contextual consideration upon which a judgement is formed. [6] In other words, critical thinking is that the ability to form an objective judgment on the idea of well-supported reasons. it's the power to spot flaws in arguments and counteract claims that haven't any supporting evidence. It also enhances creativity and be ready to generate possible explanations for his or her findings, consider implications, and apply new knowledge to a broad range of social and private problems. [7] Critical thinking is usually referred as logical thought process. It's a cognitive skill which will be taught and imbibed. Generally it's perceived that critical thinkers have better decisions making abilities, are ready to solve problems better and are professionally more competent. [8] The simplified definition of critical thinking by Beyer (1995) may be a person making reasoned judgment. It otherwise means an individual makes a disciplined thought so as to assess the validity of a press release that would be an argument, a replacement concept, a replacement story, research, or maybe an easy sentence. [9]

2.1 Characteristics of Critical Thinking

Wade (1995) has sequenced eight characteristics of critical thinking. [10]

1. Questioning
2. Define the matter
3. Examine the evidence
4. Analyze the assumptions
5. Avoid emotional reasoning
6. Avoid simplification
7. Consider other interpretations
8. Dealing with ambiguity

Ambiguity may be a vital and productive component of the critical thinking process. [11] Beyer (1995) explains the varied aspects of critical thinking. [9]

Dispositions: Critical thinkers are often open-minded, very skeptical yet fair-minded, give due diligence to others evidence and reasoning, respect others views, give due credit to others points of view and can most frequently change their stance when adequately convinced by others views.

Criteria: Applying criteria to think critically to have conditions that has got to be met for something to be judged as believable.

Argument: Usually a press release or a proposal with supporting evidence. Critical thinking includes identifying, evaluating, and constructing arguments.

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Reasoning: the power to draw conclusions from one or multiple sources. so as to be ready to draw a conclusion there must be logical relationships among the statements or data from which inference is drawn.

Point of View: having the ability to see different points from various angles is that the key to critical thinking and this helps in shaping or constructing the inference.

Procedures for applying criteria: conventional thinking use a general procedure, but critical thinking uses many procedures that include questioning, making judgments, and identifying assumptions.

2.2 Critical Thinking in Reference to Health Care Professionals

Critical thinking when employed by Health professionals reflect the knowledge that they need derived from other interdisciplinary subjects so on ensure patients are provided a holistic health care. [13] Critical thinker undergoes a series of cognitive steps: [14]

1. Gathers information from verbal, written expressions, reflections, observation, experience and reasoning
2. Raises clear, well-defined questions
3. Gathers and evaluates relevant information
4. Uses ideas which will be interpreted and used effectively
5. Arrives at well-reasoned conclusion or solution
6. Tests outcomes against relevant criteria and standards
7. Uses special thought strategies consistent with task and wishes
8. Evaluates all assumptions, implications, and practical consequences
9. Communicates with others effectively in generating exemplary solutions to complex problems

2.3 How Critical Thinking can Help Medical Students?

Critical thinking helps healthcare professionals within the some ways as follows: [15-19]

1. Avoid medical/clinical errors
2. Identify better alternate options for diagnosis and treatment
3. Increases productivity
4. Enhances clinical deciding in resource-limited settings
5. Quality thinking and quality work output brings in innovation through creativity
6. Avoid litigations to an excellent extent
7. Builds confidence
8. Helps ride up the leadership ladder
9. Understand the topic matter better
10. Facilitate learn process throughout life

Conclusion

In the healthcare sector, medical professionals were known to use critical thinking, especially once they derive knowledge from other interdisciplinary subject areas to supply a holistic approach to their patients. Medicos can utilize their ability to think critically for achieving this special task.

- Avoid medical/clinical errors
- Identify better alternatives for diagnosis and treatment
- Better ability to form clinical decisions
- Working during a resource-limited environment
- Increased productivity including Quality thinking, quality work output.

To an extent, critical thinking can't only be taught but also developed and enhanced by experts through technology. As massive information is out there within this times, students only need a befitting trainer to guide them through the knowledge and inculcate within the right and proper way. Medical Students got to develop the power to use

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critical thinking skill set effectively towards complex problems and to critical choices they're forced to face, as a results of the knowledge explosion and other dynamic technological changes. Since questioning is one of the important aspects of critical thinking, it's essential to point out students the thanks to ask good, relevant and logical inquiries to think critically and succeed in important aspects of critical thinking, it's essential to show students the way to ask good, relevant, and logical inquiries to think critically and succeed.

There has been increasing recognition that medical education must focus more on the upper order thinking processes which is required to encounter the emerging challenges in medical education. Higher order thinking has become one among the essential characteristic of future health care professionals and an important attribute of medical professionalism. Hence, knowing and brooding about critical thinking has become the necessity of the hour and to explore the avenues for its application in medical education through appropriate means.

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References

[1] P H Harasym, TC Tsai, P Hemmati, Current Trends in Developing Medical Students' Critical Thinking Abilities. *Kaohsiung J Med Sci,* 24(7), 341–355, 2008.

[2] KS Jacob, Politics of Medical Education in India, *Economic and Political Weekly* 2016; 51(12), 12–15, 2016.

[3] P Dressel , L Mayhew. General Education Exploration in Evaluation. Washington, DC: *American Council on Education*; 1954.

[4] N Facione, P Facione , Externalizing the Critical Thinking in Knowledge Development and Clinical Judgment. *Nurs Outlook*, 44, 129–36. 1996.

[5] Global minimum requirements of Medical Education. http://www.iime.org/ documents/gmer.htm

[6] American Philosophical Association. Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction. *ERIC Document*, ED, 315–423, 1990.

[7] M Scriven, R Paul, Defining critical thinking: *A draft statement for the National Council for Excellence in Critical Thinking.* 1996, http://www.criticalthinking.org/University/ univlibrary /library.nclk

[8] P A Facione, CA Sanchez, NC Facione, J Gainen, The Disposition Toward Critical Thinking. *The Journal of General Education*, 44(1), 1–25,1995.

[9] BK Beyer , Critical thinking. Bloomington, IN: *Phi Delta Kappa Educational Foundation*; 1995.

[10] C Wade, Using writing to develop and assess critical thinking. Teach Psychol. 22(1), 24–28, 1995.

[11] SM Strohm, RA Baukus, Strategies for fostering critical thinking skills, *J Mass Comm Educator*, 50 (1), 55–62, 1995.

[12] EA Jones, G Ratcliff. Critical thinking skills for college students, *National Center on Postsecondary Teaching, Learning, and Assessment*, University Park, PA; 1993.

[13] R Alfaro-LeFevre, Critical thinking indicators. 2016, www.AlfaroTeachSmart.com

[14] E Krupat, J M Sprague, DWolpaw , P Haidet , D Hatem, B O'Brien, Thinking critically about critical thinking:Ability, disposition, or both? *Medical Education*. 45, 625–635, 2011.

[15] K Crosby, The Role of Certainty, Confidence, and Critical Thinking in the Diagnostic Process: Good luck or good thinking? *AcadEmer Med*. 18, 212–214, 2011.

[16] R Alfaro-LeFevre, Critical Thinking, Clinical Reasoning, and Clinical Judgment: A Practical Guide (5th ed.). St. Louis, MO: El-sevier Saunders, 2013.

[17] E Gambrill, Critical Thinking in Clinical Practice: Improving the Quality of Judgments and Decisions (3rd ed.). Hoboken, NJ: John Wiley & Sons, Inc. 2012.

[18] JG Finlayson, Habermas: Avery Short Introduction. New York, NY: Oxford University Press. 2005.

[19] SC Yanchar, BD Slife , R Warne, Critical Thinking in Disciplinary Practice. *Review of GenPsy*. 12, 265–281, 2008.

Segmentation of MRI Brain Tumor Image Using Fuzzy C-Means and Fuzzy K-Means Clustering Algorithms

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ABSTRACT

According to a report by International Association of Cancer Registries (IACR), more than 24,000 people reportedly die due to brain tumors annually. In addition to that the WHO states that around 400,000 people globally are affected with the brain tumor. MRI provides very detailed pictures of soft tissues organs like the brain. It plays a major role in determining the damages and infections in the brain but manual segmentation of the high resolution MRI images does not promise accurate results and hence automated analysis is essential.

In this work, both the C and K means clustering algorithms are implemented and checked for their performance and quality. Firstly, we are introducing the conviction of Fuzzy C Means which includes the spatial information to get a better approximate of the clusters centers and results are obtained. Secondly, we introduce the Fuzzy K means clustering, an unsupervised clustering algorithm which dispenses better computation compared to C means but time consuming. The results found after the implementations are acceptable and allow us to declare that the use of several clustering algorithms results in higher diagnosis accuracy.

Keywords: *Brain Tumor, Magnetic Resonance Imaging (MRI), Fuzzy C-Means (FCM), Fuzzy K-Means (FKM), Cluster Segmentation*

1. Introduction

Tumors are a group of anomalous cells which can be either benign or malignant. These may be classified into primary or secondary tumors. Brain tumors cause impairment in some regions of the brain and the fluid surrounding it. In order to separate the normal tissues from abnormal ones, segmentation is performed.

Segmentation, a dividing method, is carried out to segregate various types of tissues which are present in the brain cerebral region such as white matter, cerebrospinal fluid and grey matter.

Image processing is a methodology of extracting characteristics associated with the input image. This field is flourishing rapidly with its recent research covering the engineering and computer science disciplines. Classical methods such as Positron emission tomography image, Computer Tomography image and Magnetic Resonance Image are some of the image modeling techniques.

Currently, brain tumor segmentation is done manually, consuming vast amount of processing time and may have produce inaccurate results, due to the randomness in the image and feature reality of the brain tumor. This added impulse to implement automated segmentation of tumor from the image. Several automated segmentation algorithms are being developed every year.

Prior Information Guided Fuzzy C Means Algorithm, Ant Colony Optimization, Modified Fuzzy Logic Clustering, Region Growing Algorithm, Seeded Region Growing, Level Set Algorithms etc are some of the algorithms developed in the recent years.

Fuzzy logic is a computing method based on the degree of truth and not the Boolean logic. In this project, fuzzy logic is being used for its ability to decide on imprecise data. It provides a valuable flexibility for reasoning, even in case of inaccuracies and uncertainties of any situation. This theory was introduced in the year 1965 by Zadeh, based on the human decision making ability that ranges from yes to no. It mainly consists of 4 parts, Fuzzification module, knowledge base, inference engine and de-Fuzzification module.

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K-means is a grouping algorithm where attributes are grouped into number of K clusters, where K is a positive integer. Here, the grouping is mainly done by minimizing the Euclidean distance between the Cluster Centroid and the corresponding data.

In C-Meanseach data point belongs all the clusters present in the tumor image. It creates an ideal C partitions by limiting the weighted inside group amount of squared error objective function.

2. Proposed System

The proposed framework has basically four modules in particular Pre-preparing, Segmentation utilizing C-meansand K-means clustering algorithms, finding the objective function in case of C-meansand Euclidean distance in K-means and Feature extraction of different segmented regions. This project uses C-meansand K - means clustering algorithms for the betterment of the clustering process with reduced computational time. This method of automatic clustering helps the doctors to overcome the difficulties and minor mistakes that can be possible. The main Agenda of this project is to achieve higher and efficient diagnosis accuracy.

2.1 Pre-processing

Initially pre-processing is done by importing/uploading the brain MRI image as shown in Fig. 1, Fig. 3 in C-Meansimplementation and Fig. 5, Fig. 9 in K-means implementation from the database into the MATLAB toolbox. The graphics image file is read using imread command, the image will be displayed using imshow command directly without converting it from RGB to grayscale in C means. Same procedure is followed for K - means but the image should be converted into grayscale to make the process of clustering more convenient. Since the tumor image cannot be used for computational purposes, it needs to be converted to data format. A MATLAB command reshape is used by assigning the number of rows and column after which the image should be converted from (unit-8 to double) unsigned 8-bit integer. This provides the range of pixel values from (2 ^ 8-1) which is basically used for images to double type used for big numbers.

2.2 Segmentation of Bain Tumor using C-Means and K-Means Clustering Algorithms

2.2.1 C-Means

After the conversion, MATLAB function FCM should be selected by assigning data andthe number of clusters/ number of cluster centers for the FCM function to convert one-dimensional matrix array to four, two-dimensional arrays. In addition to this, it also finds thefuzzy center/vector and calculates membership function using distance formula.

2.2.2 K-Means

After the conversion, MATLAB function Kmeans should be selected by assigning data points and number of cluster centers. This enables the K means function to convert one-dimensional matrix array to four, two-dimensional arrays and also find the fuzzy center/vector and calculates membership function using Euclidean distance formula.

2.3 Objective Function in Case of C- Means and Euclidean Distance in K-Means

The comparison between geometries and definitions of coordinate systems will result inspatial functions. One way of accomplishing the grouping is through objective function clustering, which can minimize or maximize the objects to be partitioned into clusters with similar properties.

2.3.1 C-Means

The condition is checked for the minimum objective distance between last two iteration counts, if it is found to be minimum it will clustering will be terminated, else re-calculation is done to the cluster centers again and undergoes clustering. Minimum objective distance can be found by subtracting the last two iteration values.

2.3.2 K-Means

The condition is checked for the minimum Euclidean distance between the two centroids of same cluster or different cluster. If it is found to be minimum, clustering will be terminated, else recalculation is done to the cluster centers again and undergoes clustering.

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An Index Image as shown in Fig. 6. and Fig. 10. Are formed at the intermediate stage which is segmented into four different regions with the pixel value of mxn matrix (4x1 matrix). The index image shows different shades of gray, white and black, where each color represents a single cluster or region.

2.4 Feature Extraction of Different Segmented Regions

In the end, images will be segmented separately as 'Brain', 'Bone', 'Tumor' and 'Background' and plotted in different quadrants as shown in Fig. 2, Fig. 4. In C-Means and Fig. 7, Fig. 11 so that the user can identify images very accurately.

In case of K-means, the separated binary image of the tumor as shown in Fig. 8 and Fig. 12. At the end are plotted by performing opening and area opening filters to remove unwanted areas.

3. C-Means Implementation

The Main goal of FCM is to limit square amount of weighted distance between all information/data points and to focuses on cluster centers:

3.1 Mathematical calculation for brain tumor clustering

Steps involved in clustering:

1. The First step is to initialize membership matrix randomly using this equation.

$$\sum_{j=1}^{c} \mu_j(x_i) = 1 \tag{1}$$

Where i ranges from 1, 2 , 3, 4. up to k

2. Secondly, the Centroid is Calculated using the equation (2).

$$C_j = \frac{\sum_i [\mu_i(x_i)]^m x_i}{\sum_i [\mu_i(x_i)]^m} \tag{2}$$

3. Next, the dissimilarity between the data points and Centroid is calculated using Euclidian distance.

$$D_i = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \tag{3}$$

4. Updation of the newly obtained membership matrix using the equation (4) is done.

$$\mu_j(x_i) = \frac{[\frac{1}{d_{ij}}]^{\frac{1}{m-1}}}{\sum_{k=1} [\frac{1}{d_{ij}}]^{m-1}} \tag{4}$$

Here **m** is the Fuzziness index. The default range of **m** is always between [1.25, 2]

5. Unless the centroids are not changing, repeat the procedure from step 2.

Parameters

n is the Number of data points. VJ is the Cluster center.

M is the Fuzziness index/parameter. C = Number of cluster centers.

μij = Membership of data point to the cluster center

dij = The Euclidean distance among ith and jth data points and cluster center.

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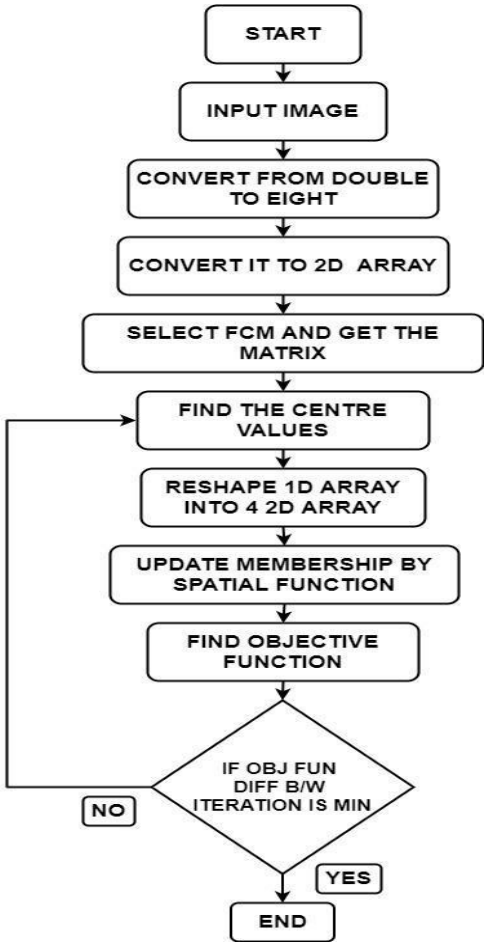
3.1 Fuzzy C-Means Flowchart

In the flowchart shown below an, input is provided and processed according to the following steps by converting it to eight from double and then converting it to 2D array.



Flowchart 1: C–Means Implementation of Flowchart

At the end of the flowchart, a condition is set to find the difference between last two iteration counts of the objective function, if it found to be minimum the process will be terminated, else the center values should be calculated again and the flowchart steps will be loop until the minimum iteration count difference is found.

3.2 Fuzzy C-Means Algorithm

The proposed method of our algorithms is as follows:

1. Select the tumor image to be clustered (ideally JPEG format) from the Google database of MRI images
2. Image will be perused by utilizing 'imread' function of MATLAB work
3. Image is generally a 2D exhibit of power esteem, converting it to a single dimensional exhibit makes the grouping simpler
4. Convert it from unit-8 to two fold kind to expand the scope of pixel esteems
5. For the picture, notice the number cycles by utilizing target work as indicated by the recipe and it shifts from one picture to another
6. FCM(Fuzzy C - implies bunching) is the inbuilt function of MATLAB for Fuzzy Clustering
7. Ascertain the fuzzy center (vector) and compute the work utilizing membership function and distance equation

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8. Reshaping the segment of one dimensional cluster to four 2D arrays
9. Showing the results of grouping
10. Four pictures will be shown as Segmented cerebrum, Segmented tumor, Segmented bone and Segmented background

3.3 Fuzzy C-Means Code

```
clear all;
clc;
close all;
clear workspace;
mri = imread('tumor1.jpg');
imshow(mri);
imData = reshape(mri,[],1);
imData = double(imData);
[IDX nn obj] = fcm(imData,4);
c1 = nn(1, :);
c2 = nn(2, :);
c3 = nn(3, :);
c4 = nn(4, :);
imIDX1 = reshape(c1, size(mri));
imIDX2 = reshape(c2, size(mri));
imIDX3 = reshape(c3, size(mri));
\imIDX4 = reshape(c4, size(mri));
figure,
subplot (2,2,1), imshow (imIDX1), title ('segmented Brain');
subplot (2,2,2), imshow (imIDX2), title ('segmented Tumor');
subplot (2,2,3), imshow (imIDX3), title ('segmented Bone');
subplot (2,2,4), imshow (imIDX4), title ('Background');
```

3.4 Output & Results

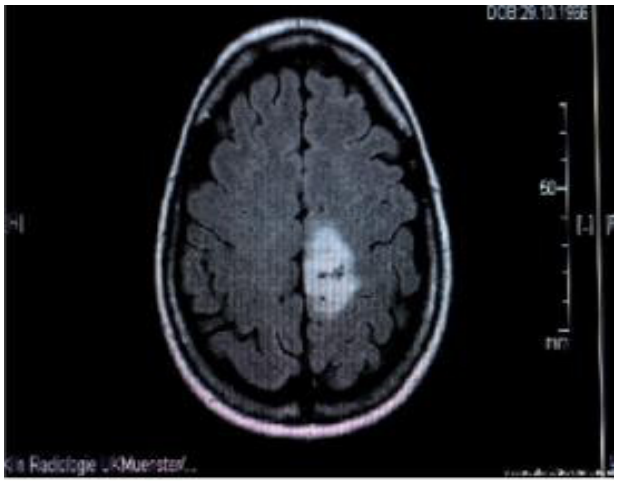

Fig. 1: Input Tumor Image

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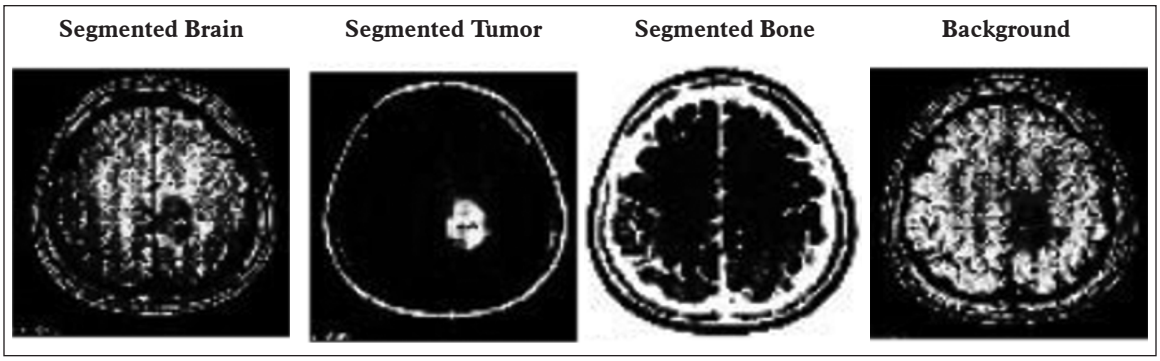

Fig. 2: Segmented Output Image

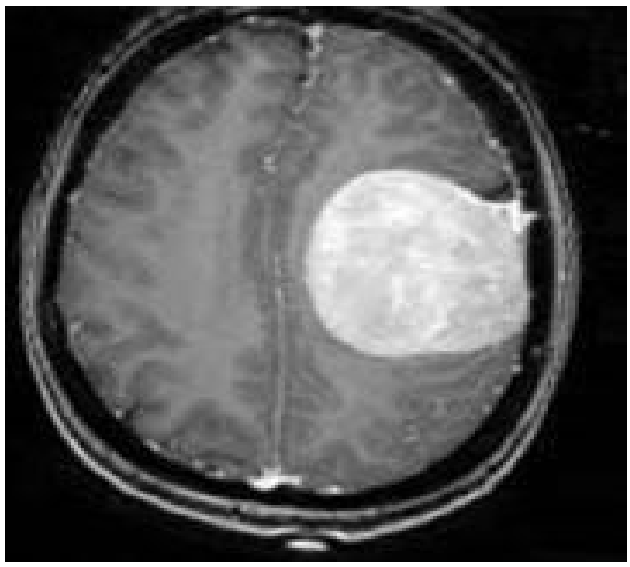

Fig. 3: Input Tumor Image

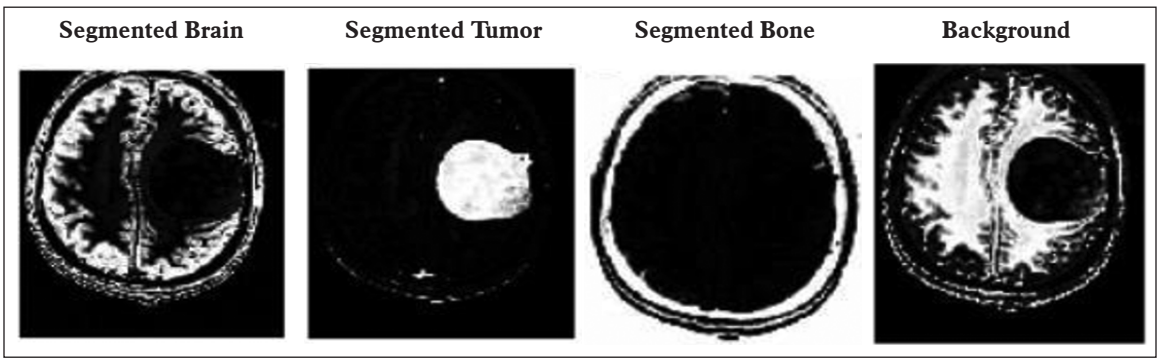

Fig. 4: Segmented Output Image

4. K -Means Implementation

K - means grouping is a technique for vector quantization, initially from signal preparing that intends to segment n data points into k clusters in which every data point is assigned with only one cluster with the closest Euclidean distance.

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K means calculation is an exceptionally famous calculation utilized for image segmentation and examination. It follows special case amplification for taking care of the issue. The partitioning of the dataset into K pre-characterized, non-overlapping and non-covering subgroups.

$$J = \sum_{i=1}^{m} \sum_{k=1}^{K} w_{ik} ||x_i - \mu_k||^2. \quad (5)$$

Where, ||xi –vj|| is the Euclidean distance between ith data and jth Cluster centroid. In which the data point xi, if it belongs to cluster *k*, wik will be 1; else, wik will be 0. Also, μk is declared as the Centroid of xi's cluster.

$$\frac{\partial j}{\partial w_{ik}} = \sum_{i=1}^{m} \sum_{k=1}^{K} ||x^i - \mu_k||^2 \quad (6)$$

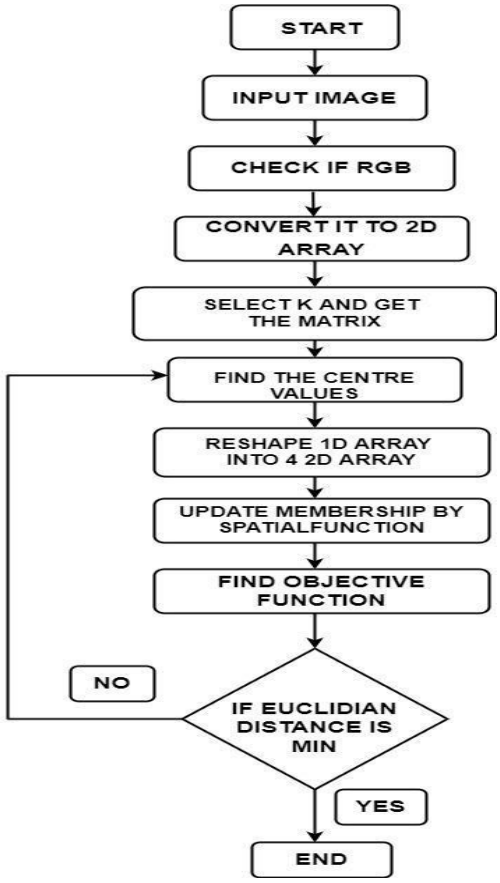
$$\Longrightarrow w_{ik} = \begin{cases} 1, \ if \ k = argmin_j ||x^i - \mu_j||^2 \\ 0, \ Otherwise. \end{cases} \quad (7)$$

$$\frac{\partial J}{\partial \mu_k} = 2 \sum_{i=1}^{m} w_{ik}(x^i - \mu_k) = 0 \quad (8)$$

$$\mu_k = \frac{\sum_{i=1}^{m} w_{ik} x^i}{\sum^m w_{ik}} \quad (9)$$

4.1 Fuzzy K -Means Flowchart

In the flowchart shown below an input is provided and processed according to the steps by converting it to eight from double and later converting it to 2D array, then the followed steps are



:.

Flowchart. 2: K-Means Implementation of Flowchart

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At the end of the flowchart, a condition for Euclidean distance between two cluster centers is checked, if found to be minimum the process will be terminated, else the center values should be calculated again and the flowchart steps will be followed until unless the minimum iteration count difference is found.

4.2 Fuzzy K - Means Algorithm

The proposed method of our Algorithms is as follows

1. Import the tumor image to be clustered (ideally JPEG format) from the Google database of MRI images.
2. If the Tumor image is in Red, Green, Blue (RGB) colour, convert it to a grey scale image, and read the image.
3. Image is generally a 2D exhibit of power esteem, converting it to a single dimensional exhibit makes the grouping simpler.
4. Convert it from unit-8 to two fold kind to expand the scope of pixel esteems.
5. Minimum Euclidean distance is to be calculated.
6. FKM (Fuzzy K - implies grouping) is the inbuilt capacity of MATLAB for Fuzzy Clustering.
7. Re-arrange the fuzzy center (vector) and compute the participation work utilizing membership function and distance equation.
8. Reshaping the segmented one dimensional cluster to four 2D arrays.
9. Display the grouping result.
10. Four pictures will be displayed as Segmented cerebrum, Segmented tumor, Segmented bone and Segmented background.

4.3 Fuzzy K -Means Code

```
close all;

clear all;

clc;

 warning off

a=rgb2gray(imread('Tumor3.jpg'));

figure, imshow(a);

imData = reshape(a, [ ] , 1);

imData = double(imData);

[IDX nn] = kmeans( imData , 4)

imIDX = reshape( IDX, size(a));

figure,

imshow(imIDX,[ ] ), title('index image');

figure,

subplot (3,2,1), imshow (imIDX==1, [ ]), title ('segmented Brain');

subplot (3,2,2), imshow (imIDX==2, [ ]), title ('segmented tumor');

subplot (3,2,3), imshow (imIDX==3, [ ]), title ('segmented Bone');

subplot (3,2,4), imshow (imIDX==4, [ ]), title ('Background');
```

```
bw = (imIDX==2);
se = ones(5);
bw = imopen(bw,se);
bw = bwareaopen(bw,400);
figure,imshow(bw)
```

4.4 Output & Results

Fig. 5: Input Tumor Image

Fig. 6: Index Image

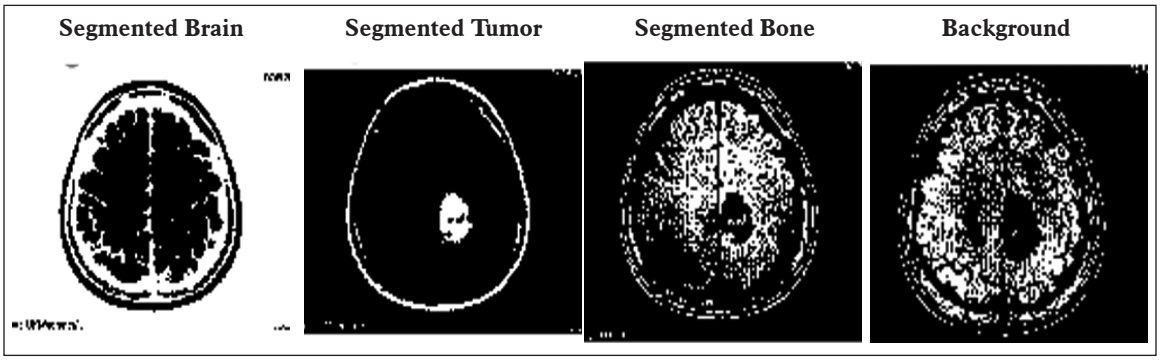

Fig. 7: Segmented OutputImage

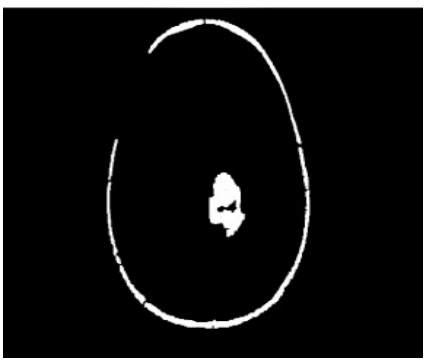

Fig. 8: Segmented Tumor Image

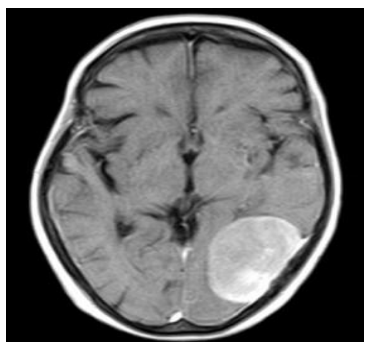

Fig. 9: Input Tumor Image

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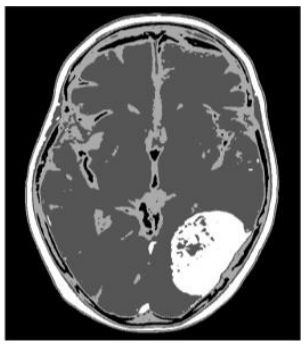

Fig. 10: Index Image

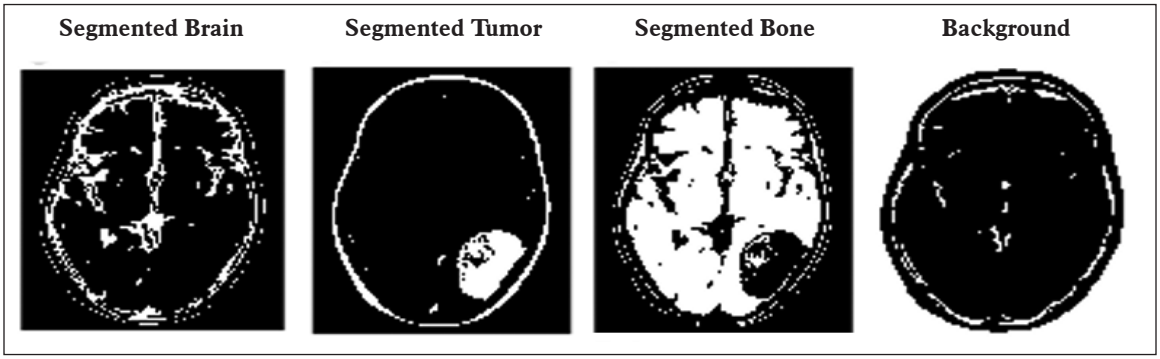

Fig. 11: Segmented Output Image

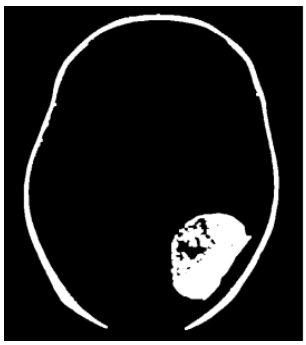

Fig. 12: Segmented Tumor Image

Conclusion

In spite of many clustering algorithms such as region developing, cross breed bunching and joint grouping, we found that the Fuzzy C - Means clustering algorithm for MRI tumor segmentation is more precise, accurate and less time consuming, extremely quick and basic. Utilizing FCM clustering and its various variations, a few issues from various regions have been adequately settled. A few alterations or hybridization with different calculations are required for effective use of the calculation in different broadened applications. In spite of being quick and basic, this calculation doesn't ensure high accuracy for MR image segmentation. Contrasted with K means calculation, the presentation and accuracy results of Fuzzy c - means calculation results in better precision. Results and the quantity of cycle checks shows that the fuzzy C method performs quick as contrasted with K-means calculation. Furthermore, the PSNR algorithm of both the calculations increments yet at the expense of time with the presentation of new modified clustering. FCM requires more calculation time than K-means grouping yet delivers close outcomes contrasted with K-means clustering.

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References

International Journal Articles

[1] Shbib, Reda, Hussein Trabulsi, and HalaSabagh. 2019. MRI Brain Image Segmentation using Modified Fuzzy Logic *Clustering (MFLC), (JUNE). ISSN: 2278-0181 IJERTV8IS060438 Published by : www.ijert.org Vol. 8 Issue 06, June-2019

[2] Kaur, Harsimranjot, and Reecha Sharma. 2016. Segmentation of tumor region from MRI brain image using modified Fuzzy C logic and seeded region growing, (SEP -OCT). *IOSR Journal of Computer Engineering* (IOSR-JCE) e-ISSN: 2278-0661,p-ISSN: 2278–8727, Volume 18, Issue 5, Ver. I (Sept - Oct. 2016), PP 20–24 www.iosrjournals.org

[3] T, Rajesh K., Geetha K, Satheesh R, and Barkath N. S. 2017. MRI Brain Image Segmentation using Fuzzy C Means Cluster Algorithm for Tumor Area Measurement (SEPTEMBER). *International Journal of Engineering Technology Science and Research* IJETSR www.ijetsr.com ISSN 2394–3386 Volume 4, Issue 9 September 2017

[4] Jose, Alan, S. Ravi, and M. Sambathh. 2014. Brain Tumor Segmentation UsingK- Means Clustering And Fuzzy C-Means Algorithms And Its Area Calculation 2, no. 3 (March). ISSN(Online): 2320–9801 ISSN (Print): 2320–9798, *International Journal of Innovative Research in Computer and Communication Engineering*, Vol. 2, Issue 3, March 2014

International Conference Papers

[5] Hooda, Heena, Om P. Verma, and 2 Tripti Singhal. 2014. Brain Tumor Segmentation: A Performance Analysis using K-Means, Fuzzy C-Means and Region Growing Algorithm. *IEEE International Conference on Advanced Communication Control and Computing Technologies* (ICACCCT). ISBN No. 978-1-4799-3914-5/14/$31.00 ©2014 IEEE

[6] Thilagam, M., and K. Arunesh. 2016. Analysis of brain MRI images for Tumor segmentation using Fuzzy C means Algorithm, *4 Proceedings of the International Conference on Electronics and Sustainable Communication Systems* (ICESC 2020) IEEE Xplore Part Number: CFP20V66-ART; ISBN: 978-1-7281-4108-4

[7] Raghate, Ganesh S., and Suresh S. Salankar. 2015. Modified Fuzzy C Means with Optimized Any colony Algorithm for Image Segmentation. 978-1-5090-0076-0/15 $31.00 © 2015 IEEE DOI 10.1109/CICN.2015.246

[8] BEDDAD, Boucif, and Kaddour HACHEMI. 2016. "Brain Tumor Detection by using a Modified FCM and Level Set Algorithms." (December).Proceedings of 20 16 4th International Conference on Control Engineering & Information Technology (CEIT -2016) Tunisia, Hammamet- December, 16-18,2016 ISBN: 978-1-5090-1055-4 © 2016 IEEE

Research Paper

[9] Almahfud, Mustofa A., Robert Setyawan, Christy A. Sari, and De Rosal I. Moses Setiadi , Eko Hari Rachmawanto. 2018. An Effective MRI Brain Image Segmentation using Joint Clustering (K-Means and Fuzzy C-Means). 978-1-5386-7422-2/18/$ 31.00 2018 IEEE

Research Article

[10] Gahukar, Sayali D., and S.S. Salankar. 2014. Segmentation of MRI brain image using Fuzzy C means for brain tumor diagnosis, (APRIL).Sayali D. Gahukar et al Int. Journal of Engineering Research and Applications www.ijera.com ISSN : 2248-9622, Vol. 4, Issue 4 (Version 5), April 2014, pp.107-111

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An Investigation of the Anticancer and Antimicrobial Activities of Green Synthesized Silver Nanoparticles Derived from *Solanum nigrum* Leaves Extract

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ABSTRACT

In this work, the silver nanoparticles (AgNP) were produced using *Solanum nigrum* leaves methanolic extract (SNLME) without the use of any non-environmentally friendly and harmful chemicals. Ultraviolet-visible spectroscopy (UV-VIS) has confirmed that biosynthesized AgNP exists. The Fourier-transform infrared spectroscopy (FTIR) spectrum was mainly utilised to confirm the presence of various functional groups responsible for the formation of nanoparticles and the spectroscopy and crystallisation of AgNP in their utilisation of biomolecules as capsulating agents. The viability of silver nanoparticles has been assessed using zeta potential calculations. A negative zeta potential showed the stability of the synthesized silver nanoparticles. The morphology of AgNP was examined using Scanning electron microscopy (SEM) which were seen to be fine round shaped particles. The AgNP showed significant action against *Staphylococcus aureus*, mild action against *Escherichia coli*, and least action against *Candida albicans*. Furthermore, the produced nanoparticles demonstrated a good IC50 value of 18.24 μg/ml against the PA1 Ovarian cell line after 24 hours of treatment. In conclusion, the findings of this study showed that manufactured Silver Nanoparticles have the potential to be a therapeutic agent for eliminating microorganisms and treating cancer.

Keywords: *Solanum nigrum, MTT Assay, Silver Nanoparticles, PA1 Ovarian Cancer Cell Line*

1. Introduction

Solanum nigrum is a dicot plant in the Solanaceae family that is used to cure a number of fatal illnesses. This plant may reach a height of three metres and has lance-shaped leaves with serrated edges. The plant family Solanaceae has over 2800 species split into 99 genera, with a diverse range that includes several commercially significant species [1]. The plant's juice is used to cure ulcers and other skin problems. Herbs and fruits are used to treat allergies and over-hunger, as they are laxatives, appetite stimulants and tonics. People have found that juice extracted from the plant's roots is effective in treating asthma and whooping cough. According to traditional medicine, the usage of the natural herb, helps to fight tumours, slows ageing, fights inflammation, improves liver health, helps remove fluid, increases urination and wards off fever. There has been various scientific research that indicate the effectiveness of the plant in fighting the development of cervical cancer in mice. Inhibition of cancer cell proliferation includes both breast and pancreatic cancer cells. Its anticancer effect is mostly reliant on the activation of various cellular and molecular pathways, which results in cell and molecular death, autophagy and tumour metastasis suppression. Because of its solvent-free nature and low toxicity, plant-based nanoparticle production has gotten a lot of interest in recent years. Furthermore, their synthesis is quicker and cheaper [2]. Bacteria, yeast and fungi have all been shown to produce AgNP during the biosynthetic process. The utilisation of these nanoparticles in a range of biological applications has been shown. Shampoos, soaps, detergents, fragrances and toothpaste, as well as therapeutic and medical goods, may include metal nanoparticles. As a consequence, they may communicate with human processes directly. This work tried and described the green synthesis of AgNP from *Solanum nigrum*. The same method was used to assess their effects on biological processes [3]. The increased need for environmentally friendly chemistry and chemical technology is becoming more necessary due to the global environmental issues we face. The overall dimension of a nanoparticle is no larger than 100 nanometres. Medical imaging contrast agents and gene transfer carriers are now significant players in clinical medicine, with uses that range from the former to the latter. Nanoparticles differ from bulk materials owing to their size in having several different features, such as chemical reactivity, energy absorption and biological mobility. Nanotechnology is the controlled manipulation and study of structures and devices with length scales ranging from one to one hundred nanometres as a consequence of atomic, chemical and macromolecular science and technological advances [4-5]. Nanoparticles, for example, take on unique properties and functionalities

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that are not seen in the bulk of objects. Nanoparticles' tiny size, surface modification and enhanced solubility open up a slew of new study possibilities for biologists [6]. Nanomaterials' more recent features enable novel techniques of communication at the extremely tiny scale amongst biomolecules that perform complicated biological tasks. Researchers from varied backgrounds may develop and create multifunctional nanoparticles capable of targeting, detecting and treating cancer in this fast-growing area. Paraphrase in formal language Physicists use the unusual features of nanometre-scaled atomic and molecule assemblies in nanotechnology, which is one of the most significant scientific endeavours of the early twenty-first century. Scientists can deliberately construct and employ nanoparticles as contrasting imaging agents for medication delivery and diagnostic reasons because we can monitor their physical, chemical and biological characteristics. In the industrialised world, epithelial ovarian cancer is the fourth largest cause of female cancer mortality [7]. The late onset of the illness, which suggests that it is extremely metastatic in the abdominal region, is typically the cause of the high fatality rate. Despite the fact that contemporary treatment effectively treats a large number of women, the majority of women with severe illness will have a recurrence within 18 months. Until chemoresistance removes further therapeutic choices, any patient is susceptible to periodic platinum-based chemotherapy retreatment, which becomes relatively chronic and devoid of any deteriorating symptoms. AgNP stop bacteria from dividing and harm their cell membranes and contents. Because of their low toxicity and wide range of in vitro and in vivo uses, silver nanoparticles are often utilised as an efficient antioxidant [8]. The unique interaction between AgNP and the disruptive breathing mitochondrial chain which leads to the production of reactive oxygen species and a decrease in the adenosine triphosphate synthesis is known to provide a powerful anti-cancer impact. Noble metal nanoparticles have gotten a lot of interest recently because of their remarkable electrical, electrical, mechanical, magnetic and chemical characteristics, which differ greatly from bulk materials [9].

Silver is one of the 500 nanomaterials that has been commercialised the most. In the future years, the yearly supply of silver nanoparticles is expected to rise. In the fields of high-sensitivity biomolecular identification, catalysis, biosensors and medicine, important inhibitory and bactericidal actions, as well as anti-fungal, anti-inflammatory and anti-angiogenesis behaviours, are recognised. Silver nanoparticles may be made via ion sputtering, chemical removal, sol gel and other techniques. Unfortunately, several nanoparticle manufacturing procedures employ toxic chemicals or demand a lot of energy, which makes purification difficult and costly [10-13]. As a consequence, chemical degradation would occur during the synthesis procedures or in future applications, posing constraints regardless of the technique used. The aesthetic sense is taken into consideration while creating the green synthesis [11]. They are crucial to the calculation and show off their abilities to the fullest. Silver nanoparticles' antibacterial properties have resulted in their usage in a number of household items, including textiles, food storage containers, household appliances and medical equipment. Silver is non-toxic and an effective antibacterial agent [6]. Silver compounds, which exhibit a broad range of antibacterial activity, have been recognised for many years as possessing strong bactericidal and inhibitory qualities and have been used for decades to prevent and treat a number of ailments [14-15].

2. Materials and Methods

2.1 Plant Material Collection

Fresh *Solanum nigrum* plant leaves were collected from Bangalore and properly cleaned with sterile water. In addition, 70g of dry plant material was weighed and immersed in 600ml of methanol before being extracted in a Soxhlet device at 100°C for 7 hours. After boiling, the solvent was cooled, filtered using Whatman filter paper and condensed for further investigation.

2.2 Silver Nanoparticles Synthesis

A 0.1 M aqueous solution of silver nitrate (AgNO3) was packed for the production of silver nanoparticles. At room temperature, a 20mg/mL leaf extract of *Solanum nigrum* was combined with 50mL of a 50mM AgNO3 solution for the bio reduction method. The first colour changes, as well as the pH shift, were recorded. A UV-Visible absorption spectrophotometer 119 with a resolution of 1 nm between 200 and 1000 nm and a scanning speed of 250 mm/min was used for the investigation. To evaluate the rate of interaction between metal ions and leaf extract, the ultraviolet-visible spectra of silver nanoparticles were examined at various time intervals up to 48 hours. Only AgNO3 solution was used as a control. Before being utilised for further characterisation and biological tests, the fluid containing the targeted nanoparticle was filtered using a 0.22-micron syringe filter and dried.

2.3 Characterization of the Synthesized Ag Nanoparticles

The optical characteristics of *Solanum nigrum* AgNP were evaluated using a UV-VIS. The decrease of Ag+ ions was detected by monitoring the spectra in the region of 200–900 nm and comparing it to a control (distilled water +

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plant extract) as a null. Using a DLS method with the Horiba between 0.2–1000 nm, the particle size distribution and zeta capacity of the *Solanum nigrum* AgNP colloid were determined. 1 ml of the sample was placed in the cuvette for hydrodynamic diameter measurement, and the device was automatically balanced for 3 minutes. 1 ml of the material was deposited in the zeta cell and duplicated three times after balancing for the zeta potency research [16]. A scanning electron microscope (SEM) is a type of electron microscope that scans with a focused beam of electrons. When electrons contact with atoms in a sample, a range of signals are produced that provide information about the sample's surface topography and composition. The resolution of a SEM is excellent (1nm). SEM was used to examine the specimens. The generated *Solanum nigrum* nanoparticles were seen using SEM. The many functional groups contained in the sample were discovered using FTIR spectroscopy. The silver nanoparticle solution was centrifuged at 10000 rpm for 60 minutes to measure the FTIR. To remove any loose proteins or enzymes that aren't encapsulating the silver nanoparticles, the pellet was washed three times with 10 mL of deionized water. The pellet was vacuum-dried and FTIR analysed.

2.4 Antimicrobial Assay

The agar well diffusion approach was used to evaluate the antimicrobial activity of synthesized nanoparticles against *Staphylococcus aureus* (MCC 2408), *Escherichia coli* (MCC 2079), and *Candida albicans* (MCC 1023). Bacteria were grown on Meuller-Hinton agar, while yeast was grown on YE Potato Dextrose agar. Fresh overnight cultures of inoculum (100 L) were spread on agar plates, and 6 mm diameter wells were cut to add 10 L of various concentrations of research sample and normal [17]. Positive controls for bacteria and yeast were Ciprofloxacin and Clotrimazole, respectively. As a negative regulation, phosphate buffer (PBS) was used. The plates were then incubated overnight at 37°C. The diameter of the inhibition region established the next day was calculated to determine the anti-microbial behaviour of the synthesized nanoparticle.

2.5 Anticancer Activity Against Ovarian Cancer PA-1 Cell Line

The Human ovarian Teratocarcinoma cancer PA-1 cell line was used to investigate the cytotoxicity of AgNP. Acclimatization of cells was performed one week previous to the experiment in a culture flask containing DMEM culture media supplemented with 1% antibiotic solution and 10% foetal bovine serum (FBS) and maintained at 37°C in a Co2 incubator. When the cells reached optimum confluence, they were planted in 96 well culture plates according to the MTT testing protocol. Cell viability was assessed after the cells were treated with AgNP at various concentrations and incubated for 24 hours at 37°C in a CO2 incubator [18]. Following incubation, the spent media was removed, and 200l of fresh media was applied to each well, supplemented by 10 l of MTT (3-(4, 5-dimethyl thiazolyl-2)-2, 5-diphenyltetrazolium bromide). Following incubation, 200 l of DMSO was added to the medium, and the optical density (OD) was determined to be 540nm.

3. Results and Discussion

Silver nanoparticles were created using a solution of *Solanum nigrum* methanolic leaf extract and silver nitrate. Silver nitrate had been neutralized using plant leaf extract, as shown by the browning of the reaction liquid. The pH was determined both before and after the nanoparticle production. The transition in pH from neutral pH 7.0 to slightly acidic pH 5.0 after nanoparticle synthesis indicated nanoparticle synthesis. Similarly, the control and treated mixtures' peaks changed during the wavelength scan, indicating nanoparticle synthesis. The formation of brown colour and, as a result, the synthesis of silver nanoparticles is depicted in Fig. 1.

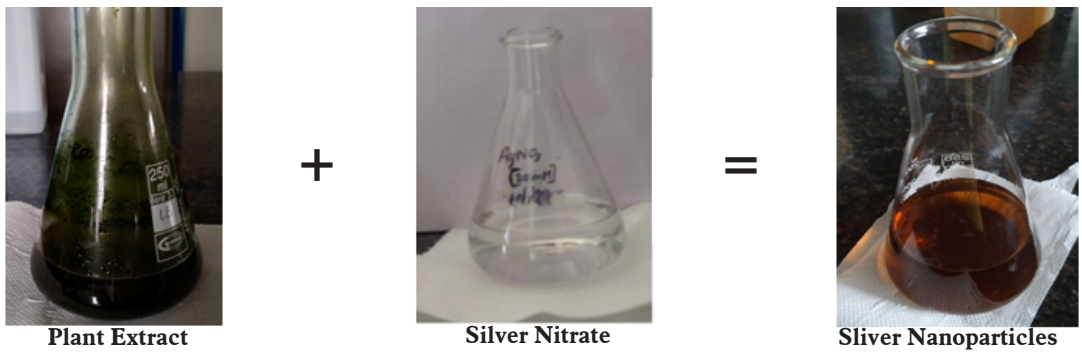

Fig. 1: Symbolizing the Brown Colour of Nanoparticles and their Production

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UV-VIS was used to evaluate *Solanum nigrum* leaf extract in the reaction solution for decreased silver nitrate. The highest absorbance peak was found at 320-370nm, and the silver nanoparticles generated were used for characterization as well as antibacterial and anticancer investigations. Fig. 2 depicts the UV-VIS spectra of silver nanoparticles synthesised from *Solanum nigrum* methanolic leaf extract. In distilled water, a 5mg/mL stock solution of nanoparticle sample was produced and sonicated for 15 minutes at 40kHz with a bath-type nicator (GT-Sonic Model: VGT-1613GTD).

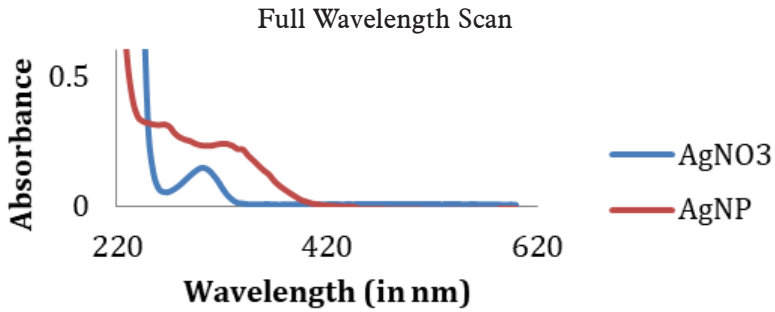

Fig. 2: Silver Nanoparticles Made from methanolic *Solanum nigrum* Leaf Extract were Studied Using UV-VIS Spectroscopy

In a cuvette, the nanoparticle suspension was diluted 10:1000 with distilled water until the FTIR analysis. The Zeta potential was found to be -34 mV, with a mean size distribution of 40 nm. The surface charge of nanoparticles is determined by their zeta potential. Nanoparticles with a Zeta Potential higher than or equal to +25 mV or less than -25 mV are generally considered relatively stable. Because of Van der Waal's inter-particle attraction, dispersions with low zeta potential values will ultimately collide. Fig. 3 shows an FTIR graph of silver nanoparticles that depicts the expected functional classes. Table 1 lists the functional groups predicted by FTIR in silver nanoparticles, and Fig. 4 depicts the Zeta potential values found.

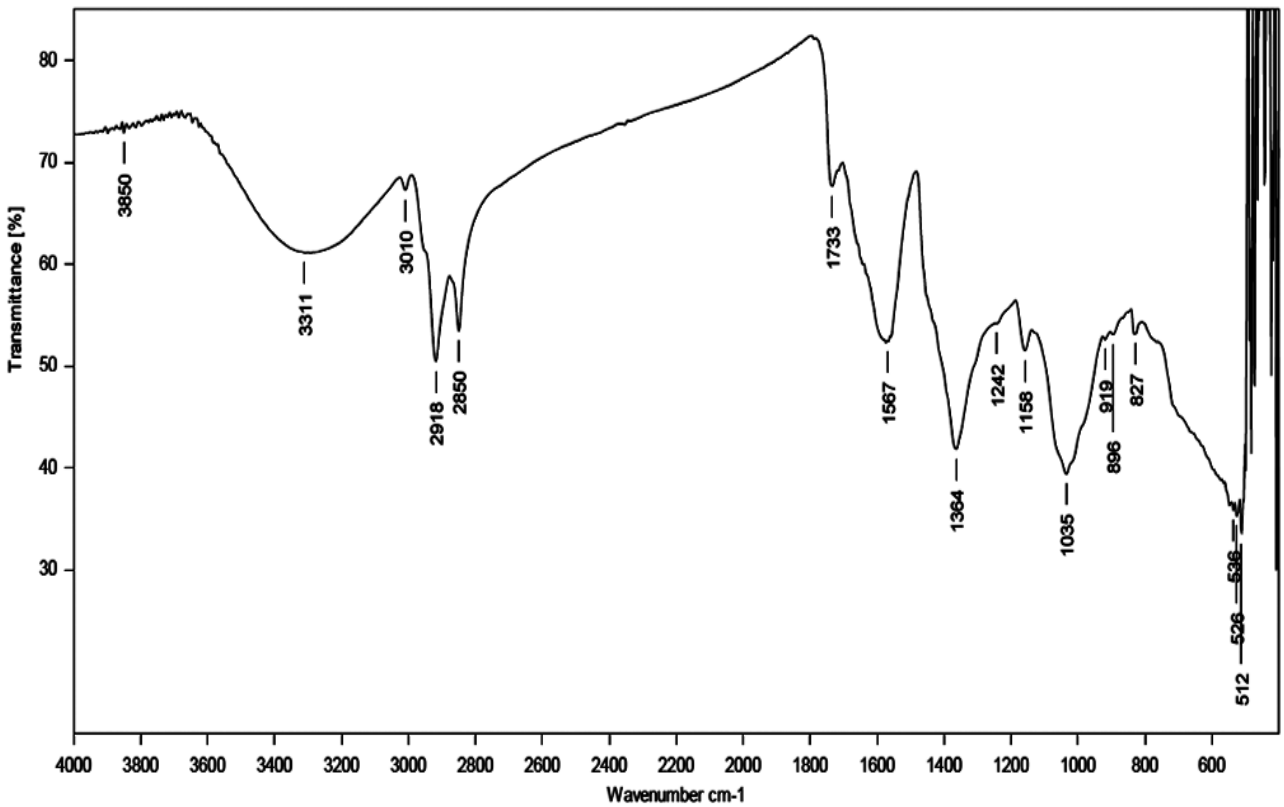

Fig. 3: The Functional Groups in Silver Nanoparticles are Predicted using an FTIR Graph

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Table 1: Silver Nanoparticle Functional Groups as Predicted by FTIR

Sl. No.	Standard Peak (cm-1)	Sample Peaks (cm-1)	Functional Group	Compound Class
1	3000	3261	O-H Stretch	Alcohol
2	2740	2945	C-H Stretching of Methylene Group	Alkane
3	1678	1832	C=O Stretch	Carboxylic Acid
4	1598	1577	C-N	Amide
5	1578	1546	N-O Stretching	Nitro Compound
6	1230	1354	COO^-	Symmetric Stretch of Carboxyl Anion ; Linked To Amide
7	1350	1155	C-O Stretching	Primary Alcohol
8	1085	1045	C-C Stretching	Alkane
9	650	827	C=C Stretching	Alkene
10	630	536	C-I	Halo Compound

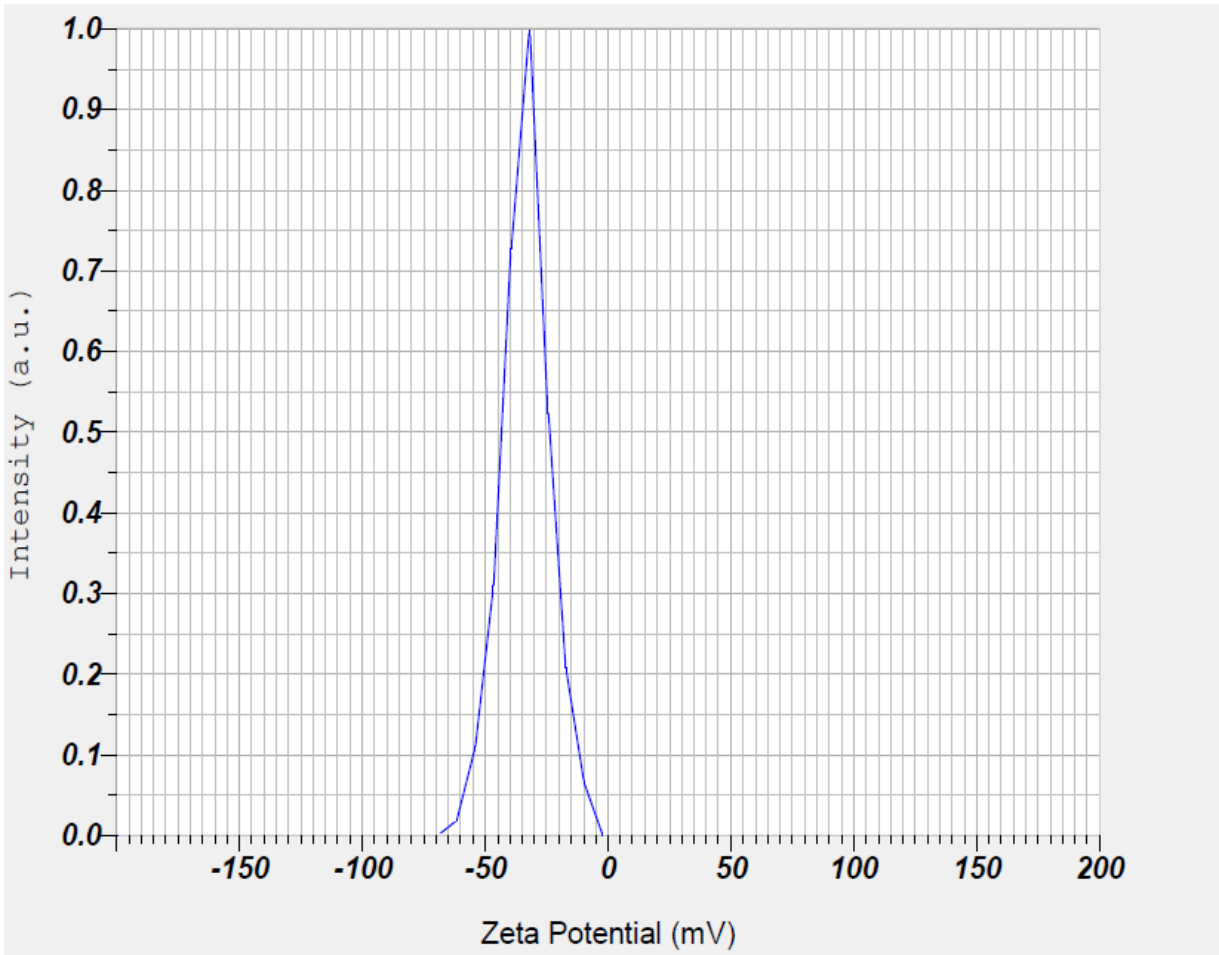

Fig. 4: The Zeta Potential of a Synthesised Silver Nanoparticle is Shown

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Fig. 5 illustrates high-density Ag-NPs produced by *Solanum nigrum* leaves extract from the SEM investigation. The white individual dots in the SEM image are silver nanoparticles, whereas the bigger spots are silver nanoparticle aggregates. The majority of the silver nanoparticles are 6.2 nm in diameter and are spherical and standardised Ag-NPs with sizes ranging from 6 nm to 7.9 nm. Even when aggregated, the capping agent guaranteed that the nanoparticles remained stable and did not come into touch with one another. During SEM examinations, bigger silver nanoparticles were observed, which might be the result of smaller ones aggregating.

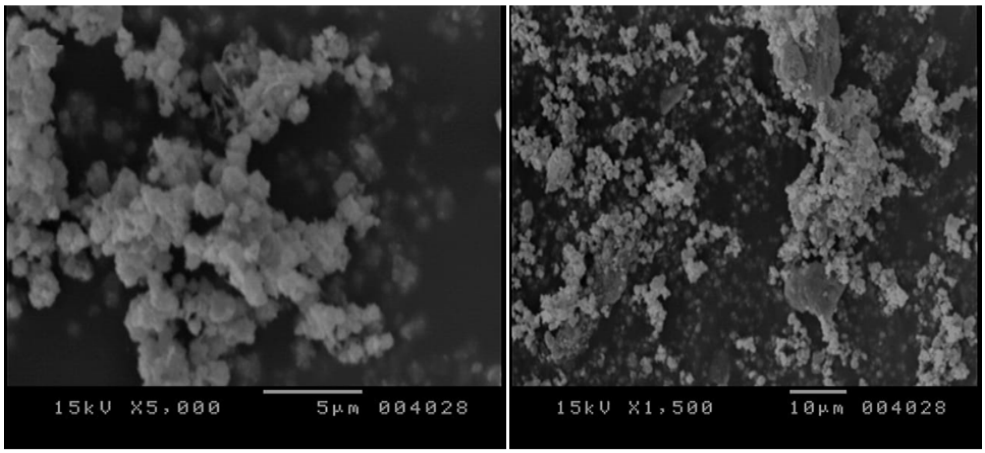

Fig. 5: The Lyophilized Silver Nanoparticles were Predominantly Spherical Particles with a Size of Less than 40 nm, According to Scanning Electron Microscopy Pictures

When discussing antimicrobial trials, it's important to remember that the results are dose-dependent. In comparison to the monitor, it demonstrated positive inhibitory behaviour against the tested organisms. Well 1 represents 5 mg/mL, well 2 represents 10 mg/mL, well 3 represents 15 mg/mL, well 4 represents harmful regulation, and well 5 contains 10 mg/mL Ciprofloxacin/Clotrimazole as a supportive monitor. Table 2 shows the inhibition zones obtained with various concentrations of silver nanoparticles to supplement the results. The PA-1 ovarian cancer cell line was used to test the antiproliferative activity of the synthesised nanoparticle. These cell lines are created from tumours with a variety of chromosomal defects. The ovarian teratocarcinoma cell line PA-1 has a single chromosomal aberration: a reciprocal t(15;20) translocation (p11.2;q11.2). These cells were sub cultured until they reached 90-100 per cent confluency before being counted for cryopreservation using a Hemacytometer. In a second MTT assay, the IC50 for 24h therapy against the PA1 Ovarian cancer cell line was determined to be 18.24 μg/ml. Figure 7 shows a graph highlighting the silver nanoparticle concentrations that trigger cytotoxicity in the PA1 Ovarian cancer cell line. Silver nanoparticles suppress the growth of the PA1 Ovarian cancer cell line in Fig. 8, allowing us to compare the texture of cells in the control and nanoparticle-treated groups. It is found that at a concentration of 18.24 μg/ml, it can destroy 50% of the cells, meaning that it has a positive cytotoxic effect on ovarian cancer.

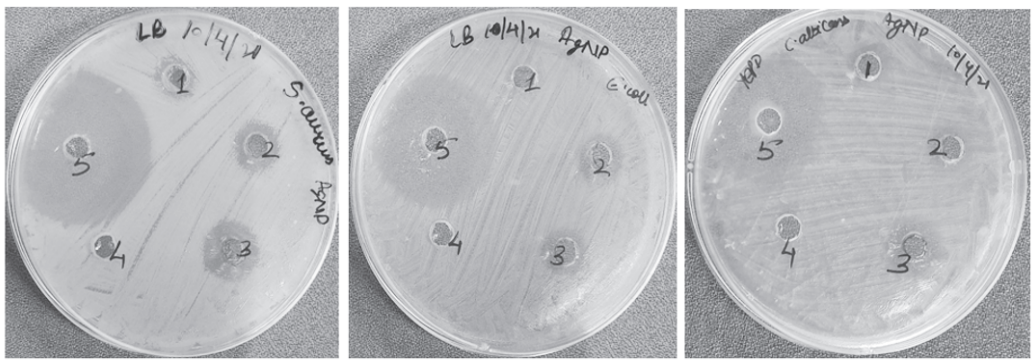

Fig. 6: Petri Plates with Inhibitory Zones Created by Several Organisms. Well 1 – 5 mg/mL AgNP (10μL); Well 2 – 10 mg/mL AgNP (10μL); Well 3 – 15 mg/mL AgNP (10μL); Well 4(-) - PBS (Negative Control) (10μL) and Well 5 (+) - 1mg/mL Ciprofloxacin/Clotrimazole (Positive Control) (10μL).

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Table 2: The Inhibitory Zones Produced by Varying Amounts of Silver Nanoparticles are Depicted

Microorganism	Test Extract	Zone of Inhibition in mm			Positive Control (+)	Negative Control (-)
		5 mg/mL (1)	10 mg/mL (2)	15 mg/mL (3)		
S.aureus	AgNP	11	15	22	48	-
		15	16	27	49	-
E.coli	AgNP	8	17	19	38	-
		9	19	16	39	-
C.albicans	AgNP	18	16	20	29	-
		17	18	19	28	-

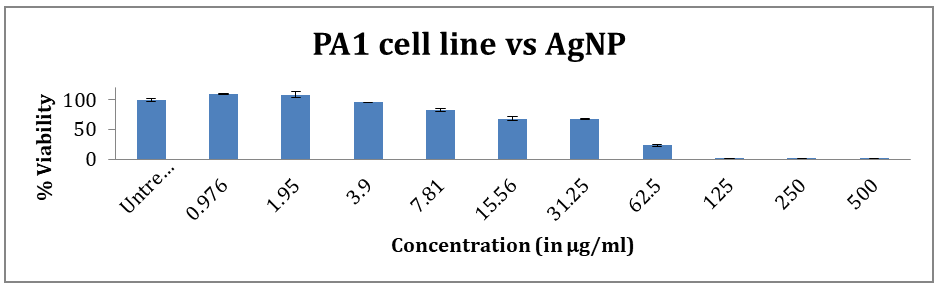

Fig. 7: The Cytotoxicity of Silver Nanoparticles Against the PA1 Ovarian cancer Cell Line is Depicted in the Graph Below

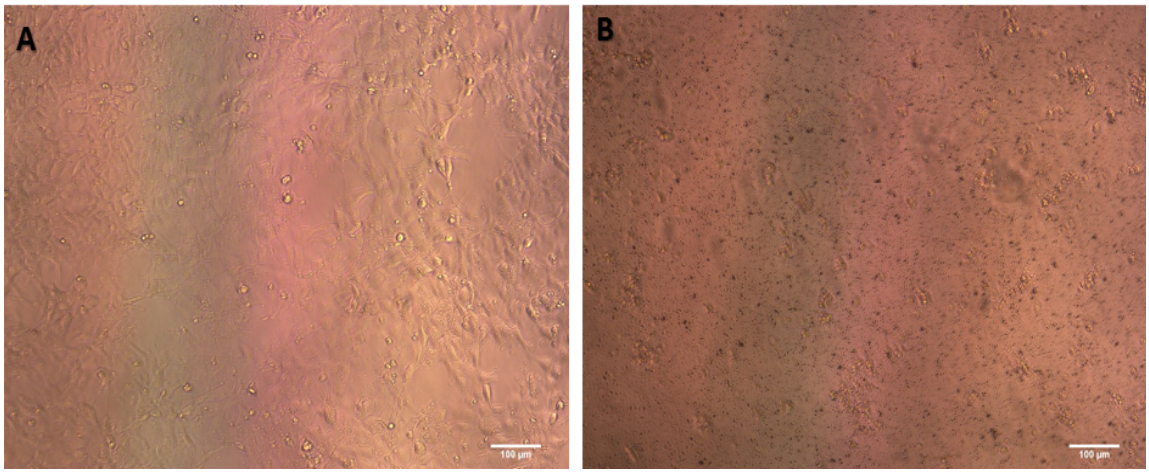

Fig. 8: Silver Nanoparticles have Anti-Proliferative Properties Against the PA1 Ovarian Cancer Cell Line. A-cells as a Control, B-cells Treated with Nanoparticles

Green synthesis of silver nanoparticles utilizing biological microorganisms or plant extracts has developed into an easy and less expensive alternative to chemical synthesis. Since it is always environmentally safe and cost-efficient, this biological approach outperforms chemical processes. Plant extracts-mediated AgNP synthesis has also been shown to be beneficial among biological processes [19]. Using methods such as UV-VIS, Fourier Transform Infrared Spectroscopy, Scanning Electron, Microscopy Transmission Electron and Spectroscopy Research, Silver Nanoparticles may be identified and analysed till created. UV-VIS typically observes surface plasm resonance of nanoparticles at 320-370 nm. In addition, Fourier Transform Infrared Spectroscopy studies reveal that the plant extract functions as a reduction and capping agent for the Silver Nanoparticles. The synthetic nanoparticles are

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round, according to electron microscopy, and they are around 20-52 nm in size for better uses [20]. Another concept is that metal nanoparticles are adaptable agents for many uses, in particular nanomedicine for very sensitive testing, thermal ablation, improved radiation treatment, medication and gene transfer. Research has demonstrated that plant extract chemicals are used in synthesis to function AgNP as reductants and cap agents, resulting in negatively loaded surfaces with high zeta potential in a wide variety of pH ranges, between acidic and alkaline environments. Biological trials using pathogenic cell viability strains and tests have shown that AgNP produced are not hazardous to mammalian cells and have a high antibacterial effect. Often coupled with an interplay of silver and caping layers that include natural chemicals, the synergistic combination is an alternative to AgNP. S. *nigrum* extracts and purified substances have since been used in animal models to research antitumor, antiseizure, anti-inflammatory, and hepatoprotective behaviours. The extract has been found to have beneficial results in the majority of trials. As a consequence, the final findings highlight the strongest nanoparticles synthesized in terms of physical and chemical requirements, as shown by techniques such as UV-VIS, FTIR, Zeta potential and SEM. Biological tests, such as antimicrobial and anticancer activity, produced promising results, lending credence to the plant's use in conventional medicine. While dispersed experiments have suggested that nanoparticles synthesized from S. *nigrum* are a potential therapeutic agent, further research is needed to validate and improve their use in treating specific ailments.

Conclusions

According to the findings of this study, the Methanolic leaf extract of S. *nigrum* possesses good reducing and capping characteristics for the green synthesis of AgNP. UV-V spectroscopy was used to determine the reactivity of reduced silver nitrate with a leaf extract of *Solanum nigrum*. The highest absorption peak was recorded for *Solanum nigrum* at 450 nm, respectively. The FTIR spectrum was utilised to assess the existence of diverse functional groups and it was discovered that alcohol, alkane, amide and nitro groups were the predominant functional groups. The Zeta potential was observed to be -34 mV and the mean size distribution was 40 nm. The zeta potential of nanoparticles determines their surface charge. Generally, nanoparticles having a Zeta Potential greater than or equal to +25 mV or less than -25 mV are relatively stable. SEM was utilised to determine the morphology of AgNP, which was determined to be spherical in form. The synthesized AgNP have a strong antimicrobial property and can therefore be used to tackle the proliferation of multidrug-resistant strains. According to the findings, the synthesised silver nanoparticle has a significant inhibitory activity against *Staphylococcus aureus* and a mild reaction against *Escherichia coli*. It had a strong degree of inhibitory activity against *Candida albicans*, a yeast that was included in the analysis. The produced AgNP have a high antibacterial activity and may thus be utilised to combat the spread of multidrug-resistant pathogens. Furthermore, the synthesised Silver Nanoparticle (AgNP) demonstrated an IC50 of 18.24 μg/ml against the PA1 Ovarian cancer cell line within 24 hours of treatment, demonstrating that the produced nanoparticle is a promising agent in cancer therapy. Because green synthesis is an ecologically sustainable, efficient, and low-cost technique, nanoparticles derived from this plant species might be employed instead of extracts to inhibit or prevent cancer cell growth.

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References

[1] S Pal, Y K Tak, J M Song, Does the antibacterial activity of silver nanoparticles depend on the shape of the nanoparticle? A study of the gram-negative bacterium *Escherichia coli*, *Applied and Environmental Microbiology*, 73 (6), 1712–1720, 2017.

[2] N Prabhu, D T Raj, K Yamuna Gowri, S Ayisha Siddiqua, D Joseph Puspha Innocent, Synthesis of silver phyto nanoparticles and their antibacterial efficacy, *Digest Journal of Nanomaterials and Biostructures*, 5(1), 185–189, 2010.

[3] N. Chouhan, Silver nanoparticles: Synthesis, characterization and applications. In Silver Nanoparticles-Fabrication, Characterization and Applications, *Intech Open*, 11 (2), 21–57, 2018.

 ISBN: 978-93-91355-21-0 (e-Book)

[4] B Nair, T Pradeep, Coalescence of nanoclusters and the formation of sub-micron crystallites assisted by *Lactobacillus* strains, *Crystal Growth and Design*, 2 (4), 293–298, 2012.

[5] S Garima, B Riju, K Kunal, R S Ashish, P S Rajendra, Biosynthesis of silver nanoparticles using *Ocimum sanctum* (Tulsi) leaf extract and screening its antimicrobial activity, *Journal of Nanoparticle Research*, 13(7), 2981–2988, 2011.

[6] A Singh, D Jain, M K Upadhyay, N Khandelwal, H N Verma, Green synthesis of silver nanoparticles using *Argemone Mexicana* leaf extract and evaluation of their antimicrobial activities, *Digest Journal of Nanomaterials and Biostructures*, 5(2), 483–489, 2010.

[7] K Ratika, and A Vedpriya, Biosynthesis and characterization of silver nanoparticles from aqueous leaf extracts of Carica papaya and its antibacterial activity, *Int. J. Nanometre*, 13(2), 17–20, 2013.

[8] D V Parikh, T Fink, K Rajasekharan, Antimicrobial silver/sodium carboxymethyl cotton dressings for burn wounds, *Textile Research Journal*, 75(2), 134–138, 2005.

[9] V Alt, T Bechert, P Steinrucke, An in vitro assessment of the antibacterial properties and cytotoxicity of nanoparticulate silver bone cement, *Biomaterials*, 25(18), 4383–4391, 2004.

[10] G Gosheger, J Hardes, H Ahrens, Silver-coated megaendoprostheses in a rabbit model—an analysis of the infection rate and toxicological side effects," *Biomaterials*, 25(4), 5547–5556, 2004.

[11] M E Rupp, T Fitzgerald, N Marion, Effect of silver coated urinary catheters: efficacy, cost-effectiveness, and antimicrobial resistance, *American Journal of Infection Control*, 32(8), 445–450, 2004.

[12] R Anjali, G Anupam, C Goutam, Mosquito larvicidal and antimicrobial activity of synthesized nano-crystalline silver particles using leaves and green berry extract of *Solanum nigrum L*, *CAA Cancer J. Clin*, 18(1), 17-19, 2016.

[13] K S Prasad, D Pathak, A Patel, Biogenic synthesis of silver nanoparticles using *Nicotiana tobaccum* leaf extract and study of their antibacterial effect, *African Journal of Biotechnology*, 10(3), 8122–8130, 2011.

[14] M Vivek, P S. Kumar, S Steffi, S Sudha, Biogenic silver nanoparticles by *Gelidiella acerosa* extract and their antifungal effects, *Avicenna Journal of Medical Biotechnology*, 3(3), 143–148, 2011.

[15] D Jain, H Kumar Daima, S Kachhwaha, S. L. Kothari, Synthesis of plant-mediated silver nanoparticles using papaya fruit extract and evaluation of their anti-microbial activities, *Digest Journal of Nanomaterials and Biostructures*, 4(3), 557–563, 2019.

[16] P Kumar, S S Selvi, A L Prabha, K P Kumar, R S Ganeshkumar, M Govindaraju, Synthesis of silver nanoparticles from Sargassum tenerrimumand screening phytochemicals for its antibacterial activity, *Nano Biomedicine and Engineering*, 4(5), 12–16, 2012.

[17] N Sap-Lam, C Homklinchan, R Larpudomlert, W Warisnoicharoen, A Sereemaspun, and S. T. Dubas, UV irradiationinduced silver nanoparticles as mosquito larvicides, *Journal of Applied Sciences*, 10(23), 3132–3136, 2010.

[18] C MarambioJones, E M V Hoek, View of the antibacterial effects of silver nanomaterials and potential implications for human health and the environment, *Journal of Nanoparticle Research*, 12(5), 1531–1551, 2020.

[19] M D A Farooqui, P S Chauhan, P Krishnamoorthy, J Shaik, Extraction of silver nanoparticles from the left extracts of clerodendrum incerme, *Digest Journal of Nanomaterials and Biostructures*, 5(1), 43–49, 2019.

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Interlink between Fingerprint, Brain Lobe & Psychology of an Individual Alongside Dermatoglyphics Multiple Intelligence Test

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ABSTRACT

The epidermal ridges seen on the palm, sole, fingers, and toes are referred to as dermatoglyphics. These epidermal ridges are generated during the same intrauterine time as neural development in a fetus's intrauterine existence. Dermatoglyphics and fingerprint patterns are used to determine a person's brain dominance and personality. Fingerprints, palm prints, and foot patterns on the 10 fingers, 10 toes, palmar, and plantar surfaces, respectively, mirror the many areas of our brain, and these dermatoglyphics symbolise the various sections of brain. Fingerprints reveal a variety of traits, including those of identical twin infants. Individual features, consistency, and unique patterns are the fundamental principles of fingerprints. Fingerprint imprints are regarded as representations of human brain cells. The size and location of brain lobes affect fingerprint development. The size and location of brain lobes affect fingerprint development. The Dermatoglyphic Multiple Intelligence Test is a scientific investigation of fingerprint patterns based on knowledge of Neuroscience, Genetics, Dermatoglyphics, Psychology, and Embryology. Fingerprint categorization, fingerprint sensing, and fingerprint reader are all part of the Dermatoglyphic Multiple Intelligence Test. By administering a DMIT exam to each individual, they will be able to enhance their personality, learning styles, thinking, and brain dominances.

Keywords: *Dermatoglyphics, Fingerprint Pattern, Dermatoglyphic Multiple Intelligence Test, Brain Lobes, Personality, Learning styles, Thinking, Brain dominances*

1. Introduction

Psychometrics is a field of psychology that examines psychological measuring theory and practise. It's all about evaluating people's abilities, attitudes, personality traits, and educational achievements objectively. A reliable, valid est that has been validated on a population sample.

Young people and students can use psychometric analysis to help them make career selections. "Every human being is different," and those who recognise this are more successful than those who don't. Psychometric analysis aids in the identification of talent, allowing one to pick a job that best matches their abilities. When an instrument generates a score that is utilised for high- stakes business choices like recruiting, performance evaluations, prospective assessments, culture audits, or management effectiveness, psychometric analysis is required. The DMIT Test Assessment technique was created by scientists and medical experts. Institutions from all across the world have approved the DMIT Test. According to medical experts and clinical experience, finger prints provide an accurate examination of people's Multiple Intelligences and inborn potential. Only an IQ test has traditionally been used to evaluate a person's degree of intelligence. Dermatoglyphics is the scientific study of fingerprint patterns. The Dermatoglyphics Multiple Intelligence Test combines a scientific study of Brain Lobes, 9 Multiple Intelligence, and Human Psychology with fingerprints to create the Dermatoglyphics Multiple Intelligence Test. Throughout the foetal stage, developmental and genetic variables play a significant influence in fingerprint formation. Developmental variables include the physical status of the foetus in the womb, as well as the length of the umbilical cord. Experts, on the other hand, believe that fingerprints are the consequence of our DNA. Though the genetic coding of the foetus does not completely define the patterns that will appear on the fingertips, it does identify the components that will cause fingerprints to develop. Fingerprints are closely connected to an infant's intellectual development. Between the 13th and 19th weeks of an embryo's development, fingerprints are formed. After the 13th week, fingerprints begin to appear inside the embryo. By the 24th week, it had stabilised. The connection between fingerprint patterns and human brain lobes has been studied in several research. The number and progression of ridges in the finger prints can be used to evaluate the brain lobes. Everyone's fingerprints are

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unique, according to medical professionals. Fingerprints reveal a wide range of traits, including those shared by identical twins. Fingerprint imprints are thought to reflect human brain cells.

Dermatoglyphics and Multiple Intelligence: Dermatoglyphics research is generally more than 200 years old. In the 1970s, dermatoglyphics was mostly utilised to select competent athletes for the Olympics. Dermatoglyphics, somatotype, and fundamental characteristics profile are utilised by Brazilian Military Athletes to improve their performance. Dr. Harold Cummins is the creator of Dermatoglyphics. Harold Cummins is widely regarded as the "Father of Dermatoglyphics."

He looked at nearly every element of fingerprint analysis in a variety of industries. Dermatoglyphics was developed to identify hereditary disease using fingerprint patterns. Dermatoglyphics were created as a result of the Down Syndrome theory. In 1983, Dr. Howard Gardner created the phrase "multiple intelligence." The Multiple Intelligence Theory (MI. Theory) was developed particularly to address issues in education and psychology. Each kid is born with a distinct combination of intelligences. According to Garret, various types of intelligences may be discovered by analysing a person's fingerprints, which is generally done through a test called the Dermatoglyphics Multiple Intelligence Test (DMIT) (2014).

2. Objectives of the Study

The goal of this study was to evaluate the Dermatoglyphics Multiple Intelligence Test results (DMIT). This study was performed to evaluate the DMIT's prominent qualities, as well as the respondents' perceptions of its advantages, with the goal of determining the DMIT's implications for improving an individual's life in all aspects.

2.1 Research Methodology

The research technique utilised in the study's conduct has been explained in this project. The study's goal is to look into "Consumer Awareness of DMIT and PSYCHOMATRIC Test." The research attempts to address all areas of consumer awareness and perception of DMIT and PSYCHOMATRIC TEST. This methodology describes the general goal of the research, data collecting methods, sample procedures, questionnaire creation, and analytic tools. A research technique is a method for solving a research problem in a methodical manner. It may be thought of as a science that studies how scientific research is carried out. We look at the numerous stages that a researcher takes to investigate his research topic, as well as the reasoning behind them. Theresearcher must understand not just the research methods and procedures, but also the approach.

2.2 Research Design

This study used the descriptive research approach. The research design refers to the method used to describe data as well as the characteristics used to characterise the population. The objectiveof descriptive research is to collect data that is trustworthy, accurate, and methodical in order to provide readers a realistic picture of the data set they're looking at.

A well-run research project will have a well-defined data collection system. This paradigm underpins the study's design. This is a descriptive study. It reflects public opinion and the effectiveness of foreign education and DMIT. Non-probability sampling was employed in this research.

2.3 Sample Size

The study's respondents include 50 people between the ages of 15 and 50 who were purposefully picked from various academic institutions across India, notably in cities. Similarly, the study's respondents include 50 people ranging in age from 15 to 50 years old from Bengaluru's schools, colleges, kindergartens, and corporate offices.

2.4 Instruments

The researchers employed documented materials in the form of DMIT reports, the questionnaire, and the Interview Schedule (IS) as basic data collection techniques to achieve the study's first and second objectives. The data was analysed with the help of Microsoft Excel. Microsoft Excel is a business-oriented spreadsheet programme. The app was used to organise and analyse the rawdata gathered during the survey. Excel was also useful for creating graphical representations of the data that had been categorised.

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2.5 Procedures

2.5.1 Dermatoglyphics Multiple Intelligence Test Software

It is software designed to know about an individual personality, brain dominance, multiple intelligences, lobe analysis, neuron distribution, acquiring style, learning style, quotients, SWOT based analysis, management skills, suggested subjects, suggested activities, individual's strength,weakness, goals.

2.5.2 Process of using DMIT Software

Software consists of two sections, collection of individual's data which includes their personal details and their fingerprints using scanner. All the 10 fingerprint patterns are collected as: Left Hand: L1- Thumb finger, L2 – Index finger, L3 – Middle finger, L4 – Ring finger, L5 – Little finger. Similarly for Right Hand designated as R1, R2, R3, R4, R5.

Next part of software is the report generation software in which the collected data is analysed for the fingerprint patterns and ridge counting is performed and fed into the software with key terms as follows: L represents the Loop pattern, RL represents the reverse loop pattern, WC represents the whorl composite pattern, WT represents the whorl target pattern, WSE represents the whorl simple elongated pattern, WTEP represents the whorl target elongated peacock pattern, WTP represents the whorl target peacock pattern, WDL represents the whorl double loop pattern, WDLP represents the whorl double loop peacock pattern, AS represents the simple arch pattern, TA represents the tented arch pattern. The ridge counting of each fingerprint pattern is performed stating diagonally from delta moving towards the core neglecting the minutiae present. On providing this information, personal details and fingerprint pattern with ridge counts to the software, report will be generated regarding an individual brain and personality analysis. The report is counselled for respective individual. The generated reports were explained to each individual.

Sample: The given sample consists of fingerprint pattern, ridge counts.

				
L1	L2	L3	L4	L5
WDLP	WDL	L	L	L
23	20	18	18	19

				
R1	R2	R3	R4	R5
WDL	WDL	L	WDLP	WDLP
24	21	18	24	20

2.6 Data Analysis

Analysis and interpretation, like with any data, are required to bring order and understanding to the research. This necessitates creativity, commitment, and a rigorous approach. As a result, in this study, the Taylor-Power and Renner (2003) techniques for assessing data from questionnaires and interview schedules were used. This comprises gathering information about the data, reducing the scope of the analysis, categorising the data, identifying patterns and correlations within and between categories, and interpreting the results.

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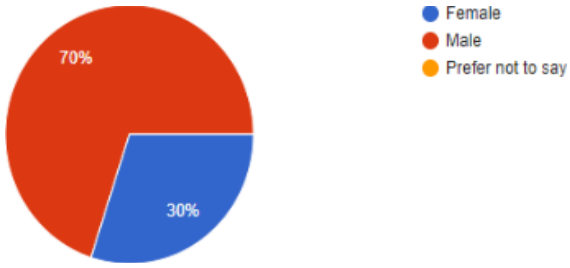
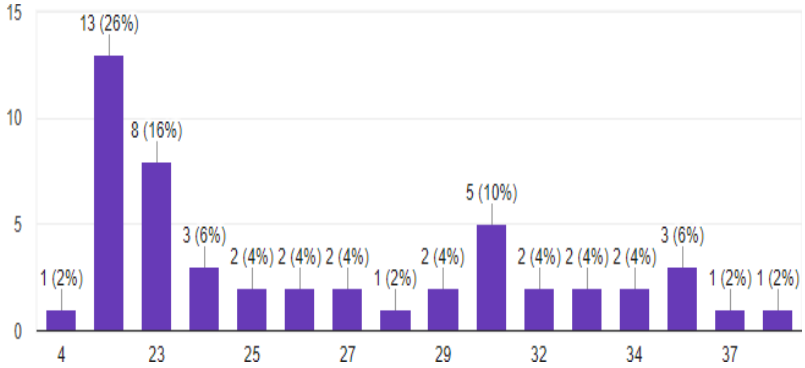
Q. 1. Gender



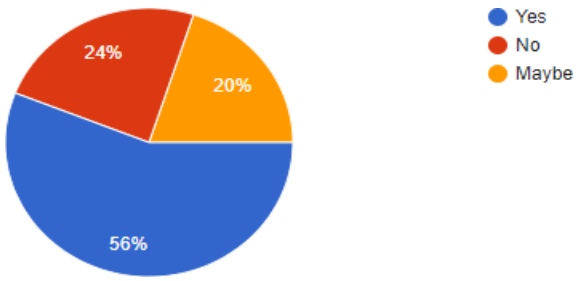
Interpretation: Above Graph shows that : 70% of Respondents are male and rests 30% are female.

Q. 2. What is your age?



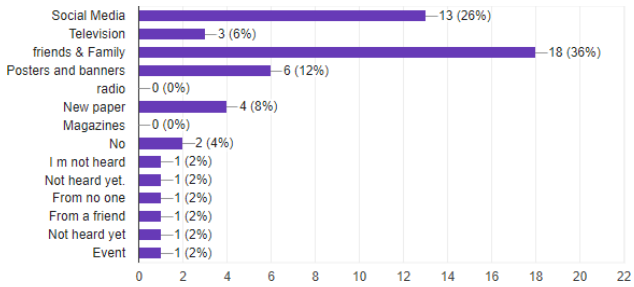
Interpretation: Above Graph shows that: 44%f the respondents who answered the question are of the age category 4-23, 38% respondents belongs to 24-32 age group, 18% of respondents belongs to 33- and above age group.

Q. 3. Have you heard about Dermatoglyphics multiple intelligence test?



Interpretation: 56% of respondents who answered this question are heard about dermatoglyphic multiple intelligence test; 24% of respondents are not heard about DMIT; and 20% of respondents are not sure about whether they heard or not about DMIT.

Q. 4. Choose the source from which you heard about DMIT?



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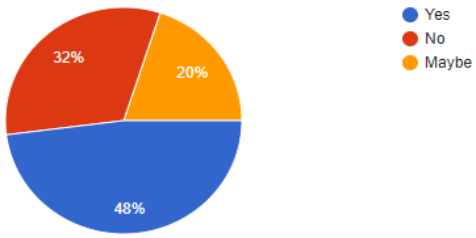
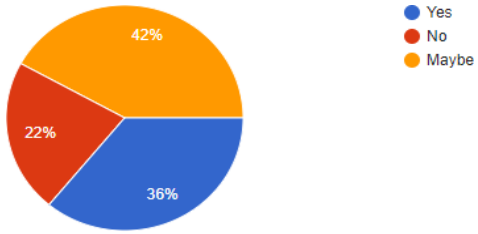
Interpretation: Sampling shows that 38% of respondents get to know about DMIT through friends and family;26% respondents aware through social media;12% respondents aware about it through posters and banners;8% of respondents are aware through newspaper;6% of respondents know about it through television and 2% of respondents through some events and rest 8% are not aware about DMIT.

Q. 5. Have you or any of your friend tried DMIT?



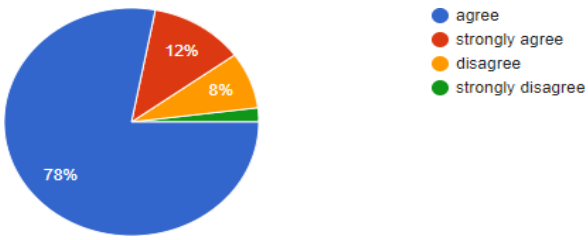
Interpretation: Survey result shows that 48% of respondents s or their friend tried DMIT;32% of respondents s and their friends are not tried DMIT; and 20% of respondents s are not sure about this.

Q. 6. Were you or your friend satisfied with report?



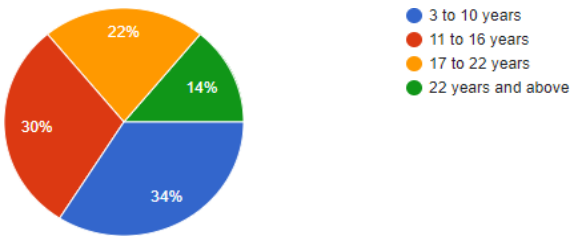
Interpretation: 42% of respondents s who answered this question are not sure about whether they or their friends satisfied with report or not;36% of respondents or their friends are satisfied with report; and 22% of respondents or their friends are not satisfied with report.

Q. 7. Do you agree with the statement "DMIT is Science not an astrology?



Interpretation: According to the results of the survey, 78 percent of respondents agree with the statement that "DMIT is science, not astrology"; 12 percent strongly disagree with the statement;8% disagree with the statement; and 2% highly disagree with the statement.

Q. 8. According to you at what age group DMIT give best result?



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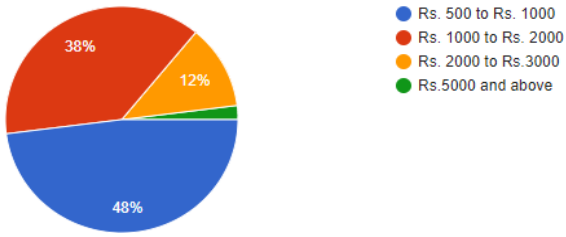
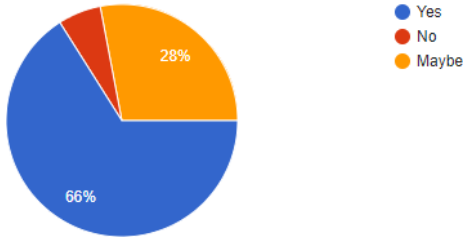
Interpretation: Survey shows result that 34% of respondents have their opinion that DMIT give best result to age group of 3 to 10 years;30% respondents have opinion that DMIT give best result to age group of 11 to 16; 22% have their opinion on age group of 17 to 22 and 14% have their opinion on age group of 22 years and above.

Q. 9. What should be the fees of DMIT?



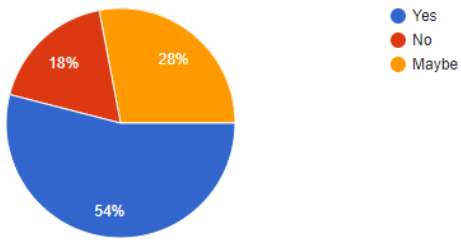
Interpretation: 48% of respondents are feel that the fees of dmit is should in between 500 to 1000rs; 38% respondents that it should be in between 1000 to 2000rs; 12% of respondents feel that it should be in between 2000 to 3000rs;and 2% Of respondents feel that it should be 5000 or more.

Q. 10. Do you think that DMIT helps to recommend specialized career and course for graduate students?



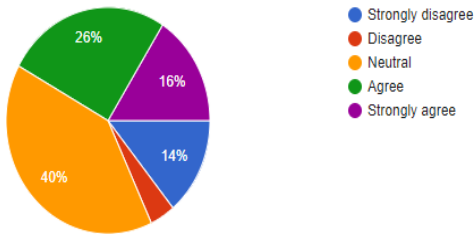
Interpretation:66% of respondents who answered this question thinks that DMIT helps to recommend specialized career and course for graduate students;28% of respondents are not sure about this and 6% of respondents are not agree with this statement.

Q. 11. Should DMIT is mandatory in schools and colleges?



Interpretation: 54% of respondents thinks that DMIT should be mandatory in school and colleges; 18% respondents thinks that DMIT should not be mandatory in school and college; and 28% respondents thinks that it may be mandatory in school and colleges.

Q. 12. Do you agree with statement that "skills are and inborn talent"?



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Interpretation: 40% of respondents who answered this question are have neutral opinion with the statement; 26% are agree with the statement;16% are strongly agree with the statement;14% reespondents s are strongly disagree with the statement and 4% are disagree with the statement.

2.6. Results and Discussion

The dermatoglyphics multiple intelligences test's key features

To make reading and understanding easier, several DMIT resource businesses and consulting organisations have organised their DMIT reports differently. However, only the most prevalent prominent characteristics are provided for the purposes of this study. These include: an overview of Dermatoglyphics technology and the Dermatoglyphics Multiple Intelligence Test/Analysis; a Student Personality Assessment that measures Adversity Quotient (AQ), Creativity Quotient (CQ), Emotional Quotient (EQ), and Intelligence Quotient (IQ); and a Student Personality Assessment that measures Adversity Quotient (AQ), Creativity Quotient (CQ), Emotional Quotient (EQ), Student Profile based on Gardner's Multiple Intelligences as evidenced by fingerprints; Student Learning Styles based on Visual, Auditory, and Kinesthetic Domains; Report Interpretation; and Customized Academic and Relationship Advice The following steps are used by DMIT resource businesses and consultant organisations in order to create a DMIT report: Finger capture, verification, and scientific finger print analysis; DMIT report creation in laboratories; and report briefing and consultation with experienced dermatoglyphics counsellors. The Perceptions of the Respondents in Relation to the Benefits Derived from the DMIT Reports

3. Results and Discussion

3.1 *DMIT Test for Children*

The DMIT Test for Children includes useful parenting advice. This is a thorough Brain analysis that is highly adaptive, instinctual, and responsive to their unique needs and skill sets. The ideal amount of time for schooling is 3 to 10 years, which should be thorough and allow for assistance based on their learning patterns. The DMIT Test for Children includes useful parenting advice. This is a thorough Brain analysis that is highly adaptive, instinctual, and responsive to their unique needs and skill sets. The ideal amount of time for schooling is 3 to 10 years, which shouldbe thorough and allow for assistance based on their learning patterns.

3.1.1 Children's DMIT Test Advantages

Improve the relationship between children and parents by learning the best learning style for your child, customising learning programmes based on their learning style, understanding the right parenting techniques and teaching style, and choosing activities based on their Multiple Intelligence and innate abilities.

3.2 DMIT Test for Students

The DMIT Test is recommended for students. The adolescent years, from 11 to 17, are critical. Astudy problem is predicted to affect 70% of school-aged youngsters. The DMIT Test contains increasingly intense pruning as the mind learns to concentrate and construct a good identity. Early identification of the best learning styles will help you improve your IQ, EQ, CQ, AQ, and SQ scores. This might be the point at which you make a decision on your career path.

Benefits of DMIT Test for Students: (Age group: 11 years to 17 years)

Recognize the inherent potential of students. Recognize the difference between your analytical and creative minds. The right and left sides of the brain, Recognize your nine different intelligence distributions. Personal Quotients: IQ, EQ, CQ, AQ, and SQ, ATD Perspective Analysis and Learning Sensitivity, and ATD Perspective Analysis and Learning Sensitivity Learn to recognise your strongest learning communication personalities. Comparison of the right and left hemispheres of the brain Determine your supplemental activities using the DMIT Reportas a guide. Get career advice based on your 9 Multiple Intelligences, an analysis of your strengths and weaknesses based on your brain lobe usages, and a DMIT Test Report that suggests ways to address your deficiencies. Determine your favourite learning style. Learning styles include visual, auditory, and kinesthetic.

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Why DMIT Test need to be done for Students ?

Rather than inborn aptitude or Multiple Intelligence, students often choose their academic streamsubject owing to parental pressure. They will not study in the manner in which they should. Parents are putting in a lot of effort to get their children ready for a variety of activities. As a result, parents notice that the majority of their children obtain average grades, with only a few receiving outstanding marks. They want their child to be a high achiever in most areas, but one who falls short of their parents' expectations. The future prospects of their children are a source of concern for their parents. Children want to challenge their parents' authority. The majority of parents dislike their jobs. They're stumped. Right now, in our community, relationship compatibility is a major concern. Relationships are frequently broken. Misunderstandings and a refusal to compromise are becoming more widespread. Respondents are plagued by stress, uncertainty, disillusionment, and despair. Most parents and children are utterly ignorant of their inherent abilities and potential. The majority of respondents go about maximising their potential in the wrong way, and hence do not grow in accordance with their abilities.

3.3 DMIT Test Corporate Employees

A good job fit is an important component in achieving outstanding results. Dmit Test Corporate Employees can assist your company in optimising the whole spectrum of human resource operations, from selecting the best candidate to fill a job to detecting gaps and concentrating training efforts on areas that need improvement. By administering a pre- and post-test to each employee, Dmit Test Corporate Employees might be used to assess the efficacy of education, learning, and seminars.

Benefits of DMIT Test for Corporate Employees

Background checks are conducted before to hiring. Identify the best candidate for the job. Discover the potential of your employees to increase their efficiency and productivity. Examine your current manager's achievements and critical skills. HR Training & Development Based on Employee Abilities Learn about the leadership styles and traits of your staff, as well as their internal potential. Reduce operating costs while increasing the company's worth. Know your employees' IQ-EQ-AQ-CQ-SQ Personal Quotients. Planning and delivery styles Make an all-starteam of employees. Increase productivity by reorganising the workforce. Put your faith in the member of your team with the highest potential.

Conclusion

Cummins and Midlo created the term dermatoglyphics in 1926. However, with the publishing of Purkinje's thesis (1823) and Galton's famous book, Fingerprints, it became a scientific subject (1892).

Howard Gardner's Dermatoglyphics Multiple Intelligence Test is a fascinating spinoff.

The Theory of Multiple Intelligences has the following distinguishing characteristics:

Multiple Intelligence Test/Analysis for Dermatoglyphics; An overview of Dermatoglyphics and its Multiple Intelligence Test/Analysis; The conclusions of the interviews concerning the positiveeffects of the DMIT results received positive comments from the respondents, especially students, parents, and other clients. They claimed that the findings of the DMIT could be used byguidance and counselling offices at various academic institutions to critically assess the inherent acumen and aptitude of students enrolled in their programmes, as well as to aid in the ongoing mapping of the student's talent, attitude, and skills along an educational gradient. Similarly, teachers can use the results of this exam as a starting point for assisting students with their natural learning styles and study skills. The following findings have some implications for academic institutions looking to improve their career counselling programmes. This research alsoprovides baseline data on major course preferences as a measure of students' goal-setting behaviour for current and future lifestyles/expectations. Students' self-esteem and confidence must be boosted by identifying their natural abilities and guiding them toward a happier, more fulfilling life. Instructors must also be trained in this area in order for them to be the best facilitators in guiding their students toward their life goals. They'd be able to guide them based on each student's innate strengths, give them opportunities, and treat each child differently depending on their personality. DMIT's most difficult task was persuading people of the accuracy of the software, DMIT reports, and the proven links between the brain and fingerprint patterns, as well as the psychology of brain and fingerprint patterns. People regularly inquired about fingerprint collection safety, as well as the collection of an individual's fingerprint on an Adhar card. During Adhar card collecting, they will also obtain iris scans of each individual and explain the scanner used for this programme.

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References

[1] Adekoya KO, Ahmed RA, Oboh BO, Alimba CG. Relationships between Dermatoglyphics and Multiple Intelligence among Selected Secondary School Students in Lagos State, Nigeria, Lagos, Nigeria: Nigerian Society for Experimental Biology, url:, 2013.

[2] http://www.researchgate.net/profile/C_Alimba/publicati ons/, date retrieved: 3/17/2014 Brain Wonders (2011) url: http://www.brainwonders.in/benefits- ofdermatoglyphics.html, date retrieved: 3/15/2014

[3] American Psychological Association. (2008). Frequently asked questions. Retrieved June 17, 2008 from http://www.apastyle.org/faqs.html.

[4] A Parasuraman, Valarie, A Zeithaml and Leonard L. Berry. *Journal of Marketing*, Vol. 49, No 4, (Autumn, 1985)

[5] Bart Allen Berry. Dec 1999 "Quality values, Market Dominance through Customer Satisfaction". Cooper and Schindler, *Business Research Methods*, Tata McGraw Hill, 9th Edition

[6] Kotler, Philip & Lane, Keller Kevin (2008), *Marketing Management,* Edition 13th, Pearson.

[7] Maas, J. B. (Producer), & Gluck, D. H. (Director). (1979). Deeper in hypnosis [Motion Picture]. Englewood Cliffs, NJ: Prentice-Hall

[8] Sillick, T. J., & Schutte, N. S. (2006). Emotional Intelligence and Self-esteem Mediate between Perceived Early Parental Love and Adult Happiness. *E-Journal of Applied Psychology*, 2(2), 38–48. Retrieved from http://ojs.lib.swin.edu.au/index.php/ejap/article/view/71/100

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Critical Thinking to Augment Waste Management-Design Thinking Approach

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ABSTRACT

Critical thinking makes people think about problems skilfully and analytically to evaluate the problem without making any possible conclusions. However, Design Thinking enables critical thinkers to accomplish it in reality. Gen Z is described as the 'always on' generation, capable of multitasking. This work is carried out by Gen Z students wherein urban millennial working couples are identified as "users". An effort to understand prospective generations was made and tabulated. The work uses Stanford Design Thinking Methodology to enable users to discard household waste conveniently. Literature suggests that limited focus is shown on identifying the desired outcome from the user point of view and more emphasis is given to the ideation phase. Conflicts of interest analysis were carried out and validated with the user. Opportunity mapping was conducted to generate ideas that were further segregated based on identified parameters. The solution architecture envisaged includes the user at the centre interacting with a timely information interface. The solution feedback is taken and further improvement points are reported.

Keywords: *Critical Thinking, Gen Z, Design Thinking, Millennials, Waste management, IoT*

1. Introduction

According to the survey, India generates 62 million tons of waste each year, Karnataka produces 6500 tonnes. Out of which 5000 tons of waste is generated from Bengaluru alone. only 30% of waste is collected by Bruhath Bengaluru Mahanagara Palike (BBMP) directly and the remaining 70% is collected by the private contractors. Due to various reasons, these waste pile up as landfill. It is also common to see waste being dumped in the open plots, causing health risks to residents in the vicinity. Currently, this is leading to contamination of surface water. But, In the long run it can lead to contamination of underground water, soil and air. Thus, it can be considered as a problem which needs to be addressed from multiple stakeholder perspective and this work tries to address from an urban, working couple point of view.

2. Literature Survey

The related work with solid waste management and the beneficial solution for the working couple to discard their household waste on time have been discussed in this section. Katja Tschimmel et al (2012) [1], provided information regarding the speculative and realistic approach to the concept of design thinking, its background, characteristics, etc. Linda M. Murawski (2014) [2], presents a study regarding the skills that are transferable from the classroom to the workplace. Margaret Lioyd et al (2010) [3], in their paper, described the capability of the students and their ability of critical thinking irrespective of course or year level. ChaisriSriprom et al (2019) [4], gave insights about the behaviours and explained how to support this generation are key to the effectiveness of teaching, learning, and collaborations with other generations. Roslinda Murad et al (2019) [5], illustrates how technology can bring changes to accelerate the learning process of Gen Z and also discusses the ideas of smart education-driven By Gen Z. Debbie C Hampton et al (2016) [6], throws light on the characteristics of Gen-Z and a comparative study on the 3 generations(Gen X, Gen Y, Gen Z). Reddy Dhana Raju (2021) [7], presents a case study of different methods and results of the waste management that are in function in various clean cities of India, also discussed the strategies that give optimum results in WM using 5R's (Reduce, Reuse, Recycle, Recover and Residual Management). B P Naveen calls (2021) [8], attention to describing the practice of waste management in Bangalore by having a

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detailed report from BBMP, and stated few measures to overcome the same. V R Shankar Cheela et al (2021) [9], provides information involving a participatory approach to collect the data from local bodies to stakeholders in the formation of smart city, also the process of transfer and storage of MSW is depicted. T H Christensen et al (2020) [10], gave a detailed report on LCA (life cycle assessment) and its insights on the identified six application areas defined from the user's point of view in integrated waste management. G Velvizhi et al (2020) [11], gave insights that IoT-based technologies can be implemented to tackle the problems faced by the present Waste Management system. Furthermore, the paper gives a thorough material of the proposed model/solution for the easy disposal of household wastes. Krishna Gowda et al (2007) [12] described the existing condition and the imperfections in various aspects of Waste Management and proposes viable planning tactics which will make for a cleaner city, cutting down environmental pollution and safeguarding the quality of groundwater. The problem of solid waste needs some aggregate approaches such as reuse of solid waste to produce energy using wet waste, this has also been explored in prior studies by Dr.G.l. Parvathamma et al (2014) [13]. T.V. Ramachandra et al (2007) [14] gave detailed information about storage function and its retention.

3. Generation Characterisation

GenY or the millennials are born between1981-96 and the Gen Z's are born between 1997-2012. GenY's value more financial stability when compared to Gen Z's. GenZ's are more solicitous about education expenses than GenYs. The characteristic understanding is important as the work of providing the solution is carried out by the GenZ students for users who belong to the millennial generation.

Table 1: Characteristic Differences between GenZ and Millennial

Generation Traits	Gen Z	Millennial
Mental energy	Realistic	Optimistic
Interactions	Independent	Collaborative
Shopping interest	Gaming, sports	Fitness
Attitude towards technology	Digital natives	Digital pioneers
Sharing of data	Private	Public
Peer interaction at the global level	Global citizens	Global spectators

4. Methodology

The work is completed by Gen Z understudies wherein metropolitan millennial working couples are recognized as "users". This work utilizes Stanford Design Thinking Methodology to empower users to dispose household waste with ease. Urban Millennial encounter obstacles in discarding the waste due to the time constraints on workdays. The typical problems include discarding wastes on open plots, Social awkwardness, Stray dogs or rodents mess up the piled-up waste, the waste collector doesn't show up at fixed timings. By thorough understanding of the problems faced by users, objectives were set to provide a seamless experience in disposing of waste. Providing solutions requires a thorough understanding of the problem and desired outcomes which the user approves. In this regard, conflict of interest analysis was performed to gather first-hand information of desired outcomes expected by users and was validated as shown in Fig 1.

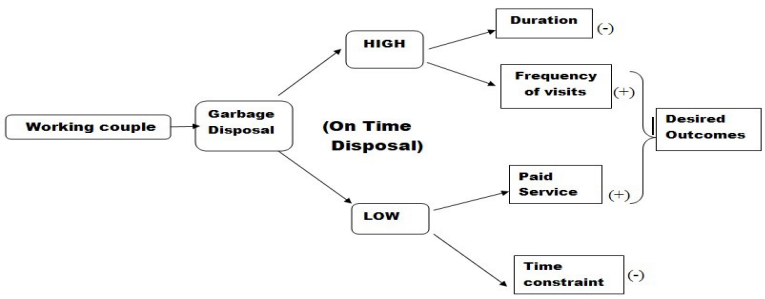

Fig. 1: Conflict of Interest Analysis

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The desired outcomes taken into consideration are Faceless transaction, Paid service, need-based, freedom to dispose of waste conveniently.

4.1 Stanford Design Thinking Approach

Stanford Design Thinking methodology consists of 5 stages namely- Empathy, Define, Ideate, Prototype and Testing. The methodology adopted for this work is as represented in Fig 2.

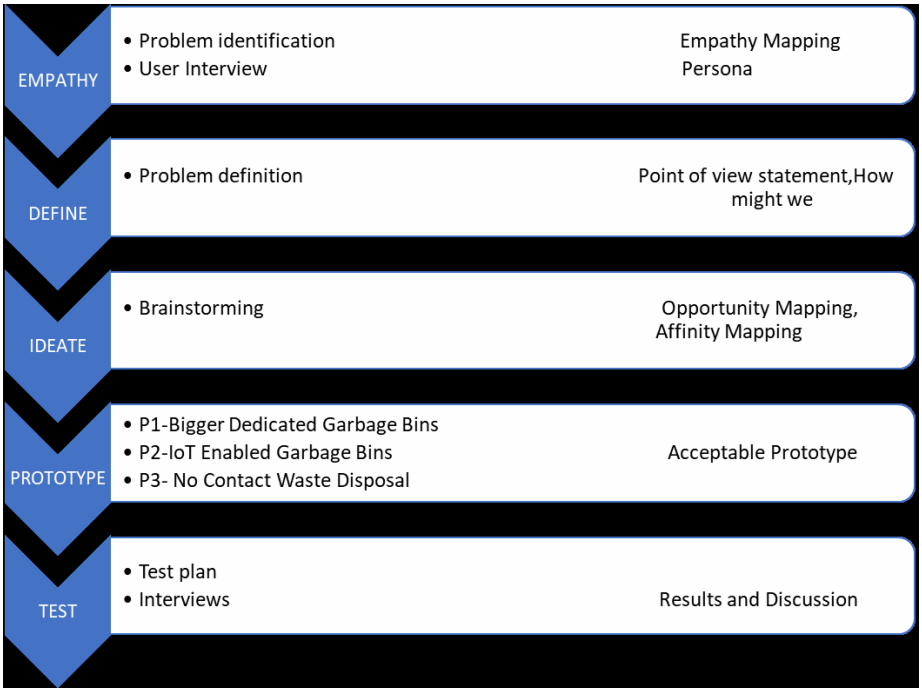

Fig. 2: Methodology Followed

4.1.1 Empathy Phase

Empathy map played an essential role in understanding and visualizing the difficulties faced by the urban millennial couples. The age group of the working couples considered for the study is 25–50. Telephonic and personal interviews were conducted to collect information and identify insights and persona was created to better depict the needs. Persona helps in generation of the fictional character representing a whole lot of the user gives a concept of their mental activity and perspective thinking on the lines of critical thinkers as well as design thinkers, one should be encouraged to righteously question ideas and assumptions, rather than accepting them without super reflections in case of critical thinking. The notable insights obtained was that working couples have high willingness to discard garbage in an appropriate manner but are unable to do so.

4.1.2 Define

The Point of View statement and How Might We? (HMW) provides critical understanding and helps comprehend the problem. The lead users were identified as urban millennial couples, they are unable to discard household waste on time due to time constrain which results in the accumulation of wastes. The solution should be designed in such a way where the user is at the centre interacting with timely information interface and also help them manage their daily waste that should be regularly discarded and the garbage collector should show up at particular time frame.

4.1.3 Ideate

Numerous ideas were brainstormed using certain techniques like mind mapping, storyboards, reverse thinking, brain writing, and questioning assumptions. Opportunity Mapping was done to identify potential areas to concentrate on, which were further segregated based on identified parameters. The ideas generated were segregated into 4 categories as shown

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below. Opportunity mapping provided direction to generate ideas concerning technology (low/high), cost-intensive (low/high). In affinity mapping all the ideas generated were sorted into different categories, which are listed below.

Table 2: Affinity Mapping

Self-Taught	Utility Incharge	Next-Door	Design Thinkers
Reduce consumption itself	Use a special type of dustbin which is airtight	Maintain premises clean	Composting pitas for degradable wastes
Immediate disposal of wet waste in a proper way	Use different materials to wrap and throw garbage (not plastic cover)	Get a bigger garbage bin	Installing the litter baskets in each street.
Good quality garbage bins	Stop using polythene bags to discard waste	Using big garbage bins outside the house	Using recycling technology

The ideas were installing trash bins across streets making it convenient for the users to discard garbage as per their wish, IoT based solution where the users get notified about the trash bin space availability and finally, a meshed trash bins installed in the corner of the ground floor of a building where garbage can be disposed. It was spotted that the last idea mentioned is contact-less disposal, the user has full freedom to dispose of garbage as their need, as well as paid whereas the second and first ideas give only freedom to the user.

4.1.3.1 ***Processing of Waste:*** The different facilities use different technologies to process the waste to be discarded. The quantum of waste that is being abandoned at the BBMP processing centres is around 3000 Thermal Design Power (TDP). The same is being currently supervised through the following facilities using the technologies mentioned.

Table 3: Technologies Adopted at Different Sites in BBMP

Sl. No	Location	Plant Volume	Method Adapted for Garbage Disposal
1	M/s Terrafirma	1000MTPD	Composting and Bio Methanization
2	KCDC	300MTPD	Composting
3	M/s MSGP Infra Tech Private Limited	500MTPD	Composting, RFD, Granules
4	BBMP at (a) Lakshmipura (b) Bingipura	 250MTPD 850MTPD	Landfill
5	Mavallipura	70MTPD	Composting

4.1.3.2 ***Transportation of the Waste:*** In the collection, 17.5% of the Industrial Zones have municipal bins and 94% of the residential zones have adopted the door-to-door method. Recycling is undertaken mainly by non-profit organizations attaining a high level of proficiency. 3.14% of waste reduction is accomplished through composting, 60.71% of the waste is disposed in dump yards and 21.14% is disposed in open plots/sites. About 670 MSWvehiclesincluding 240 Compactors, 430 Tippers, Lorries, Dumper placers; Mechanical sweepers both BBMP and contractors are used for deportation of MSW to the Processing and Landfill sites. Bangalore is divided into 8 zones for the disposal and treatment of solid waste.

Table 4: Different Zones and their Disposal Facilities in BBMP

Sl. No	Zone	Disposal Site/ Facility
1	South	Bingipura, Mavallipura, KCDC
2	East	MSGP, Mavallipura, KCDC
3	West	Terra Firma, Mavallipura, KCDC
4	Yelahanka	Mavallipura, Terrafirma
5	Bommanahalli	Bingipura, Laxmipura
6	Mahadevapura	Terrafirma
7	Dasarahalli	MSGP
8	Raja Rajeshwari Nagar	MSGP/ Terrafirma

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4.1.4. Prototype

Prototype A describes introducing enormous garbage bins across roads. This prototype works with the removal of trash by the functioning couples at the advantageous time because of the establishment of rubbish removal units called big trash bins across the roads, as shown in Fig. 2. Prototype B describes IoT-based areas for waste management. Here the working couples get a notification through the cell phone application to dispose of the waste when the service provider is close to their area, whether the containers introduced are unfilled and clients can dispose of the trash and can discard the waste tomorrow if the garbage bin is full, as shown in Fig. 3. Prototype C describes meshed trash bins installed outdoors building. The metropolitan millennial couples can dispose the waste in the introduced meshed trash bins that are located in a corner, at their advantageous time and the trash collector can gather the junk by opening the inclined mesh-like lid which has two openings both horizontal and vertical, during their working hours even in the absence of the couple. The metropolitan millennial couples disposing of the garbage single-handed, in the wake of introducing the meshed trash bins at their reach. To profit from this extra assistance from service providers, one needs to pay and use it, as shown in Fig. 4 and 5.

Fig. 2: Big Trash Cans

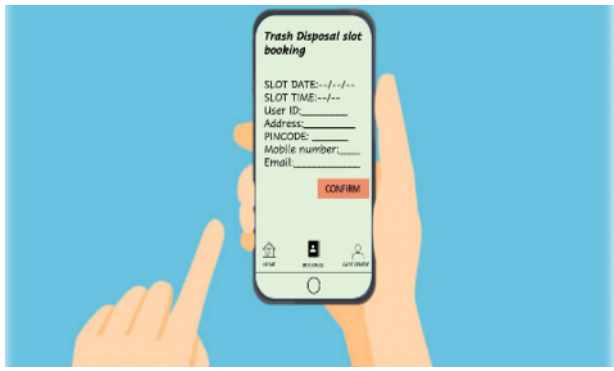

Fig. 3: IoT Enabled Garbage Bins

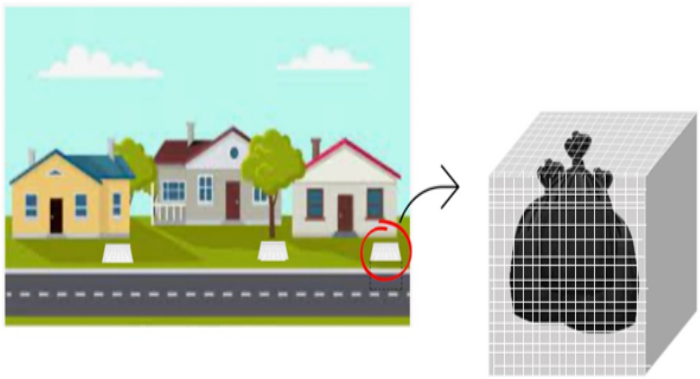

Fig. 4: Meshed Trash Bins

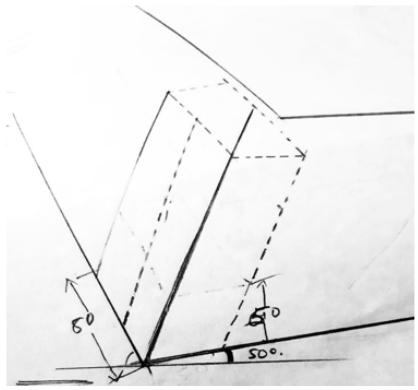

Fig. 5: Isometric View of Concept Sketch

Table 5: Review of the Users Concerning the Constraints

Pretotype	Feasibility	Costing	Satisfactory Criteria	Functionality	Potential Innovativeness
A	3	6	4	3	1
B	3	7	3	5	5
C	7	9	7	9	9

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Results and Discussion

Information gathered from the models outlined and by working around them, the feasible prototype has been found on meeting numerous subject matter experts and considering user feedback in the region i.e., the meshed trash bins that will be introduced in each house help working couples in waste management. Likewise, this paid help can be additionally improved with membership plans. This disposes of all kinds of hardships and outcomes that were being found by working couples which was the fundamental subject of this work.

Out of the ideas, the most favourable ones were selected and worked around the problem to overcome the obstacles faced by the user. The users were interviewed and the feedback was taken to enhance the work. Since the users are working couples, it's focused on metropolitan regions and the concept was explained to the few selected houses in RR Nagar and Mahalakshmi Layout and the feedbacks were both positive and negative, that are as follows

1. Idea is innovative
2. Involves lot of construction
3. Creates a lot of mess during construction
4. Indeterminate about idea implementation
5. Even though the idea is implemented the garbage might stink until it is collected

The test has been performed with the help of subject matter experts (SME) by exhibiting the model to them and considering all their feedbacks and responses the prototypes were scaled from 1-10. By examining the reactions for the third prototype i.e., meshed trash bins can be processed for the execution.

Conclusion

Waste handling doesn't just mean assortment and transportation yet additionally incorporates its treatment, managing the waste activities. The techniques for working on reusing the waste gathered should emphatically alter over days for a cheerful future. The prominence of the grouping of waste is known for so long yet not instilled in the routine. Therefore, the vital piece of concern is the diffusion of knowledge amongst the general. Exhibit prototypes to the users quite early which ensures that new ideas stay on course that will meet user needs while getting rid of the flaws the prototype with favourable criteria that gives user satisfaction is chosen at the end. This interpretation of social innovation was accomplished with the help of two prominent techniques- Design Thinking and Critical Thinking.

References

[1] Naveen BP and Sivapullaiah PV, Solid Waste Management in Bengaluru-Current Scenario and Future Challenges Innovative Energy & Research 2016, 5:2

[2] H N Chanakya, T V Ramachandra and Shwetmala, towards a Sustainable Waste Management System for Bangalore, Centre for Sustainable Technologies, Indian Institute of Science, Bangalore, India.

[3] G. Velvizhi, S. Shanthakumar, Bhaskar Das, A. Pugazhendhi, T. Shanmuga Priya, B. Ashok, K. Nanthagopal, R. Vignesh, C. Karthick: Biodegradable and non-biodegradable fraction of municipal solid waste for multifaceted applications through a closed-loop integrated refinery platform: Paving a Path Towards Circular Economy [2020], pp. 22–27.

[4] Ajay Singh: Managing the Uncertainty Problems of Municipal Solid Waste Disposal [2019], 7.

[5] Abarca-Guerrero, L., Maas, G., Hogland, W., 2013. Solid Waste Management Challenges for Cities in Developing Countries. Waste Manag. 33, 220232.

[6] Bautista, J., Pereira, J., 2006. Modeling the Problem of Locating Collection Areas for Urban Waste Management. An Application to the Metropolitan Area of Barcelona. Omega 34, 617629.

[7] Ajantha Sisira Kumara, Asankha Pallegedara: Household waste Disposal Mechanisms in Sri Lanka: Nationwide Survey Evidence for their Trends and Determinants, 114 (2020) 6271.

[8] Caifeng Chen, Xinhua Wang: Explore of Modern Family in the Waste Disposal Methods, Vol. 5, No. 1; February 2011, 113–116.

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Sleep Analysis – An Innovative Concept of Using Technology to Analyse Dreams and Determine Behaviour

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ABSTRACT

Extensive study in psychology shows that the dreams of individuals often portray their deepest or most hidden desires and emotions. Although we are physically in our most dormant state, it is proven that our subconscious can experience various thoughts such as – ingenious ideas, post-traumatic stress, desires, etc. Many people also believe that dreams can represent individuals' current mental state and give a basic understanding of their subconscious mental health when appropriately analyzed. In the world that we live in today, in which technology plays a pivotal role in our lives, it is quite surprising that not much research has gone into using this technology to help understand the moment of our day in which we are at the closest with our true conscience. Critical thinking being the process of skillfully conceptualizing and analyzing a problem statement to come up with the most efficient solution, is what is precisely required to go ahead and tackle this problem. This paper aims to use critical thinking to thoroughly research existing literature and propose various technological solutions to help analyze these dreams.

Keywords: *Dream Analysis, Natural Language Processing, Machine Learning, Computer Science, Psychology*

1. Introduction

Dreams are often regarded as 'out of this world' experiences as some sensations and feelings that we experience in them are not familiar to us in our daily lives. Sometimes we feel as if we fly over the buildings, while at other times, we feel like we are one among a thousand warriors fighting an age-old battle. Often these feelings resemble or take the form of the emotions that we are experiencing subconsciously at that moment. As human beings, we go through various stages of sleep. We dream during some of these stages, and during others, we experience deep sleep (Sleep in which our mind is normally inactive). Officially we as human beings have our sleep classified into three major stages: light, deep, and REM. During light sleep, our muscles may jerk as they are relaxed; our respiration and heart rate decrease, which allows our body temperature to drop, and waking up is considered much easier during this stage of sleep. On the other hand, during deep sleep our blood pressure levels increase by a considerable amount, and our body promotes the growth and repair of muscles. This is done by increasing blood flow to the muscles, releasing our body's natural growth hormone, and by allowing for cell and tissue repairs to occur. Our brain, at this stage, experiences slow brain waves and flushes out its waste. When we wake up during this stage of sleep, we are often viewed as dizzy and disoriented. Then comes our last but most important stage of sleep for the course of this paper, REM sleep. Over here, REM stands for 'Rapid Eye Movement sleep and is the type of sleep that re-energizes your mind. During this stage of sleep our heart rate and respiration increases, and our body's temperature regulation is switched off. We may experience vivid dreams, and our bodies might become immobile to help prevent us from acting out on these dreams in real life. This stage of sleep particularly interests us as it has a lot of benefits for memory, learning, and problem solving, which is influenced by our dreaming patterns.

Critical thinking is the intellectually involved process of actively conceptualizing, evaluating, synthesizing, analyzing, and applying the information gathered by experience, observation, reasoning, reflection, and communication. Thus it seemed like the most appropriate process of thinking that was required to finally identify the problems that are faced by individuals during sleep and find innovative ways to solve them. Some topics that will be spoken about through the course of this paper are dream analysis and the most underrated phase of sleep Hypnagogia. This paper aims to spark interest in the path to understanding sleep and finally being able to come up with innovative solutions to be able to once and for all put to an end the different problems that individuals face with respect to this area.

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2. Literature Study

[1] This study about Hypnagogia is the doctoral thesis of Dr. Andreas Mavromatis of Brunel University. This thesis goes into a detailed analysis of a particular period of sleep known as Hypnagogia. The period of sleep is closely related to the creative process, as, during this phase of sleep, our brain happens to be on a route of creating a large amount of highly creative work. People often exclaim that they feel like they are elevated into a higher degree of mental freedom during this stage of sleep. Many individuals often say that they get answers to questions they have been pondering about for quite some time and even describe it as an entirely new way of thinking. This thesis also explains how various scientists leveraged this stage of sleep in their daily work. For example, Thomas Alva Edison, when stuck on a problem, would often take a short nap with a few steel balls in his which he termed as a 'cat nap'. When he would start to enter the stage of Hypnagogia, his brain would change from a beta to an alpha wavelength. While entering this stage of sleep, his hands would relax, which ultimately let the steel balls in them fall over into a pan kept below creating a noise that would wake him up. He found that waking up at this period allowed him to have new ideas in his head that he could never think of beforehand [1].

[2] This paper hopes to open up interdisciplinary opportunities and studies about unconscious thought and metaphors. It speaks about the different types of metaphors in dreams and how cognitive linguistics relates to psychoanalysis. It also details how we analyze dreams and draw metaphors from the dreams and relate them to real everyday emotions that a person is going through. It gives examples of these types of metaphors and shows practically how cognitive linguistics relates to psychoanalysis. This paper also shows us that based on an individual's lifestyle, various metaphors keep re-arising in the dreams of these individuals. These metaphors can take up different forms but relate back to one thing that was/is affecting our mental state, and that these metaphors re-create our identity in a much denser sense of truth. They state that in these metaphors, we often condense and enlarge our identity. They suggest that the principal function of metaphors in our dreams is to leave a trace of the personal experiences and their emotional responses, which helps condense the dreamer's identity. Through this paper, there have been over 4 case studies that show practically how subjects often experience in their dream what they feel in their subconscious mind [3].

[3] This paper looks at how dreams can somehow define the emotional content of a person during youth and how dream analysis plays a crucial role in trying to explain/understand that set of emotions. The study focuses on female adolescent problems and has taken five teenage girls with emotional problems as case study examples. It speaks about how unpopular adolescents often face different emotional problems and think negatively about themselves. Societal demands often make them have feelings of depression, self-criticism, inadequacy, and self-blame, which are not great emotions to have in our youth as they lead to harmful thoughts. Hence, it is essential to recognize and analyse these thoughts at an early stage to prevent further mental or physical damage to the person or to the environment/surroundings. It was noticed that boys battling through something mentally often externalized their emotions while girls often internalized them. Thus, adolescent girls were taken into consideration for this study as internalizing one's problems is often portrayed in their dreams as they are registered in the subconscious of one's mind. The study was carried out with three goals in mind which were named to determine: (a) how dreams of adolescents contain their manifested emotional problems; (b) how analyzing these dreams can help the youth have a greater understanding of their selves; (c) how with this information psychologists can be informed at an early stage to be able to plan an intervention into their lives and help get the youth get back onto the right track. They first explain how dreams occur twice during sleep: firstly, during REM (rapid eye movement) sleep and secondly, during SW (slow-wave) sleep. REM sleep dreams are characterized by the fact that the brain goes under the influence of various chemicals that inhibit the brain from a state of wakefulness. In Slow Wave Sleep, the brain is in a state similar to that of wakeful awareness. While analyzing dreams, the most seen nouns were "house" and "mother," while most occurring verbs were "go" and "do." The technique used here in this paper to analyze the dreams was 'amplification', which formed associations with each item in the dream. These include people, words, and objects with which the dreamer would suggest what memories are evoked by these items. This was done with many dreams at once. The most important conclusion from this research was that dream analysis is critical for psychologists to intervene and understand what is going on at a young age in students' minds. In all the study members, there was always seen a direct correlation between the female's emotional problems and recurring themes in dreams. It also states that with the help of past roots, many hidden emotional problems of individuals are uncovered, which could be in the form of fear, interpersonal problems, or even traumatic experiences. This paper gives us a great base in hoping to understand the real pain that people go through and how analyzing their dreams can help find a solution to these problems [7].

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3. Proposed Solutions

3.1 Problems Observed in Field

After examining the papers present in our literature study, we can observe some of the setbacks and issues currently present in the field. The main problem that needed to be highlighted was that it had been scientifically proven that dreams portray the subconscious of the human mind, yet little to no research has gone into the technology required to automate these processes. It has also been noticed that as dream analysis is a very grueling task with a lot of repeated brute force required, psychologists often overlook it in therapy. It is also seen that our subconscious thoughts are often present as metaphors in our dreams. Looking through various reports and gathering these metaphors are also a task with a lot of grunt work. This task would also require to be automated to a certain degree.

Hypnagogia is also a place in the space of psychoanalysis that is very less exploited. It has been seen that the benefits of this stage of sleep are pretty remarkable, and various profound scientists have exploited its capabilities to the maximum. We still require a proper and efficient solution to tackle the controlling of this phase of sleep for the average man. If it works, the pros would easily outweigh any other creative thought generation method present on the market today.

3.2 Objectives

Sleep is a vast topic with various research areas associated with it, i.e., lucid dreaming, sleepwalking, dreams, etc. Thus, we will be focussing on just a few of these issues to hopefully propose viable solutions for a suitable for future research in these areas. The objectives for the course of this paper are –

1. To propose a viable solution to be able to record and analyze dreams
2. To identify specific niche needs and technologies to be able to help out the large field
3. To be able to automate the redundant tasks which occur in the logging of these dreams
4. To provide a few ideas regarding procedures to analyze dreams
5. To provide a solution to extract crucial confirmation in dreams

Critical thinking involves synthesizing multiple perspectives to create a solution to some problems in the field, and that is what we aim to do through the course of this project. We aim to uphold these pillars of critical thinking by really understanding the point of view of various recognized and eminent individuals in this field and analysing this point of view to create a fault-tolerant technological solution.

3.3 Conceptualized Solutions

As mentioned before, various problems require technological solutions to help automate this field. Upon analyzing these problems, we aim to fulfill the objectives we set before ourselves to help progress this currently unexplored field.

Through the course of some of these solutions, we will draw inspiration from Jung's method of dream analysis known as amplification. In this method, he proposed using historical, cultural, and mythic parallels to clarify material that is much harder to understand. Jung suggests that analysts should try and form connections between dream imagery and personal meanings in the dreamer's life. It is a way of showing proof of concept through the collective unconscious. He exclaims that this method is a natural thinking process characterized by parallel, analogy, and creative collaboration. It could be considered a way to analyze the deep and true desires of the human mind when it is in its most raw form, as during the dreaming phase, thoughts are not orderly or linear. There have been various interpretations of everyday items that occur in one's brain when one dreams. These items can often be found to have equivalent meanings between different patients, which can be realized through amplification. Through these observations, we propose various technological solutions which can be explored in this field.

The first use case of technology would be to automate this process of amplification as defined by Jung. By this, we mean creating a dream logging system in which users can log their dreams down each morning into a database and can be reviewed later for further use. Although these systems already exist, we aim to increase their number of use cases by stating some points as to how they can be advanced. As we mentioned earlier, we need to automate the process of amplification. To do so, we propose a system that can understand and process in which words in the dream that we log is important to us. To do this, we use parts of speech tagging to find each type of word in the sentence and then extract only those types we need (example – proper nouns, verbs, etc.). After being able to do so per dream,

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we next need to be able to find words in these lists of words per dream that repeat the most. Upon this, the system should propose questions to the user about each word that it has found repeating in the dreams. These questions should be carefully crafted so as to invoke the deep emotions of the user. When this occurs, the user should be able to self-reflect on these verbs and nouns and write down what they seem to be associating it too. This means that they should explore all emotions and try to understand the significance of these items and why their brains would form corresponding relations. When they do so, they should log them into the system to create a basis for their own dream dictionary. Doing this would create a basis for further human intervention. The process of dream analysis for psychologists is quite tasking as they must read through each and every single dream and find similarities and common occurrences; this is not only a grueling task but may also be one in which humans can make a lot of mistakes as it is hard to keep track of lots of information at a time. This is seen as the reason that psychoanalysis is not really effective in the field when treating people with severe trauma, as they often require immediate attention while the process of analyzing dreams manually takes very long. This is why a system handling the grunt work and creating a basic dream dictionary for each user really condenses down the work that the psychologists have to do, allowing them to be able to analyze the dreams faster and stage an intervention even quicker as they have a point to start working from.

Jung also believed that the images that cross our minds during stages of sleep are sometimes consistent among people with similar cultures and backgrounds. Although it is a disputed fact in today's world, the root thought does make some sense. This concept stems from the thought that the deepest part of our subconscious mind, which gets activated when we are unconscious, is inherited genetically and not defined by the personal experiences we've had in our lives. He referred to this as the collective unconscious between humans and believed that as this imagery and knowledge is passed down genetically, it exists when we are born. He felt the only time we can tap into these thoughts is during moments of crisis. These thoughts expressed in our unconscious state are supposed to fall into a category of 'archetypes' which are patterns, signs, or symbols which define our behavior and thinking that we have received from our ancestors. These archetypes can take the form of people or items dependent on what your brain connects in the subconscious. All in all, this means that similar things that appear in our dreams can mean similar things to different people.

Upon analyzing this concept and behavior of our subconscious mind, the second use case is proposed, which would be to create a dream dictionary of sorts. This would happen parallel to the first use case, where people state their inferences to particular items through the process of amplification. The proposed solution is to create a publicly available database of words (themes, items, actions, etc.) that commonly reoccur in users' dreams. Along with these words, the personal definitions cited by the dreamers will be listed out. When someone is unsure of what any item in their dream means, they should go through this dictionary to hopefully find the item they are confused about and see if they can relate to other people's experiences. This could help both users and psychologists. Sometimes people might misinterpret what things mean in their dreams. Psychologists might be able to go through this online dream dictionary that we have created and try and figure out what each item represents. On the other hand, users often require constructive reinforcement to be able to use their creativity to manifest what items mean in their dreams. Thus, this solution would serve as that push needed for dreamers to understand their inner thoughts while reflecting on what others feel as well. Another use case for this dream dictionary would be to help advance the scientific community to be able to put to the test this hypothesis put forth by Jung. Psychologists will be able to analyze this dictionary to see and extract similarities between items. This same task can be accomplished to a certain degree by computers as well by passing the descriptions through Word2Vec models and clustering the vectors. We would be able to tell naively how many different interpretations there are of the same items and how close these interpretations are.

The final solution that we propose for the scope of this paper deals with the stage of sleep known as Hypnagogia. In this stage, as discussed earlier, people often report getting ingenious ideas and often solving problems that they were not able to earlier. Many scientists have found various ways to leverage this stage of sleep for their benefit. One issue that is seen upon researching this field is that there are a lot of different techniques proposed by other individuals to harness the power of this stage of sleep, but all of them are rudimentary and hard to put into practice. It is so hard to harness the power of this portion of sleep because when we wake up naturally, we rarely remember what exactly it was that we thought about during this phase. That's why so many individuals harness this portion of sleep by figuring out techniques to wake them up right before they exit this stage of sleep to remember what it was they brainstormed about.

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To better understand this stage of sleep and when exactly a person should wake up, we propose creating a dataset with features relating to the daily routine of the people. Right now, we suggest the basic features such as the amount of exercise they had done that day, are they physically exhausted, did they have a balanced diet, time of their last meal, amount of water they drank that day, number of hours of sleep for past three days, are they currently mentally affected by a traumatic event and if they have a problem that they are not able to solve currently on their mind. These are just some proposed parameters, but obviously, with more careful consideration and research, more complicated parameters could be considered, such as biological ones, etc. Upon collecting these lists of independent variables, we would need to wake the subject up at different times and record their mental state; this would be the dependant variable. Upon doing so, we should check to see if they have any elevated thinking or ideas when they wake up. Hopefully, upon doing this, we can create a machine learning model to find out if a correlation exists between what time we need to wake up to just come out of Hypnagogia with a full recollection of our subconscious events dependant upon the list of independent variables we recorded. If this succeeds, we can then create a system to learn from this dataset and our own sleeping patterns to hopefully fully utilize this state of sleep when our creative side of the brain is at full use.

Conclusion

To conclude, it would like to be said that the proposed ideas above just scratch the surface on how far we can go into this field if we try to incorporate modern-day technology along with psychoanalysis. By doing so, we can have many groundbreaking discoveries and hopefully harness the true power of one of the body's most untapped resources – the subconscious mind. Advances in this field will also benefit phycologists significantly when they are dealing with some severe cases that they cannot fully understand by traditional methods. It will also benefit the dreamer immensely and help them finally make sense of what occurs in their minds when they sleep. It was crucial to use critical thinking in developing the ideas in this field as critical thinking involves analyzing content from various sources and coming to a conclusion. We benefitted from thoroughly going through multiple forms of literature to form somewhat of a basic consensus that research is required in this field and that it is an untapped market. It is hoped that this paper will inspire more significant research into the interdisciplinary field of using technology to solve sleep-related problems.

References

[1] A Movramatis, Hypnagogia The Nature and Function of the Hypnagogic State, Doctoral Thesis, Brunel University, 1983.

[2] Bell, V., n.d. *The Trippy State Between Wakefulness and Sleep*. [online] The Atlantic. Available at: <https://www.theatlantic.com/science/archive/2016/04/deciphering-hypnagogia/478941/> [Accessed 8 September 2021].

[3] Bolognesi, M. and Bicisecchi, R., 2013. Metaphors in Dreams: Where Cognitive Linguistics meets Psychoanalysis. *Language and Psychoanalysis*, 3(1), pp.4–22.

[4] Criticalthinking.org. 2021. *Defining Critical Thinking*. [online] Available at: <https://www.criticalthinking.org/pages/defining-critical-thinking/766> [Accessed 9 September 2021].

[5] Encyclopedia.com. 2021. *Amplification (Analytical Psychology) \ Encyclopedia.com. [online]* Available at: <https://www.encyclopedia.com/psychology/dictionaries-thesauruses-pictures-and-press-releases/amplification-analytical-psychology> [Accessed 5 September 2021].

[6] Fritscher, L., 2020. *How the Collective Unconscious Is Tied to Dreams, Beliefs, and Phobias*. [online] Verywell Mind. Available at: <https://www.verywellmind.com/what-is-the-collective-unconscious-2671571> [Accessed 8 September 2021].

[7] Jones, A., Schulze, S. and Sonnekus, I., 2005. The role of dream analysis for exploring emotional content during early adolescence. *Health SA Gesondheid*, 10(2).

[8] The Pulse Blog. 2020. *What are the Stages of Sleep & What does each Stage Do*?. [online] Available at: <https://ouraring.com/blog/sleep-stages/> [Accessed 7 September 2021].

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Development of Piezoelectric Materials-A Critical Thinking

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ABSTRACT

Critical thinking is an important point for any type of research and developments because this evolves new thoughts and ideas for innovation of new materials as well as improvement of existing materials. Piezoelectricity (conversion of mechanical energy into electrical energy) was discovered by French Nobel Laureates Pierre Curie and Jacques Curie based on their critical thinking and observation on electric sparks produced on application of force or pressure on natural minerals such as quartz and tourmaline. The converse was also proved i.e. development of mechanical strain and block force on application of electricity. Piezo ceramic materials such as BaTiO3 and Lead Zirconate Titanate (PZT) with high piezo properties (d_{33}=100-250 pC/N) were developed based on further innovation and critical thinking on this subject. The effort was continued in the form of addition of various dopants and piezo properties significantly improved to 600-700 pC/N. In order to avoid PbO, a relatively poisonous material, researchers continued to think critically and discovered lead free piezo materials. Currently, the effort is continued for development of high strain and high block force lead free piezo materials. In general, piezoceramic are used for large number of applications such as sonar transducers, sensors and actuators, vibration sensors and accelerometers for aerospace application/vibration control of structures, precision opening and closing of valves, energy harvesting etc. The development of high performance piezo materials and their innovative applications were possible due to critical thinking over the years.

Keywords: *Critical Thinking; Piezoelectric Ceramics; Dopants; Material Discovery; Strain*

1. Introduction

Piezoelectric materials are discovered by Curie brother's during 1880. They observed the piezoelectric effect on certain crystals like quartz and tourmaline while studying the effect of pressure on electrical behaviour of such crystals [1, 2]. The use of these single crystals as sonar transducers was thought during World War I (1914-1918). It was believed that the sinking of Titanic (in 1912) could be barred if the ultrasonic method would have established. This episode, encouraged the scientists to develop ultrasonic equipment using the naturally available piezo crystals. The materials used for fabrication of sonar systems were single crystals of quartz, Rochelle salt, tourmaline, potassium dihydrogen phosphate etc. These materials have demerits of low piezoelectric coefficients, limited application temperature due to low Curie temperature and some are hygroscopic in nature. These drawbacks and requirement of better capacitive material for compact RADAR system during World War II channelized the thought process of innovators for discovery of barium titanate, a better piezoelectric and capacitor material compared to the other materials discovered at that time. Continuous effort of researchers and their thinking to discover better materials finally evolved in the form of lead zirconate titanate (PZT) ceramic material with piezoelectric properties 200-250 pC/N in its un-doped form. The addition of suitable dopants raised the d33 value up to 600-700 pC/N. As on today, PZT is the vastly used piezoelectric material starting from house hold appliances (gas lighter) to more sophisticated aerospace application (actuators / sensors).

Recently, the concern of lead poisoning and environmental pollution forced the researchers to critically think for discovery of lead free piezo material alternate to PZT [3]. Critical thinking over the years by researchers discovered reasonable piezoelectric properties in modified barium titanate, BNT-BKT, and KNN systems. Thereafter, constant

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thinking, strategically modification in processing conditions etc. resulted in discovery of lead free piezo materials with very high piezoelectrtic properties at par with PZT [4-6].

High strain properties of piezoelectric materials are very much suitable for actuation applications. Currently used PZT materials have strain properties of ~ 0.1 %. Therefore, researchers began searching for high strain materials and high block force materials in lead free systems. So, the gradual development in each stage is possible by critical thinking that lead to the innovation of new materials of very high properties.

Based on critically thinking over the years, researchers could innovate new environment friendly and very high performance piezoelectric materials. In this paper, chronology of events which lead to innovation of new high performance piezoelectric materials is presented in a systematic way

2. Evolution of Piezoelectric Materials

A research paper on the original experimental demo which links between macro and microscopic properties of piezoelectric material was published by Curies in 1880. The test comprised of a convincing estimation of external charges on the surfaces of the crystals such as tourmaline, quartz, topaz, natural sweetener and Rochelle salt with application of mechanical pressure. These outcomes were a worthy representative for the Curie's creative mind and constancy, taking into account that they were discovered it with just tinfoil, stick, wire, magnets, etc. During that period, this discovery was reflected a thoughtful "revelation," and immediately named as "piezoelectricity" for reorganization as a different spaces of logical familiarity.

The Curie siblings affirmed, notwithstanding, that the coordinated communication between the mechanical and electrical conversion is affected by temperature along various directions of the crystal. The Curie siblings didn't, nonetheless, anticipate that precious crystals showing the direct piezoelectric impact would likewise display the opposite piezoelectric effect. This property was numerically found from basic thermodynamic standards by Lippmann in 1881. The Curies quickly affirmed the presence of the "converse effect" and progressed forward to acquire quantified confirmation of the total reversible changes occurred in the crystal due to application of electric. A chronological event on discovery of piezoelectricity and piezoelectric materials is presented in Table 1.

Table 1: Chronology of Events of Piezoceramics

Year	Events
1880	Discovery of piezoelectricity.
1880–1920	Discovery of anomalous dielectric properties. First Ultrasonic submarine detector proposed (1917).
1920–1940	Second piezoelectric family discovered-Potassium di-hydrogen phosphate KDP (Busch and Scherrer 1935).
1940–1950	Discovery of unusually high dielectric in polycrystalline materials (Barium Titanate, 1941). First commercial application of piezoceramic: $BaTiO_3$ as phonograph.
1950–1970	Discovery of Lead Zirconate Titanate (PZT). Applications were commercialized such as remote controls, microphones, accelerometers, sonars, etc.

3. Lead to Lead-free Piezoelectric Materials

PZT is deliberated as one among the most broadly utilized piezomaterial for numerous applications. It was discovered in 1952 with very good piezoelectric properties contrasted with $BaTiO_3$ [1]. Transducer applications were commercialized during 1950s -1970s as shown in Table I. But, PbO_3, which is an element of PZT is very much toxic particularly at higher temperature during calcination and sintering due to its volatilization leading to environmental pollution [3]. Based on the environmental concerns and toxicity of lead, World Health Organization (WHO) and European Union came out with legislations regarding banning the use of lead based materials. The ban triggered researchers worldwide develop eco-friendly lead-free piezoceramics alternate to PZT by critical thinking over the

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years which lead to exploration of various lead-free piezoceramic systems which improved electrical properties capable for diverse applications.

As there were several developments taken place in the area of lead-free piezoceramics by introducing different systems, the electrical properties were still not comparable to lead based piezoceramics. Further research resulted in improved piezoelectric properties with doped lead- free piezoceramic systems developed over the years which was due to critical thinking at each stage.

3.1 Critical thinking Approach Towards Lead-Free Piezoceramic Systems

An increase in the awareness of the environmental issues and health hazards, there has been renewed interest in developing lead-free piezoceramics. Some of the explored lead-free piezoceramic systems are Bismuth Sodium Titanate (BNT), Potassium Sodium Niobate (KNN), Bismuth Potassium Titanate (BKT), etc.

The BNT system was 1st reported by Smolenskii et al. in the year 1960 and BKT was originally made by Popper *et al*. in the year 1957. The piezoelectric properties of BNT-BKT system were comparatively less than PZT but have a high Curie temperature greater than 280 °C.

The drawbacks of BNT-BKT system are low piezo properties, high corrosive field, volatility of alkali metal oxides and corrosion of furnace lining etc. made the researchers to critically think for development of other lead-free piezoceramic systems. KNN system was considered as one of the promising alternative to lead based piezoelectric materials and has an advantage of Curie temperature (Tc) greater than 400 °C. But KNN also suffered disadvantages of lowered sintered density, volatility of alkali components at higher sintering temperature etc. as shown in Table 2. These drawbacks of alkali based lead free piezo materials encouraged researchers to enhance the piezoelectric properties of barium titanate based materials with addition of various dopants and finally achieved high $d_{33} \sim 620$ pC/N. The high electrical properties of modified Barium Titanate like Barium Calcium Zirconate Titanate (BCZT) are associated to co-existence of rhombohedral and tetragonal phases at morphotropic phase boundary (MPB) region. The existing lead-free piezoelectric materials along with various dopants can be taken for further study of piezoceramics.

Table 2: Features of Some Piezoceramic Systems

	PZT	BNT-BKT	KNN	BZT-BCT
Advantages	High piezoelectric properties.	This system has Curie temperature (T_c) > 280°C.	This system has Curie temperature (T_c) > 400°C.	High piezoelectric properties.
Disadvantages	Lead oxide in PZT is hazardous to health.	Highly corrosive. Low piezoelectric properties.	Lowered sintered density. Alkali components are volatile at higher temperatures.	This system has Curie temperature (T_c) ~ 120 °C.

4. Applications

Numerous applications of piezoceramics were created during World Wars, thereafter, speakers, accelerometers, gramophone recorder and electrical signal enhancers were developed. Piezoceramics find application in actuator and sensor technologies due to their distinctive ability to link electrical and mechanical displacements. The primary mechanical utilization of a piezoelectric material was the ultrasonic submarine identifier made during World War I.

Ultrasonic transducers were additionally evolved and used to quantify the elasticity and viscosity of materials and was used in medical imaging [7]. Major scope in the area of piezoceramics led researchers to think critically which resulted their vast developments.

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4.1 First Generation of Natural Crystals (1920–1940)

Sonar systems inspired extreme advancement action on a wide range of piezo gadgets, both reverberating and non-resounding was an accomplishment. These were found to be megahertz based quartz resonators, oscillators etc. which brought about ten times expansion in dependability. A new type of testing methods was created depending on the high frequency of the propagated waves. Also, new extents of transient squeezing factor assessment were opened up permitting the examination of explosives and internal combustion engines.

4.2 Second Generation with Piezoceramic Materials (1940–1970)

During 1940-50 Soviet Union, USA and japan developed barium titanate based capacitor materials independently. They observed specific ceramic materials displayed high dielectric constants than normal singly crystals. Moreover, similar classes of materials also showed higher piezoelectric properties. These are called ferroelectric materials. The revelation of effectively fabricated piezo ceramics with astounding execution ascribes typically ignited a restoration of outrageous innovative work into piezoelectric devices.

The advances in materials science that were made during this stage include barium titanate, PZT, PMN, PMN-PT, multilayered stacks, etc. Advancement in the field of material science added to developing a new methodology for piezoelectric device enhancement - explicitly, fitting a material to a specific application. The number of applications worked on was staggering, including the accompanying features and interests where some of them are powerful; sonar, ceramic phono cartridge, piezo ignition systems etc.

5. Development of Piezoelectric Materials at CSIR-NAL

The beginning of piezoelectric materials research in Materials Science Division, CSIR- NAL started under the leadership of Dr.P.K.Panda and funded by National Program on Smart Materials (NPSM) owing to the requirement of such strategic materials in the field of aerospace. Under this program, PZT powder of very high $d_{33} \sim 650$ pC/N and PMN a very high dielectric ($K > 10000$, at RT) material was developed [8-10]. Subsequently, under NPMASS and 10th FYP program the tape casting facility was established for fabrication of thin layers of piezoelectric ceramic, multilayered stacks, actuators / sensors for various in-house and industrial applications [11-14]. PZT unimorphs, bimorphs and ML stacks were used for energy harvesting purpose and better energy harvested from unimorph type PZT devises [15, 16]. Recently, preparation of PZT powder technology and fabrication of special ring type PZT for accelerometer application was transferred to M/s. IPA Pvt. Ltd, Bengaluru. The firm is currently producing PZT powder and ring type products for fabrication of accelerometers. Currently, lead free piezo materials of high piezoelectric properties ($d_{33} > 550$ pC/N) was developed [17-19]. High Curie temperature piezoelectric / piezoresistive materials was also prepared [20-22] and its use for various applications is under progress

Conclusions

While piezoelectricity was discovered in 1880 by Curie brothers but it took nearly 4 decades to exploit its potential application as sonar transducer during World War I. Thereafter, it took nearly 5 decades for discovery of high performance piezoceramic materials like barium titanate, PZT, PMN, PMN-PT, fabrication of multilayered stacks, actuators, sensors, amplified piezo stacks etc. for aerospace and industrial applications. The innovation of above materials and their applications to various sectors was possible due to critical thinking by researchers over the years.

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References

[1] B. Jaffe, H. Jaffe,W.R. Cook, Piezoelectric ceramics. Academic Press, London, 1st Edition, 1971.

[2] J. Curie, P. Curie, Developpement par compression de l'electricite polaire dans les cristaux hemiedres a faces inclinees, *Bulletin de la Societe Mineralogique de France*, 3, 90-93, 1880.

[3] Y. Fukuda, S. Ganesan, M. Pecht, Lead‐free legislations, exemptions, and compliance, in: lead-free electronics, *John Wily and Sons*. Inc., Hoboken, New Jersey, 45-79, 2006.

[4] P. K. Panda, Review: environmental friendly lead-free piezoelectric materials, *J Mater Sci*., 44, 5049–5062, 2009.

[5] J. Rödel, J-F. Li, Lead-free piezoceramics: Status and perspectives, *MRS Bulletin*, 43 (8), 576-580, 2018.

[6] P. K. Panda, B. Sahoo, PZT to Lead Free Piezo Ceramics: A Review, *Ferroelectrics*, 474 (1), 128-143, 2015.

[7] K.K. Shung, J.M. Cannata, Q.F. Zhou, Piezoelectric materials for high frequency medical imaging applications: A review, *J. Electroceramics*, 19, 141-147, 2007.

[8] B. Sahoo, P.K. Panda, Preparation of pyrochlore free PMN powder by semi-wet chemical route, *Materials Chemistry and Physics*, 93, 231-236, 2005.

[9] B. Sahoo, P.K. Panda, Ferroelectric, dielectric and piezoelectric properties of Pb1-x Cex $(Zr_{0.60}Ti_{0.40})O_3]$, $0 \le x \le 0.08$, *Journal of Materials Sciences*, 42, 9684-9688, 2007.

[10] B. Sahoo, P.K. Panda, Dielectric, ferroelectric and piezoelectric properties of (1- x)$[Pb_{0.91}La_{0.09}(Zr_{0.60}Ti_{0.40})O_3]$–x$[Pb(Mg_{1/3}Nb_{2/3})O_3]$, $0 \le x \le 1$, *Journal of Materials Sciences,* 42,4270-4275, 2007.

[11] P.K. Panda, B.Sahoo, S.Raja, Vijaya Kumar M.P, V.Shankar, Electromechanical and Dynamic Characterization of In-house fabricated Amplified Piezo Actuator, *Smart Materials Research*, 2012, 203625, 2012.

[12] B. Sahoo, P.K. Panda, Fabrication of Simple and Ring-Type Piezo Actuators and Their Characterization, *Smart Materials Research*, 2012,821847, 2012.

[13] P.K. Panda, Development of PZT Materials, fabrication and characterization of multi-layered actuators for aerospace applications, *AIP Conf. Proceedings*, 1461, 144-150, 2012.

[14] P.K. Panda, B.Sahoo, Development and Characterization of PZT Multilayered Stacks for Vibration Control, Book chapter, Micro and Smart Device and Systems, *Springer*, 143-154, 2014.

[15] P.K. Panda, B. Sahoo, J. Ramakrishna, Bindu Manoj, D.S.D. Prasad Rao, Recent Studies on Vibrational Energy Harvesting of PZT Materials, *Materials Today: Proceedings*, 5 (10), 21512–21516, 2018.

[16] P.K. Panda, B.Sahoo, M. Chandraiah, Sreekumari Raghavan, Bindu Manoj, J. Ramakrishna, P. Kiran, Piezoelectric Energy Harvesting Using PZT Bimorphs and Multilayered Stacks, *J. electronic materials*, 44 (11), 4349-4353, 2015.

[17] P.K.Panda, B.Sahoo, Effect of La_2O_3 on dielectric and ferroelectric properties of Ba1-xLax $(Ti_{0.98}Zr_{0.02})O_3$ lead free piezoceramics, *ISSS Journal of Micro Smart Systems*, 9, 103–107, 2020.

[18] M. Chandraiah, B. Sahoo, P. K. Panda, Synthesis and Electrical Properties of CaO doped BZT Lead Free Piezo Ceramics, *Ferroelectrics*, 494 (1), 192–199, 2016.

[19] M. Chandraiah, P.K. Panda, Effect of SrO on piezoelectric, dielectric and ferroelectric properties of (Ba1-x Srx) (Ti0.98 Zr0.02)O3 lead free piezoceramics, *J. Mater. Sci: Mater. Electron.* 26, 3143-3147, 2015.

 ISBN: 978-93-91355-21-0 (e-Book)

[20] P. Sivagnanapalani, B. Sahoo, P.K. Panda, Calcium niobate based piezo-resistive materials for high temperature sensor application, *Ceramics International*, 44, 20348-20353, 2018.

[21] P. Sivagnanapalani, NI Ansari, PK Panda, $Nd_2Ti_2O_7$ (NTO) with high curie temperature (T_C) for high temperature sensor applications, *Sensors International*, 2, 100093, 2021.

[22] P. Sivagnanapalani, B. Sahoo, P.K. Panda, A study on strontium niobate based piezo- resistive materials for high-temperature and high-pressure sensor applications, *ISSS J Micro Smart Syst.*, 8 (1), 25–30, 2019.

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Detection of Nonlinearity of a Nonstationary Time Series using Associated Complex Network

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ABSTRACT

The surrogate data test is the most popular test to distinguish nonlinear processes from stochastic noise processes. However, most theories derived from time series analysis presume that time series is stationary. Nevertheless, most of the real-world time series are nonstationary in nature. In a stationary time series, the variables fluctuate around a constant mean with a constant variance independent of time. In nonstationary time series data, the values fluctuate around along a long-term trend curve which depends upon time. Only a couple of methods are reported in the articles to test the nonlinearity of such nonstationary time series. These techniques use time series depending on parameters such as mutual information. In this work, we propose a novel surrogate data test based on complex network induced from the given time series to test the nonlinearity of a given nonstationary time series. An advantage of this method is that it can be automated.

Keywords: *Non-linearity, Test Statistics, Complex Networks, Non-stationary, Surrogate*

1. Introduction

In recent years, the surrogate data test for nonlinearity has gained popularity, When used to test a null hypothesis that the time series analyzed was created by a Gaussian (linear) process that undergoes a possibly nonlinear static transform. A surrogate data approach was suggested by Theiler *et al.* [1] to determine the parameters of a time series, especially a possible (dynamic) nonlinearity. The first technique for creating complex networks from time series was proposed by Zhang and Small [2], and many approaches have been proposed since then by various scholars [3-5]. Complex Network and Nonlinear Time series analysis emerges as two different fields having applications in various domains of Science and Technology. Instead of employing traditional metrics like the Lyapunov exponent and the bifurcation diagram to describe a system's behavior, network parameters like graph density, transitivity or clustering coefficient, mean degree and median degree, etc. [6, 7].

Even though most theories developed from time series analysis presumed that time series is stationary. If the distribution function of the time series value is exactly the same regardless of time, the time series is stationary. Classical surrogate data methods, such as random shuffle [8], random permutation, amplitude adjusted Fourier transform [1], or iterative amplitude adjusted Fourier transform [9], are based on the assumption of an underlying stationary process and thus produce stationary surrogate data.

However, may the real world time series are nonstationary in nature. In the articles to test the nonlinearity of such nonstationary time series only a couple of methods are reported [10]. The statistical features of a nonstationary time series, such as mean and variance, will not remain constant throughout time. In other words, a nonstationary time series is a series with a trend that can move around but revert to the mean over time. The economic and financial variables are examples of nonstationary time series in the real world

Nowadays, testing the nonlinearity of a given nonstationary time series through the network method plays a prominent role in research. There is so much literature available for various network constructing methods. In this work, we propose a new method of surrogate data test based on a complex network induced from the given time series to test the nonlinearity of a given nonstationary time series.

2. Construction of Network from Time Series

In this procedure, the initial step is to substitute a 0 or 1 (single bit encoding) for each data point in the time series based on whether the value is less or more than the median denoted as Q_1 of time series values. The M bits are taken at a time from the binary series and converted into a decimal value. That is, take the first M bits are

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converted into a decimal value, then shifted one position to the right and selected M bits and converted into a decimal value and so on until the end of the binary series. The window now moves one position at a time from the beginning to the end of the binary series, resulting in a series of decimal numbers. In this way, the different decimal numbers obtained are the nodes of the network. There will be an edge between adjacent decimal numbers in the series. Freitas *et al.* [6] have shown that the network's structural properties can capture the dynamical characteristics of a chaotic time series.

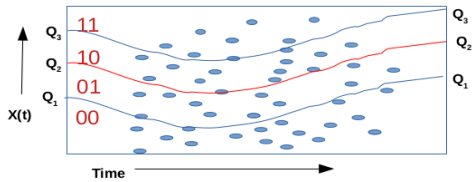

Fig. 1: The Double Encoding Method for Non-stationary Time Series

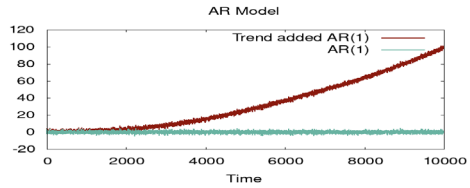

Fig. 2: AR(1) and the Trend t2 + cos(t) Added Series

In double-bit encoding, the resulting symbolic binary series will be twice as long as the original time series [11]. The values of time series have been partitioned into four layers (00,01,10, and 11), each with a double-bit encoding (b =2), with the first layer corresponding to values less than or equal to the first quartile denoted as Q1, the second layer to values above Q1 and up to Q2, the third layer to values above Q2 and up to Q3, and the fourth layer to values above Q3.

The M bits are taken at a time from the binary series and converted into a decimal value. That is, take the first M bits are converted into a decimal value, then shifted two positions to the right and selected M bits and converted into a decimal value and so on until the end of the binary series. As a result, these symbolic binary series translate to decimal series, and the various decimal numbers acquired represent the network's nodes. To construct a network there will be an edge between adjacent decimal numbers in the series. The network made in this way can significantly increase the network's efficacy in capturing the series dynamics.

By dividing the time series range into 2^n parts, we may expand this approach to n-bit encoding. A considerable improvement in the network's ability to capture stationary series dynamics. The efficiency of capturing the dynamics of the series from the network can be dramatically improved by increasing the number of partitions of the range of series [11].

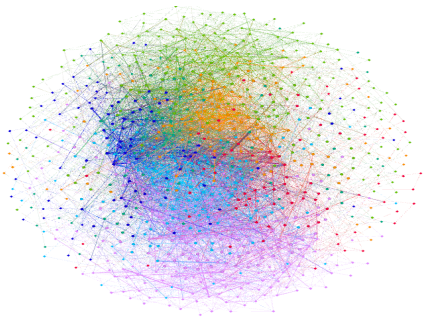

Fig. 3: Network of the Trend-added AR(1) Time Series

However, for nonstationary series, both the trend and the oscillations in the surrounding region would affect the network. In nonstationary time series, we can capture the dynamics of the time series using the 2^n encoding method. We may explain this using the 2^2 encoding method, with the median of time series data designated as Q_2. In nonstationary time series, the partition layers represent the curve. Such as the median of the series Q_2 is the trend curve and the range distance from Q_2 to Q_1 and Q_3 are calculated as median value d by 2. Maximum fluctuations from the trend curve Q_2 is d, shown in Fig.1. The binary series is then encoded to a decimal series, which is then converted to a network using the same manner as the double encoding technique. To generate the binary series in the same way, this method can be expanded to n-bit encoding. In n-bit encoding, we can produce binary series from nonstationary series in the same way. According to our observations, 6-bit encoding with M = 10 generates the most accurate results. According to our observations, 6-bit encoding with M = 10 creates very reliable outcome.

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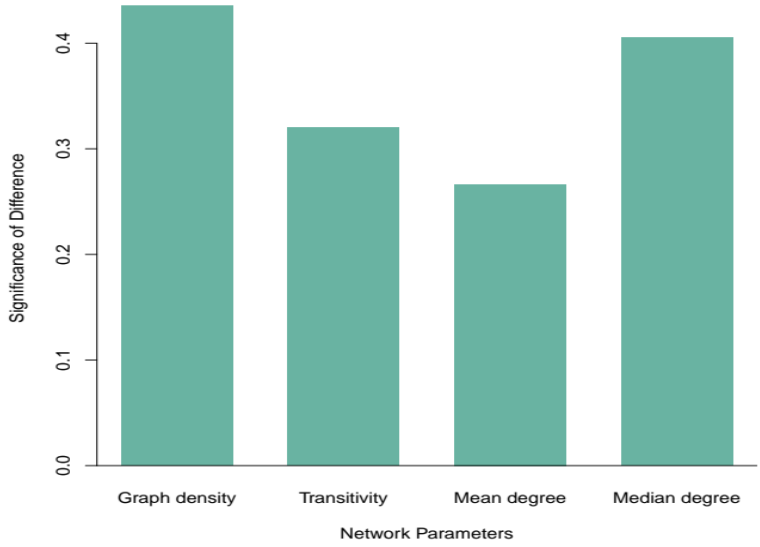

Fig. 4: Significance of Difference S Computed from AR Model $x_t = x_{t-1}/2 + a_t$.

When employing surrogate data to test nonlinearity, a variety of distinguishing statistics are often used. This paper suggests using test statistics for a surrogate data test based on characteristics linked to the structural aspects of a complex network formed from a time series. We proposed using network metrics that are easily measured, such as graph density, average path length, and clustering coefficient, as discriminating statistics. The original time series and its surrogates are converted into the network to determine discriminating statistics and find the significance of the difference value of S. We use a quality derived by a method that is sensitive to nonlinearity as a discriminating statistic. For both original and surrogate data, the discriminating statistic is determined, and depending on the significance of the difference value of S, the null hypothesis is accepted or rejected. If $S > 2$, with a confidence level of 5%, the null hypothesis is rejected. The significance of the difference value of S is computed as

$$S = (\mu org - \mu sur)/\sigma sur$$

where μ_{sur} is the mean and σ_{sur} is the standard deviations of the statistic's distribution generated from surrogates, and μ_{org} is the mean of the original data statistic.

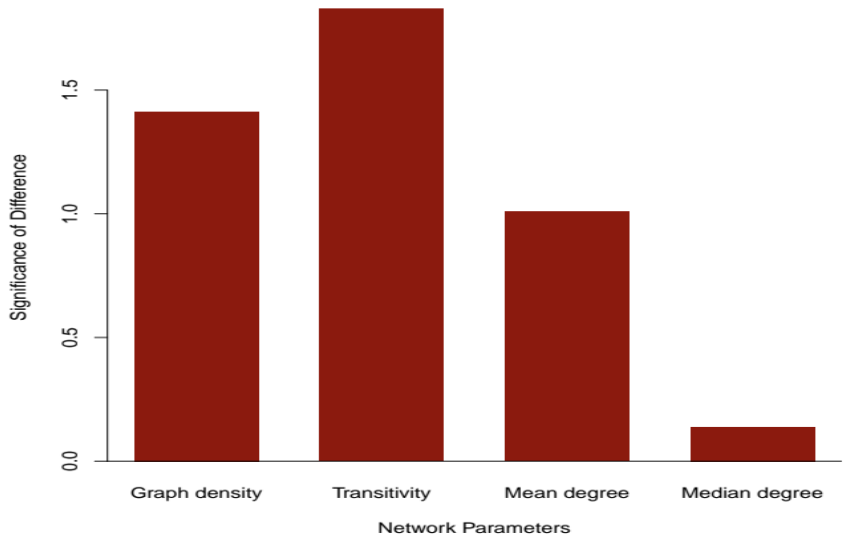

Fig. 5: Significance of Difference S of the Various Network Parameters of the AR model x t = x t−1 /2 + at with Trend f(t)=t2 + cos(t) Time Series

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Results and Discussion

We generated stationary AR(1) time series, the AR model $x_t = x_{t-1}/2 + a_t$ generates 10000 values points, where a_t is a Gaussian series. The given time series is converted into the network; after that, it generates 40 surrogates and converted into a corresponding network, then computes the S values of the network parameters. This time series was then added a trend $f(t)=t^2+\cos(t)$ to construct a nonstationary time series and repeat the same procedure. Figure Fig. 2 shows the original AR(1) time series and the trend $t^2 + \cos(t)$ added series. We can detect the dynamics of time series using the 2n encoding method for constructing network from the AR(1) time series, network is shown in Fig. 3, and the significance of difference value of S of AR(1) time series in figure Fig. 4 and add trend f(t) to AR(1) time series and its significance of difference value of S in Fig. 5 respectively. The values of S less than 2 in these two time series imply that the null hypothesis cannot be rejected.

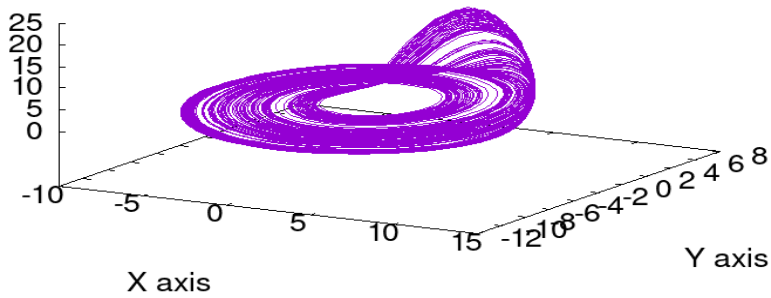

Fig. 6: Rossler System Where a = 0.2, b = 0.2 and c = 5.7 with 10000 Points

The Rossler system is a continuous-time dynamical system consisting of three nonlinear ordinary differential equations. The following nonlinear ordinary differential equations govern the Rossler system. [12]

$$dx/dt = -y - z$$

$$dy/dt = x + ay$$

$$dz/dt = b + (x - c)z$$

which is chaotic for a = 0.2, b = 0.2 and c = 5.7 shown in Fig. 6.

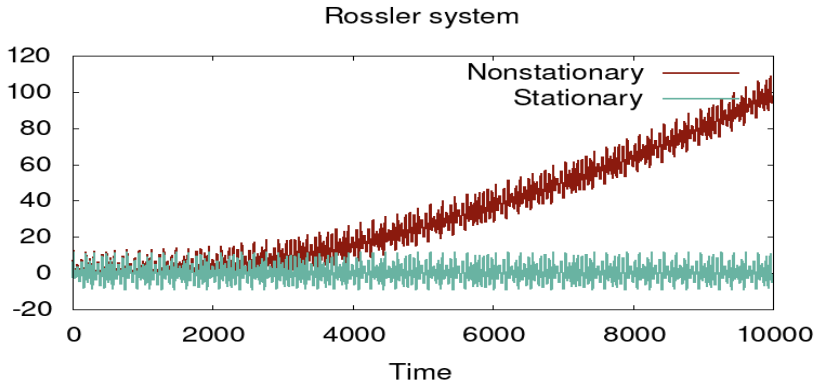

Fig. 7: Rossler Stationary and Trend-added Rossler Nonstationarytime Series of X-component

The system generated 10000 points, and we selected x-component from x_t. The original data and the surrogate distribution were used to compute the network structural parameters of the time series, and the value of significance of difference S was measured. The series was then made nonstationary by adding the same trend function $f(t)=f(t)=t^2 + \cos(t)$ and repeat the same procedure for calculated the value of significance of difference S. The Rossler time series where a = 0.2, b = 0.2 and c = 5.7 and add the trend to Rossler time series are plotted, shown in Fig. 7 and the corresponding network is in Fig. 8.

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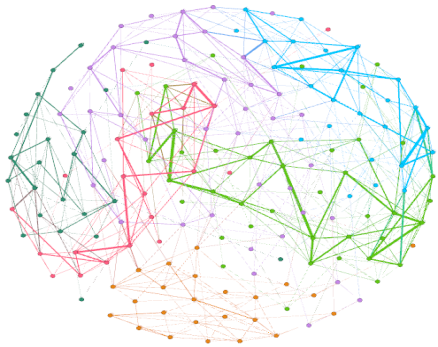

Fig. 8: Network of the Trend-added Rossler Time Series

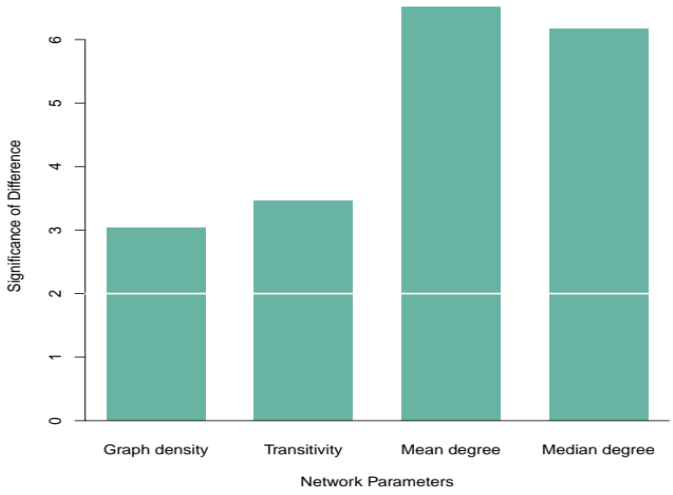

Fig. 9: Significance of Difference S of the Various Network Parameters of the Rossler Stationary Time Series

In both stationary and nonstationary Rossler time series, the significance of the difference in graph density, clustering coefficient, mean degree, and median degree as test statistics are greater than 2, result shown in figure Fig. 9 and Fig. 10. In all circumstances, we will reject the null hypothesis because the value of S was greater than 2, confirming that the Rossler time series is not a linear stochastic process.

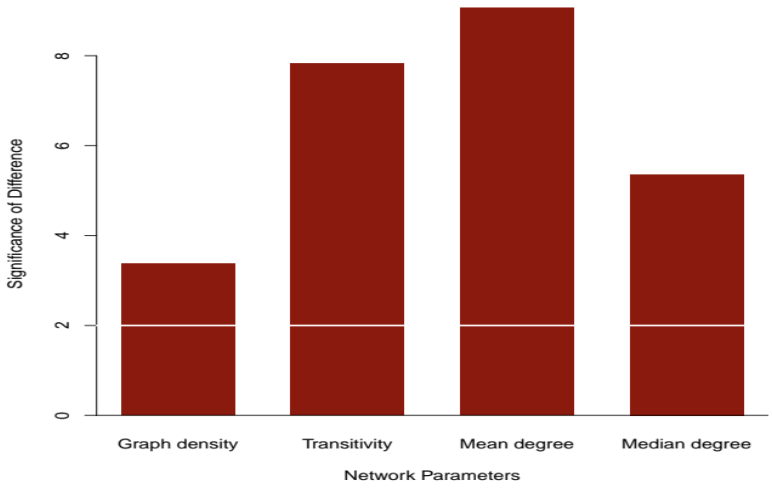

Fig. 10: Significance of Difference S of the Various Network Parameters of the Rossler Nonstationary Time Series

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Conclusion

The real world time series are nonstationary in nature, but challenging to test the nonlinearity of such nonstationary time series. For all network parameters AR(1) and trend-added AR(1), the resulting value of the significance of the difference S is less than 2, suggesting that the signal is created by a linear process at the 95 percent confidence level. The null hypothesis will be rejected in all situations in the Rossler time series since the significance of difference S is greater than 2, indicating that the series is not a linear stochastic process. We successfully prove that this surrogate data test based on a complex network constructed from the given time series can detect nonlinearity in a nonstationary time series.

Acknowledgment

The first author (MMC) gratefully acknowledges financial assistance from the Kerala Government's e-grants scheme.

References

[1] J. Theiler, S. Eubank, A. Longtin, B. Galdrikian, and J. Doynefarmer, Testing for Nonlinearity in Time Series: The Method of Surrogate Data, Physica D: Nonlinear Phenomena 58, 77 (1992).

[2] J. Zhang and M. Small, "Complex network from Pseudo Periodic Time Series: Topology Versus Dynamics," *Physical Review Letters*, Vol. 96, No. 23, p. 238701, 2006.

[3] Y. Yang and H. Yang, "Complex network-based time series analysis," *Physica A: Statistical Mechanics and its Applications*, Vol. 387, No. 5–6, pp. 1381–1386, 2008.

[4] L. Lacasa, B. Luque, F. Ballesteros, J. Luque, and J. C. Nuno, "From time series to complex networks: The Visibility Graph," *Proceedings of the National Academy of Sciences*, Vol. 105, No. 13, pp. 4972–4975, 2008.

[5] A. S. Campanharo, M. I. Sirer, R. D. Malmgren, F. M. Ramos, and L. A. N. Amaral, "Duality between time series and networks," *PloS One*, Vol. 6, No. 8, p. e23378, 2011.

[6] V. L. Freitas, J. C. Lacerda, and E. E. Macau, Complex Networks Approach for Dynamical Characterization of Nonlinear Systems, *International Journal of Bifurcation and Chaos* 29, 1950188 (2019).

[7] Yu X, Jia Z, Jian X. Logistic mapping-based complex network modeling. *Appl Math*. (2013) 4:1558. doi: 10.4236/am.2013.411210

[8] Scheinkman, Jose A., and Blake LeBaron. "Nonlinear dynamics and stock returns." *Journal of business* (1989): 311–337.

[9] Schreiber, Thomas, and Andreas Schmitz. "Improved surrogate data for nonlinearity tests." *Physical review letters* 77.4 (1996): 635.

[10] Lucio, J. H., R. Valdés, and L. R. Rodríguez. "Improvements to Surrogate Data Methods for Nonstationary Time Series." *Physical Review E* 85.5 (2012): 056202.

[11] S. Suriyaprabhaa, G. Gopinath, R. Sangeerthana, S. Alfiya, P. Asha, and K. S. Kumar, "Generalized Symbolic Dynamics Approach for Characterization of Time Series, Advances in Computing and Network Communications" 1, 53 (2020).

[12] Rössler, Otto E. "An Equation for Continuous Chaos." *Physics Letters A* 57.5 (1976): 397–398.

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Security Visualization Approaches for Cyber Network Security

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ABSTRACT

The security visualization (SV) topic provides extensive cloud services and technologies for delivering different cloud-related solutions. SV is used to check and monitor the cloud data, and these data movements are tracked during transmission or in the rest position. The technology uses for security events using standardized models and frameworks. The SV framework provides the data provenance technology as a service in the cloud platform. In this paper, SV highlighted the importance of data security for various cloud services and returned data control to cloud customers using cloud security technologies. This paper shows a security visualization framework for the network management system. It defines the security visualization model, including steps for the SV Intelligence model and SV classification approaches.

Keywords: *Security Visualization, Network Security, SV Intelligence, SV Classification, SV Framework*

1. Introduction

Cloud computing has created a trending buzzword in the IT industry. The cloud data sets use logging mechanisms, and social media logs are considered security-related events. Security visualization (SV) uses standard solutions and innovations for achieving various services for users and consumers. This technology uses real-time data sets to face security challenges. SV uses a law enforcement standard and reporting model for security events. SV has been used for security measures using visualization techniques for unauthorized access, data leakage service, and data breaching techniques. Modern cloud technologies use security solutions for web traffic and proxy problems. It uses security measures such as threat intelligence and data visual analytics events for data security [1].

The data security challenges use visualization tools to increase the network state, such as NVisionIP, PortVis, and VisFlowConnect. NVisionIP is used for the visual representation of data segments on the network. PortVis is used for data discovery in a security event that verifies the network's data flow for security measures. VisFlowConnect is a tool for enhancing the security administrator's ability to check the local networks' data traffic. Security issues have fingerprinting, data accuracy, usability issues, blending attacks, probe response attacks, and privacy network issues [2].

The next part of the paper is defined as follows. The second section reviews the recent literature works. The third section describes the security visualization model. The fourth section gives the SV classification approaches, and the final section concludes the paper.

2. Literature Survey

An enormous literature review has been done on security visualization techniques for maintaining network security. The authors in [3] have described the visualization evaluation used in research directions for cyber security solutions. It also mentions the assessment for system designs, which include information and summative motivations. The authors in [4] display the security visualization field for maintaining security. The graph drawing methods are used as a security-related feature, and the graph drawing approaches are used as security concepts.

The authors in [5] have used a visualization system for providing network security. It describes five use-case classes for maintaining a visualization security system. The different data classification methods are used in a visualization system that uses use-case-driven methods. The authors in [6] have reviewed the future of security visualization. They have defined the recent trends in network virtualization using various interaction techniques and visual metaphors.

2.1 Security Visualization Framework

SV technologies include an intelligence framework for providing SV landscapers and security attacks. The SV framework uses cloud technologies to check and monitor the behavior of the system. The data provenance scheme works as an SV service in communications systems. It helps in data visualization capabilities for cloud users. This

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method plans to monitor the data to watch past events and build current events. An example includes the transaction movement addressed by visualization from the sender to the receiver.

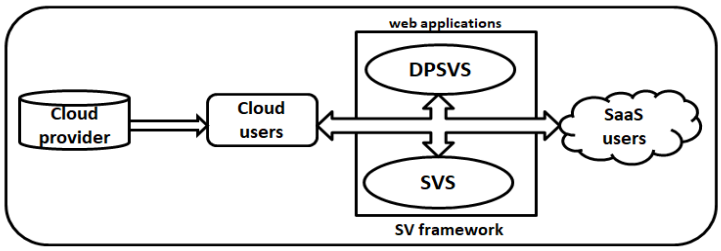

Fig 1: Security Visualization Framework

Fig. 1 depicts the security visualization framework in cloud computing, including the SV intelligence framework and model for adopting multiple security visualization techniques. The security intelligence model comprises of added SV framework for cloud technologies. The security as a Service (SaaS) model includes an additional security visualization framework and a set of web application services [7]. These web applications help detect and monitor various landscape attacks.

2.1.1 Security Visualization Service (SVS)

The security visualization service model incorporates security as a service that includes user activities, web traffic, and other security measures useful for cloud consumers and providers.

2.1.2 Data Provenance Security Visualization Service (DPSVS)

DPSVS provides cloud services that improve visualization capabilities for cloud users. It includes data actions for past and current events of data provenance for security visualization service.

3. Security Visualization Model

This section defines the security visualization model for network security. SV is known as a modern cloud security solution to address users' requests and answer queries related to their confidential data. SV is used to solve the cyber threats issues in cloud network systems. SV model makes reporting of security events and provides standard security for law enforcement issues. SV encourages security measures such as data leakage, unauthorized access visualization, and web traffic tracking of malicious activity [8]. It is used to track and monitor security events and usually works on cyber security research problems and their challenges for information security. Data security research issues include data integrity, confidentiality, and availability in the cloud environment, which is most useful for cyber security attacks happening around us. It covers cyber-attacks security, such as law enforcement and security analyst's issues, and works on cyber security techniques, workflows, and cyber security attacks.

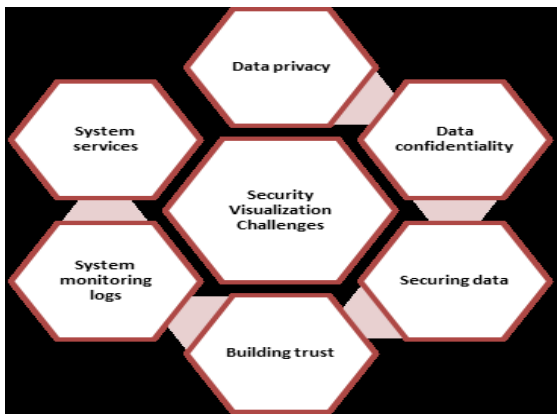

Fig. 2: Security Visualization Challenges

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Fig. 2 represents SV challenges that include user data privacy, data confidentiality, securing sensitive data, building a trust relationship for cloud providers, and providing system monitoring logs and services. SV has security for law enforcement methods like network logs, system and application logs, porting images, files, and records. It can store complex data such as ports, shreds of evidence, and work processes.

3.1 SV Intelligence Model

SV model includes policies, guidelines for maintaining security standards for corporates and organizations. The practical approaches related to SV include threat landscapes and target audiences or clients. SV model captures the type of users, security tasks, and SV techniques usage and helps the researchers deal with security attacks and countermeasures. The visual scheme checks the data set the complexity and benefits of the network users' database queries, and the investigation service helps for graphical representation purposes for law enforcement [9].

The SV Intelligence model uses intelligence tools for the SV framework for various activities and threat intelligence work and builds trust and confidence for cloud users and its providers. SV helps in providing security requirements for multiple types of people. The information visualization gives meaningful information for large storage of data. SV plays a significant role in security analysis methods. The security analysis helps review the logs, network issues, server equipment, security events, etc.

The steps for SV are given as follows.

Data Collection: Data collection means sharing data, correlate events, validation methods, third party processing and authentication.

Data Transformation: Data transformation includes types of transformation for event correlation. Here each event includes the attributes such as Event ID, time, event type and result generated. Event modeling indicates the relations between the data being virtualized.

Data Event Correlation: In data as a service model, the data visualization storage delivery system separates data storage service and the cloud service.

Visualization Results: This step displays the final visualization results.

4. SV Classification Approach

The following section describes the SV classification approach for network security systems. SV is designed for use cases of security-related data through security analysis techniques. Data visualization must be used case-driven [10]. There are five classes of use cases.

4.1 Host or Server Monitoring

The network virtualization process includes the host and server monitoring ways. Here the current state of a network is visualized using the number of users, status, and system load. It marks unexpected host or server activities. It is used to identify the malware action by the users. Thus, the network load on the visualization system is reduced enormously.

4.2 Internal or External Monitoring

Visualizations class interacts with internal and external hosts. It includes internal hosts communicates with the external monitoring IPs. This class's visualization techniques use color maps, radial panels, scatter plots, and parallel coordinates.

4.3 Port Activity

The port activity includes irregular and unusual port activities like trojans, viruses, worms, etc. The visualization systems detect malicious software residing inside the network. The visualization techniques use scaling methods by seeing large port numbers and IP addresses [11].

4.4 Attack Patterns

The visualization class is used for detecting network attacks and the various types of attacks use different visual patterns in multiple phases. The attack patterns include scanning, accessing, clearing tracks, and finally installing back doors. The visualization class adopts intrusion detection mechanisms for security administrators. The visual systems use visual correlation and false positives reduction.

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4.5 Routing Behavior

The routing behavior in the visualization class uses various routing patterns in the network. The border gateway protocol (BGP) is used for suspecting network attacks. Internet routing is used for detecting Internet traffic and misconfiguring malicious attacks over the system.

Fig. 3 depicts security visualization classification approach. The various methods include host or server monitoring, internal or external monitoring approach, port activity, attack patterns and routing behavior approaches.

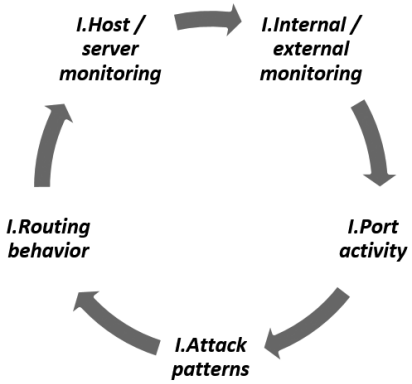

Fig. 3: SV Classification Approach

Recent data visualization tools and techniques comparison are depicted in Table 1. The visual creatures show the data visualization charts and machine learning tools using data visualization models. Creating data visualization tools and charts uses chart templates and graph makers, which helps designers, data analysts, statisticians, etc.

Table 1: Data Visualization

Types	Data Visualization tools	Data Visualization charts
1	Tableau public	FusionCharts
2	Visme	Whatagraph
3	Looker	Polymaps
4	Zoho Analytics	DataBox
5	Sisense	ChartBlocks
6	IBM Cognos Analytics	Datawrapper
7	Qlik Sense	Google Charts
8	Domo	D3.js
9	Microsoft Power BI	Chart.js
10	Klipfolio	Grafana
11	SAP Analytics Cloud	Chartist.js
12	Infogram	Sigmajs

Conclusion

SV technology is considered an additional feature in the cloud to provide security technologies from data leakage or data breaching techniques. SV is used for exploration and reporting purposes by building visual views from cloud users. The SV Intelligence model uses law enforcement specifications for investigation service. This paper has given various types of security visualization approaches.

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References

[1] Ferebee, D., & Dasgupta, D. (2008, June). Security visualization survey. In *Proceedings of the 12th Colloquium for Information Systems Security Education University of Texas* (p. 124).

[2] Sinjilawi, Y. K., Al-Nabhan, M. Q., & Abu-Shanab, E. A. (2014). Addressing Security and Privacy Issues in Cloud Computing. *Journal of Emerging Technologies in Web Intelligence*, 6(2).

[3] Ball, R., Fink, G. A., & North, C. (2004, October). Home-centric Visualization of Network Traffic for Security Administration. In Proceedings of the 2004 ACM Workshop on Visualization and Data Mining for Computer Security (pp. 55–64).

[4] Sudha, S., & Viswanatham, V. M. (2013). Addressing Security And Privacy Issues In Cloud Computing. *Journal of Theoretical & Applied Information Technology*, 48(2).

[5] Komlodi, A., Rheingans, P., Ayachit, U., Goodall, J. R., & Joshi, A. (2005, October). A user-centered look at glyph-based security visualization. In *IEEE Workshop on Visualization for Computer Security*, 2005. (VizSEC 05). (pp. 21–28). IEEE.

[6] Shiravi, H., Shiravi, A., & Ghorbani, A. A. (2011). A survey of visualization systems for network security. *IEEE Transactions on Visualization and Computer Graphics*, 18(8), 1313–1329.

[7] Staheli, D., Yu, T., Crouser, R. J., Damodaran, S., Nam, K., O'Gwynn, D., ... & Harrison, L. (2014, November). Visualization evaluation for cyber security: Trends and future directions. In *Proceedings of the Eleventh Workshop on Visualization for Cyber Security* (pp. 49–56).

[8] Tamassia, R., Palazzi, B., & Papamanthou, C. (2008, September). Graph drawing for security visualization. In *International Symposium on Graph Drawing* (pp. 2–13). Springer, Berlin, Heidelberg.

[9] Harrison, L., & Lu, A. (2012). The future of security visualization: Lessons from network visualization. *IEEE Network*, *26*(6), 6–11.

[10] Kumar, V., Chaisiri, S., & Ko, R. (2017). Data Security in Cloud Computing.

[11] Gleicher, M., Albers, D., Walker, R., Jusufi, I., Hansen, C. D., & Roberts, J. C. (2011). Visual comparison for information visualization. *Information Visualization*, 10(4), 289–309.

[12] Manzhosov, A. V., & Bolodurina, I. P. (2021). Visualization of a Spatio-Temportal Threat Model. In Advances in Automation II: Proceedings of the International Russian Automation Conference, RusAutoConf 2020, September 6-12, 2020, Sochi, Russia (pp. 533–542). Springer International Publishing.

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A Hybrid Approach to Identify Strong Personality Traits: A Forward Step Towards Character Building

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ABSTRACT

Personality assessment can provide insight on the character building of an individual and specifically, selection process of a candidate for a particular job. The relationship between human emotions and personality is a proven aspect in predicting the mental health of an individual. This research proposes a hybrid approach based on voice based emotion detection and analysing the data extracted from various social media platforms like twitter, Facebook etc. The Mel-frequency cepstral coefficients (MFCC) are used in audio classification experiments. User information collected is used to evaluate the personality of an individual on various aspects. Traditional personality assessments are done by making individuals to participate in personality tests. There are several drawbacks to this approach, such as it is time consuming, and test participants could have made up their answers. This study is helpful to classify people using Personality classification and Machine Learning approach and predict their personality with more accuracy by incorporating the emotion detection and classification through Voice Recognition on MLP classifier. The system automates the personality prediction process of the users. The system uses ML algorithms such as Random Forest regression and Random Forest classifier to predict the personality of a person. A supervised machine learning classification model has been developed and trained on Myers– Briggs Type Indicator (MBTI) Dataset, which attempts to predict the 16-way personality code as well as each binary character code along each axis. MBTI divides everyone into 16 distinct personality types across 4 axis: Introversion (I) — Extroversion (E) Intuition (N) — Sensing (S) Thinking (T) — Feeling (F) Judging (J) — Perceiving (P). The system proposes a user to attempt questionnaire and allows in viewing the results. The questionnaire contains 20 questions each from these 5 traits is given to the users, having 2 options. Based on their responses the personality will be predicted.

Keywords: *Personality Traits, Character Building, MBTI, User Behaviour, User Information*

1. Introduction

Any individuals Character refers to the qualities and characteristics, which shows how one person is different from others. The character of a person is actually a combination of ones qualities. A person with a good character will be accepted by the society. The widely accepted set of good personality traits are sincerity, trustworthiness, patience, empathy, loyalty, compassion, fairness etc. Also it is widely accepted that a person with a good character would in turn have a good personality. So in this context, a hybrid approach based on voice based emotion detection and also analysing the data extracted from various social media platforms is proposed for better accuracy in the prediction process.

1.1 Literature Survey

In existing system personality prediction isn't always carried out through a separate device for predicting personality. Google forms had been used for accumulating pattern dataset. The collected dataset was very restricted which in turn reduces the accuracy level of prediction. Michael M. Tadesse investigated the predictability of the personality traits of Facebook users based on different features and measures of the Big 5 model [1].Ahmed Al Marouf *et al.* and G. V. Rohit *et al.* predicted the personality of user by using the status information present in their social media profile [2][3].

2. System Development

2.1 Methodology Adopted for Personality Prediction based on Questionnaire

Initially the user has provided with a set of questions and the responses given by the user have been recorded. In the next phase, these responses are compared with the already existing training data sets. However, this comparison is

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performed using Classification Algorithm i.e., Random Forest Classifier. Personality trait repository basically stores all the personalities like Extroversion, Introversion and Sensitive etc. So once the processing is completed the result i.e., the predicted personality of particular user is displayed on the screen.

2.2 Methodology Adopted for Emotion Detection based on Audio

The Mel-frequency cepstral coefficients (MFCC) are widely used in audio classification experiments due to its good performance. It extracts and represents features of speech signal. The dataset will be split into training and testing samples with the test data as 30% and training data as 70%. MLP Classifier algorithm is used for better model prediction. For emotion classification, dataset is formed using 24 speakers. The subjects consist of an equal proportion of males and females. Dataset have recorded voice of each subject for 30 times. All the recorded data was labelled into three categories/classes of emotions: calm, happy, sad, angry, fearful, surprise, and disgust expressions.

2.3 Methodology for Hybrid Approach Combining Both the Methods

By utilizing the above two methodologies such as voice based emotion detection and questionnaire based personality prediction approach, Proposing a hybrid method using which an individual's personality will be predicted based more accurately.

2.4 Experimental Details

The Front end is designed using Django, a Python Framework. The Back end uses Machine Learning Model build using Sklearn Python and saved it as .h5 format, which is called in Django models.

A supervised machine learning classification model has been developed and trained on Myers–Briggs Type Indicator (MBTI) Dataset, which attempts to predict the 16-way personality code as well as each binary character code along each axis. MBTI divides everyone into 16 distinct personality types across 4 axis: Introversion (I) — Extroversion (E) Intuition (N) — Sensing (S) Thinking (T) — Feeling (F) Judging (J) — Perceiving (P). The system proposes a user to attempt questionnaire and allows in viewing the results. The questionnaire contains 20 questions each from these 5 traits is given to the users, having 2 options. Based on their responses the personality will be predicted.

STEP 1: The personality characteristics are stored in database. Later, when user enters his characteristics, his personality is verified in large pre-existing databases.

STEP 2: Each user will enter his personality characteristics and system will detect the personality of the user, based on the previous data stored in database.

STEP 3: System will extract relevant features from the answers selected by the user and compare with data stored in database.

STEP 4: System will examine the personality of the user based on the personality traits mentioned by the user.

STEP 5: The relation between personality and user behaviour is tested.

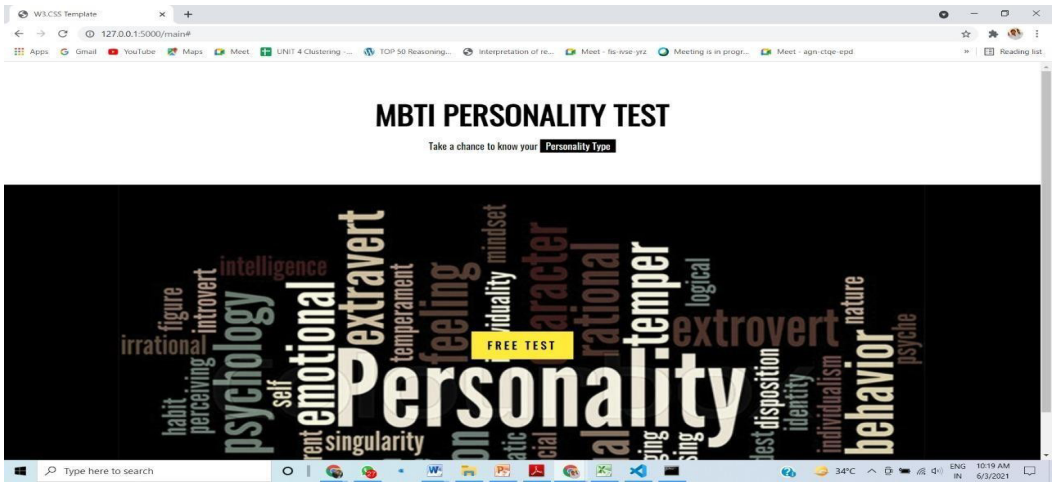

Fig. 1: Main Web Page

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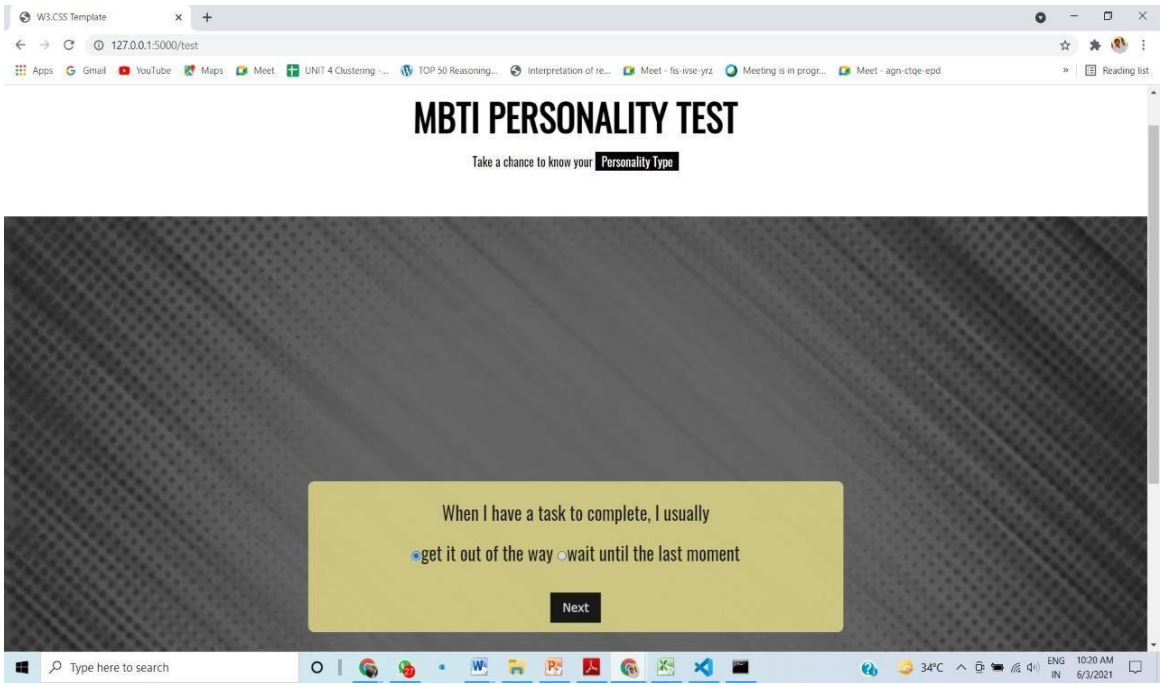

Fig. 2: Sample Question Based on Personality

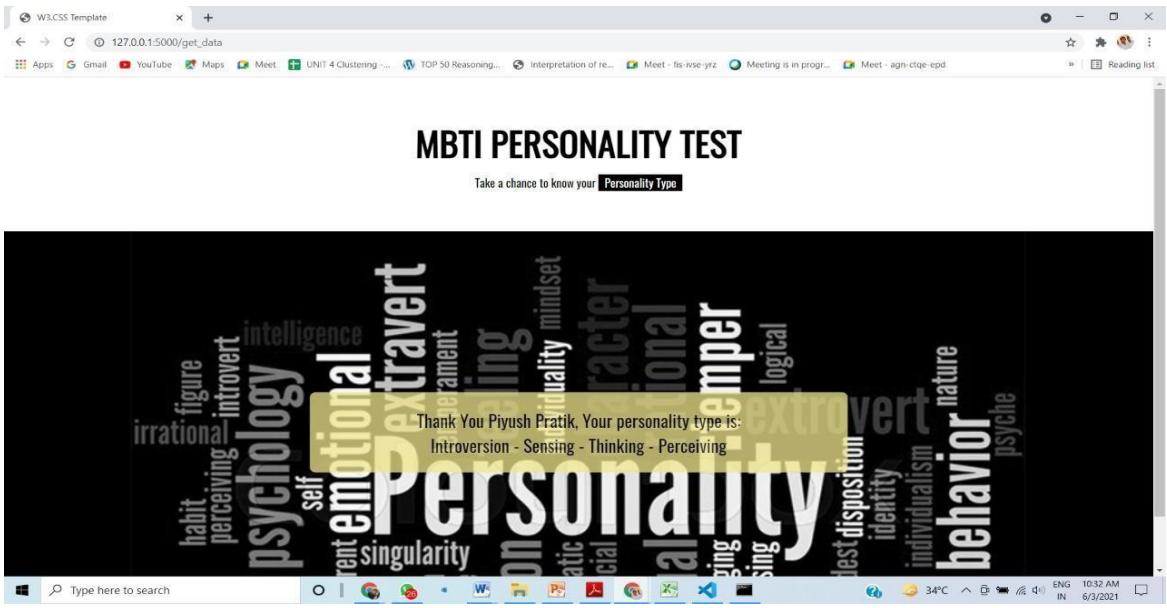

Fig. 3: Results of a Personality Test

The results of a personality test and predict the personality of a persons, who has answered all the question of a test according to their personality if the user answers correct answer, then the prediction of the personality will be accurate.

PostgreSQL is used in Django Database. Speech emotions include calm, happy, sad, angry, fearful, surprise, and disgust expressions.

Step 1: Audio data will be loaded.

Step 2: Features are extracted from it.

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Step 3: Using the emotions dictionary, the function checks whether the emotion is in the list of observed emotions.

Step 4: The dataset will be split into training and testing samples with the test data as 30% and training data as 70%.

Step 5: MLP Classifier algorithm is used for better model prediction. The process of training the model and predicting the values will be continued till the desired accuracy is obtained.

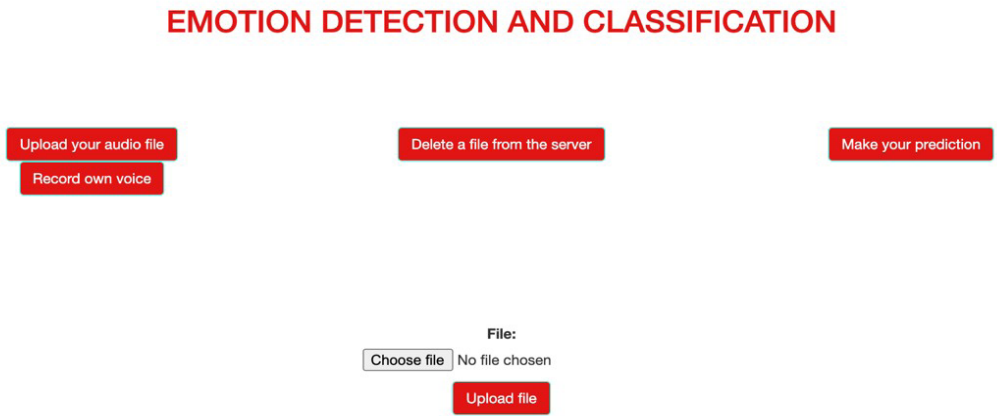

Fig. 4: Index Page to upload Audio File

Fig. 5: Select Uploaded file for Prediction

Fig. 6: Emotion Prediction from Audio

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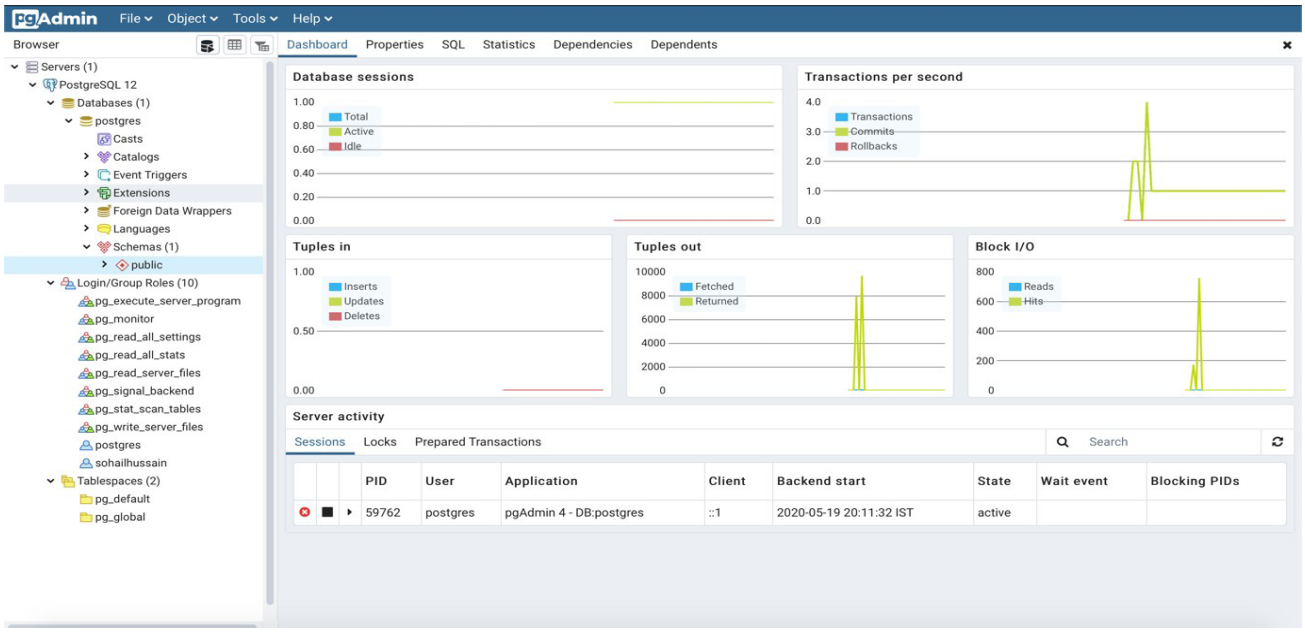

Fig. 7: PostgreSQL Dashboard for all Databases

```
In [20]: print(f'Features extracted= {x_train.shape[1]}')
         Features extracted= 180

In [21]: model=MLPClassifier(alpha=0.01, batch_size=256, epsilon=1e-08, hidden_layer_sizes=(300,), learning_rate='adaptive', max

In [22]: model.fit(x_train,y_train)

Out[22]: MLPClassifier(activation='relu', alpha=0.01, batch_size=256, beta_1=0.9,
                       beta_2=0.999, early_stopping=False, epsilon=1e-08,
                       hidden_layer_sizes=(300,), learning_rate='adaptive',
                       learning_rate_init=0.001, max_iter=500, momentum=0.9,
                       n_iter_no_change=10, nesterovs_momentum=True, power_t=0.5,
                       random_state=None, shuffle=True, solver='adam', tol=0.0001,
                       validation_fraction=0.1, verbose=False, warm_start=False)
```

Fig. 8: Feature Extraction and Training the Model with MLP Classifier

```
In [23]: y_pred=model.predict(x_test)

In [24]: accuracy=accuracy_score(y_true=y_test, y_pred=y_pred)
         print("Accuracy= {:.2f}%".format(accuracy*100))

         Accuracy= 67.19%
```

Fig. 9: Make Prediction and Check Accuracy of Model

Results and Discussion

The block diagram, shown in the Fig. 1, depicts Training and Test data set have been input into classifier which includes the input, pre-processing, classification and predicting.

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Block Diagram

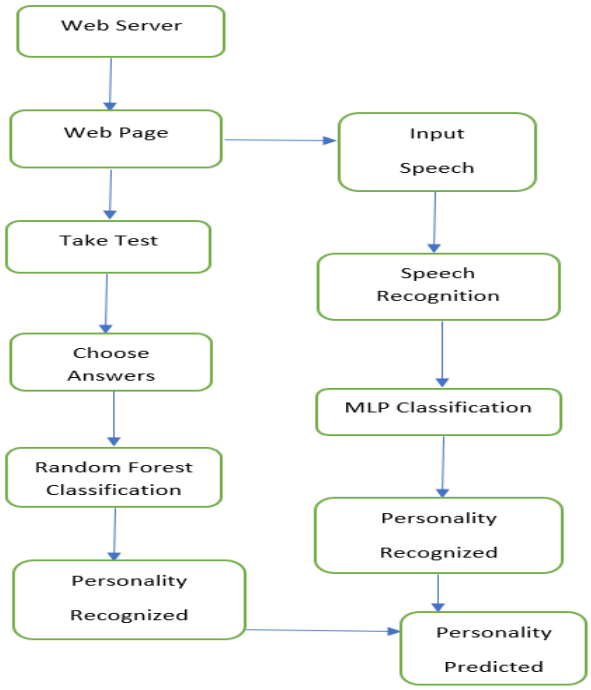

Fig. 10: Block Diagram of Hybrid System

Through webserver User can view Web Page and Take test. User has to take test by selecting answers based on their Personality and System will analyses and predict their personality based on the answer chosen by them. Also the project takes audio (.wav) as input from the user using a Python Library (Sound file) reads the sound files and match it with the Audio-Visual database of personality speech datasets i.e. trained in the model, and classify it using MLP Classifier to recognize personality. Classification of audio is time consuming so the created model saves time and efficiently classifies the audio and personality is recognized, Collecting both personality prediction which is recognized by two different algorithms .Final personality of a person will be predicted.

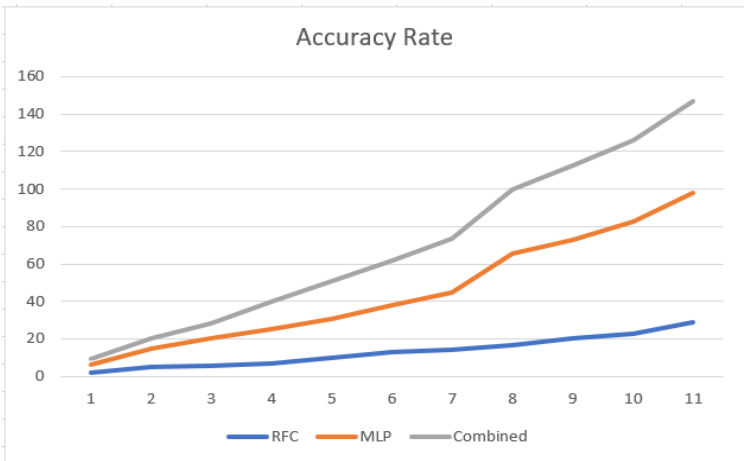

Fig. 11: Line Graph of Accuracy Rate

In the above graph a sample accuracy rate has been shown where RFC(Random Forest Classifier) has 25.8 % accuracy rate and MLP has 97.8% of accuracy and by combining both the algorithms has 152% accuracy rate out of 160% which is best.

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Conclusions

Personality prediction has various possibilities in the current era where emotional support can be provided as per the mood of the person. Personality Prediction has a wide range of application in intelligent assistant systems and robotics also. In the present scenario robot doesn't have the ability to recognize the emotion of the person communicating with it. In all the existing intelligent assistant system it can be used only as a search engine or to perform task it is asked to do. So by implementing emotion recognition in intelligent assistant system it can be used to recognize the emotion the person and act accordingly. The developed system will also be playing a critical role in selection of a suitable person for a specific job matching with the character.

References

[1] Manasi Ombhase, Student, PCE, Prajakta Gogate, Student, PCE, Tejas Patil, Student, PCE, Karan Nair, Student, PCE and Prof. Gayatri Hegde, Faculty, PCE, Automated Personality Classification Using Data Mining Techniques, 2019

[2] Sayali D. Jadhav1, H. P. Channe2, Comparative Study of K-NN, Naive Bayes and Decision Tree Classification Techniques, Department of Computer Engineering, Pune Institute of Computer Technology, Savitribai Phule Pune University, Pune, India

[3] Anisha Yata1, Prasanna Kante2, T Sravani3, B Malathi4, Personality Recognition using Multi-Label Classification, 2018.

[4] Veronica Ong, Anneke D. S. Rahmanto, Williem and Derwin Suhartono, Exploring Personality Prediction from Text on Social Media: A Literature Review 2017.

[5] Tommy Tandera, Hendro, Derwin Suhartono*, Rini Wongso, and Yen Lina Prasetio Personality Prediction System from Facebook Users, Computer Science Department, School of Computer Science, Bina Nusantara University, Jl. K. H. Syahdan No.9 Kemanggisan, Jakarta 11480, Indonesia

[6] Avnish Kumar1, Akshat Gawankar2, Kunal Borge3 & Mr Nilesh M Patil4 .1 2 3B.E IT Student, Student Profile & Personality Prediction using Data Mining Algorithms Information Technology, Rajiv Gandhi Institute of Technology, Mumbai, India 4 Assistant Professor,Information Technology, Rajiv Gandhi Institute of Technology, Maharashtra, India

[7] Fazel Keshtkar, Candice Burkett, Haiying Li and Arthur C. Graesser, Using Data Mining Techniques to Detect the Personalityof Players in an EducationalGame, 2016.

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Development of Cloud Applications through Location Tracker for Healthcare

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ABSTRACT

Cloud computing facilitates collaboration and communication of essential online health care services during the present COVID-19 crisis. In this paper, overview of cloud computing, deployment models, service models is described in the first section. The various cloud services like Azure, AWS, and open source service providers which virtually support on pay-as-you-go services are also described. The proposed work explains an application for use in the android mobile phone for registered users. The application initially identifies a COVID positive patient based on tests conducted and this information is conveyed at real time to an administrator and notification sent to the patient to be quarantined at his/her place. This will help in breaking the chain and prevent spread of the infection in the community. The mobile app developed will be an interface for the patient to be guided by the concerned doctor and hospital based on nearest location. Based on severity of the condition, the doctor can advise suitably and if need ask the patient to be shifted to the nearest hospital for further care. The communication of notification is through the GPRS connections. The location of the patient can be traced at real time and the nearby vicinity of 100 meters area. This information can be used by authorities to monitor and control the containment zones as per standard operating procedure.

Keywords: *EMR, Healthcare, AWS, IaaS, SaaS*

1. Introduction

Cloud is widely distributed networking based storage, to host process or to store data. It is a model for allowing delivery of a demand computing services over the Internet on a pay-as-you-go basis rather than managing files on local storage device, anytime anywhere with any device. It is universal access, data storing in cloud with help of servers scalable services new app in services model will be available in cloud pay as you go. Cloud computing makes it possible to save them over internet. In cloud computing user pay for what they use, to scale up they have to pay more, scale down they pay less, no server space is required in cloud computing, no experts required for hardware and software maintenance, better data security, security standards are high disaster recovery, high flexibility, automatic updates of software, teens can collaborate from wide spread locations. Data can be accessed and shared anywhere over the Internet. Initially days before the cloud existed, people were using lot of servers to store data. The required servers were needed to buy from the service providers [1]. During creation of websites, huge traffic in the network was the common problem. The server monitoring and maintenance is also costly. Troubleshooting was a big issue faced while managing the client. The important thing is data handling through these servers is complicated. Recently, everything is online as in shopping, bill payment, listening, watching movies and reading books. Since everything is online, the transactions require huge amount of memory for data handling and their maintenance can be carried out in different zones in the world. Cloud can provide required space for the huge traffic with less cost.

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Fig. 1: Cloud Space

The Fig. 1 shows the space available in a cloud and this provides huge space to store the data and run applications based on user needs. Cloud is nothing but a collection of data centers. The cloud data centers has various functions, applications, manages resources by combining the space available in the cloud. The adoption of cloud in healthcare is very important to track the information of a patient. It helps to store the location of the patient information and the information is sent to the administrator or to the administrator. Through this application the administrator can track the patient activity and his/her movements [2]. The application helps the administrator to restrict the patient in containment zones and this can avoid community spread. The health care application is deployed through a public platform in the cloud. The cloud healthcare application deployment is a dynamic process and easy to use. It is a simplified way to track the patient. The cloud usage in the healthcare industry will not cause much infrastructure problem as everything is online. The patient location can be tracked using the open source tool tracker it is a GPS tracker implemented in the AWS EC2 instance and is tested. Once the patient is registered through the mobile in the health care application, the application will track the patient information through the mobile device number and the internet protocol address is mapped to the server, the server then tracks the patient location details and his movements.

2. Models of Cloud Computing

In the cloud computing, cloud service provider provides different type of service model which the user can work on. The Fig. 2 shows the types of data storage in the various organizations for storing data [3].

2.1 Public Cloud

In Public cloud, the infrastructure is made available to general public over Internet and is owned by the cloud provider, the cost is less and the user pays only for the services they use. Public service is a type of service provided to the public. The Internet is the main source between the communication between user and the server. The third party service providers provide the services. Public cloud is available to everyone. The service provider makes the resources available to everyone through the World Wide Web. Example: AWS, SUN CLOUD, MICROSOFT AZURE

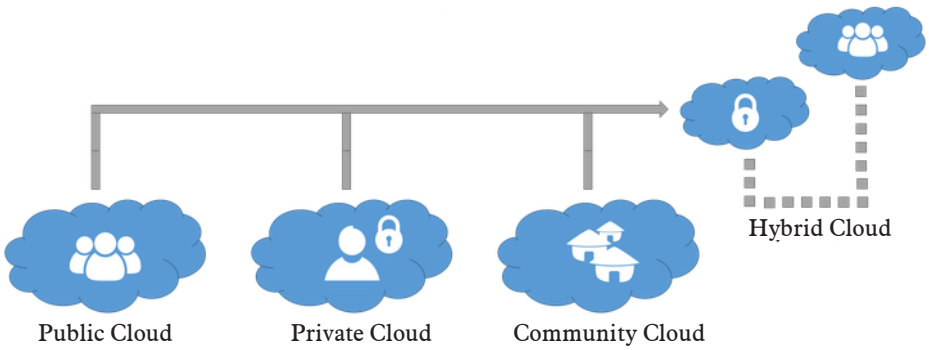

Fig. 2: Cloud Computing Models

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2.2 Private Cloud

This cloud infrastructure is exclusively operated by single organization. The cost is huge it can be managed by the organization third party and may exist on premise or off premise Private cloud is a service, provided by the service provider which is connected to a hardware and networking components within the organization to share the resources. The private cloud also contains set of servers and provides multiple applications to run on the virtualized server.

2.3 Community Cloud

Community cloud falls between the private and public cloud. It is costlier than the public cloud. It allows systems and services to be accessible by the group of organization. Google 'gov-cloud' and NASA 'nebula-cloud' are the examples of community cloud.

2.4 Hybrid Cloud

This infrastructure consists of both functionalities of public and private cloud. Federal agencies opt for private clouds when sensitive into is involved also they use public cloud to share data sets with general public other government departments. The activities performed through this model. Basically non critical activities performed through public cloud model. The critical activities performed through public model. Eg; IT ADMIN

3. Service Models of Cloud Computing

The cloud service models are used for control by the service provider. The service providers provide the services through the user demand based on the pay as you go method. The Figure 3 shows service model on demand services, network access as a medium, shared the resources at a time to multiple clients.

3.1 Software as a Service (SaaS)

SaaS is an independent platform. This services cost is applicable based on the applications usage by the user. It is a demand services. It gives the collaboration of working environment. Services can access the services from any computer. The applications are accessed over the internet. Example: Google App Engine.

3.2 Platform as a Service (PaaS)

PaaS allows user to create their own cloud applications run on the specific tools and specific language through virtual machine. It provides the environment and the tool to create a new online application in the cloud. It provides cloud platform and runtime environment for developing testing and managing applications, it helps software developers to deploy application without requiring all related infrastructure It provides the rapid application deployment with low cost. It can be deploying in private and public cloud. Example: Aneka.

3.3 Infrastructure as a Service (IaaS)

IaaS is a fundamental resource sharing the physical machines, virtual machine through the virtual storage. Rather than purchase the huge infrastructure through the cloud IaaS model can share the required resources virtually. It is a fundamental and the basic layer of the cloud computing. It allows the cloud existing applications to be run on the specific hardware. Example: Amazon Web Services.

4. AWS Services in Cloud

AWS is Amazon web services is a global data center. Across the world AWS is having 20 regions and 61 available zones [4]. Wide services are giving accurate responses getting from the AWS servers. AWS regions are the geographical area and every region consists of two or more zones/ data centers for the high availability of the applications supported to the user. AWS provides more than 300+ services in the cloud environment.

4.1 IoT Core

AWS IoT integrates with artificial integrate solutions and it will work even without the internet connectivity. It is used mainly for the business purposes. In the health care industry AWS is used to analyze and measure the rate of symptoms of the patients.

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4.2 AKS (Amazon Kinesis Stream)

AKS is help to stream the patient data into store in the data base without internet always. Mainly the AKS is used to handle the real time data in large file system. It is used to generate the bills daily and weekly. The real time metrics analysis and sends the alert messages [5].

4.3 EC2

Elastic Cloud Compute increases the efficiency of the system to store huge amount of data and maintain the data base. The EC2 provide the elasticity about the patient requirement medicines data base information and the doctor's information in the cloud and provides the interoperability.

4.4 EMR (Elastic Map Reduce)

With the managerial framework of EC2 and S3 AWS provides elastic map reduce to handle the data in large number. It will help to store and maintain the patient tracking details through upload, create and monitor the information of the patient record.

The most challenges in the cloud computing is digital transmission and storage. The virtualization in cloud helps to store the data regularly in the cloud. The following are the advantages identified in healthcare industry. The usage of cloud in the healthcare industry is secure. The data is owned by the third party server. Cost is affordable; the storage of data is scalable. The prediction algorithms are implemented through artificial intelligence and machine learning approaches. The scanning machines scan images and these are stored and retrieved digitally in healthcare devices. The computerized tomography, computerized axial tomography and MRI scanning are scanned digitally and the data is immediately updated in the patient records through the application [6].

Benefits of virtual private cloud

- It is economically feasible
- Data privacy & Security concerns have largely been mitigated
- Reduction in operational costs for health care providers

It supports IT technologies, Provides data analytic for improved decision support systems and therapeutic strategies advances clinical research. The cloud is scalable and connects the provider to the patient despite location, cloud is an economical solution.

5. Private Cloud in Healthcare

Private cloud provides limited access to computing resources and the critical need for security and privacy protections have often made it difficult for health care systems and life sciences companies to translate these rich data sets into meaningful information. Restricted area of operations in private cloud is inimitable local access. It is not globally deployable. If one wants to use from others they have to access other operations. The price of private cloud increases when the third party develops the private cloud and also when the new hardware will be added to the cloud. Scalability is limited the scalability is depends only on the number of resources used in cloud. The number of resources is directly proportional to the cost because the cost is not applicable to in-house employees. Skilled people are required to manage the cloud. Along with the other programming language developers, the cloud developers are also required in an organization[7].

5.1 Survey on Healthcare Related to Cloud

In 2004, the first whole human genome was sequenced. It cost almost three billion dollars. The cost has come down radically to under a thousand dollars, but that's generated a tsunami of data. The data gives a challenge, when compared with one DNA with another, five million differences [8] exist. The challenge is to take a data set of five million to figure out what are the differences or the mutations that are important, which of them are the causes of rare diseases, causes of cancer and how to treat the patients [9] [10]. HIPAA compliance on Google cloud platform-medical billing information and patient histories is shared between the user and the cloud provider.

6. Methodology

Security and privacy-The data stored in the cloud are prone to data theft and may be lost. Interoperability-The healthcare organizations needs a proper communication, collaboration and coordination between them [11].

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Portability-The data in the cloud can be accessed in different platforms. Service quality-The service should be fast and highly secure. Computing performance-The speed of access should be high. These are the limitations of the proposed application.

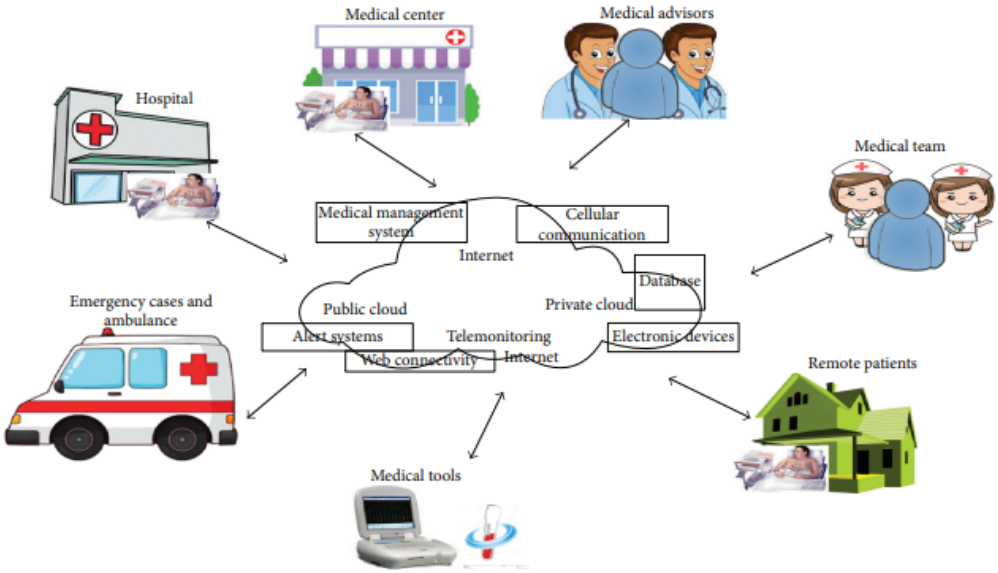

Fig. 3: Healthcare Structure for Cloud [16]

The Fig. 3 shows the healthcare structure for the cloud computing environment. In this section the interactions between the various departments are shown. Notifications are received by the patient, medical team, hospital, medical advisor and hospital regarding the patient mevements.

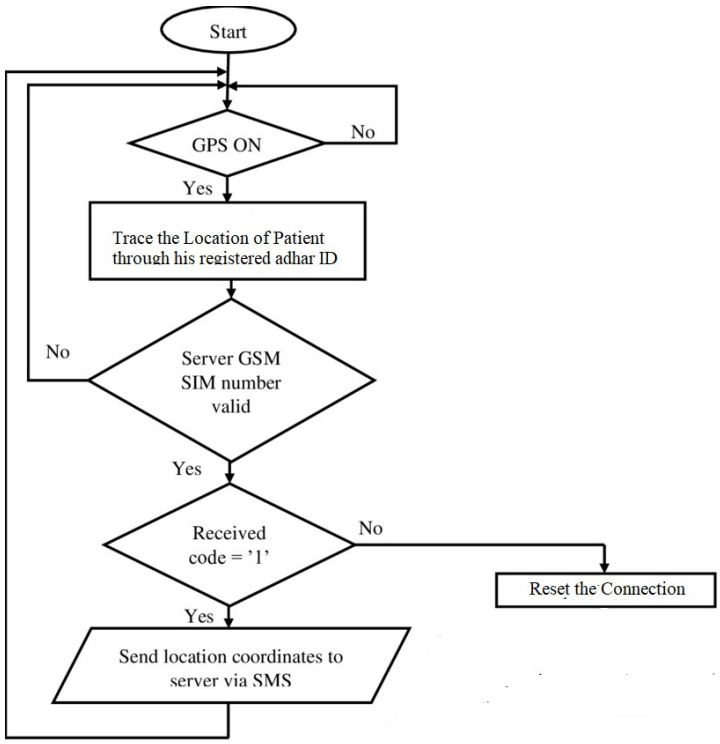

Fig 4: Patient Tracker Process

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The Fig. 4 shows the patient tracker process through the registered mobile. Once the person is identified as a COVID positive, immediately it notifies the patient and admin. Once the notification is received by the patient, GPS will track the location of the patient through the registered mobile number. This app will check the validity of the SIM also.

6.1 *Application*

Health care providers and insurance organizations want to provide clinical and operational solutions for their teams while improving data security [12]. AWS has scalable and secure HIPAA eligible services that enable innovation all while reducing complexity risks and costs [13]. Across the health care industry, AWS has an ecosystem of partners working with organizations develop services like advanced machine learning to help, predict potential health risks, develop personalized medicine and coordinate care improving outcomes for patients around the world. AWS provides secure cost effective and scalable solutions [14] [15].

6.2 *Proposed Module*

The healthcare application is developed to track the movement of patient to avoid infections from spreading to the community. Once the patient is registered through this application the admin can track the patient movement and take necessary actions.

Fig. 5: Mobile Application

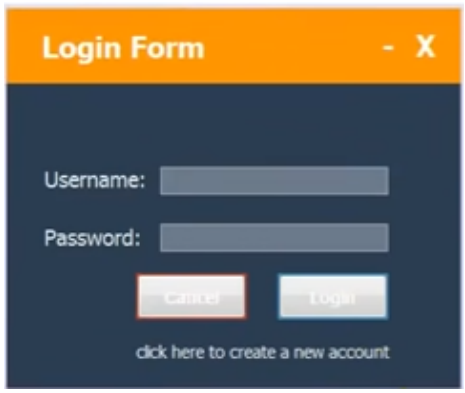

Fig. 6: Login Form

The Fig. 5 shows the mobile application for the tracking a patient. This application requires internet connectivity and sends the information to the cloud.

The Figure 6 shows the login page of the patient once the patient is registered through the ID generated and can enter the details. If the user is new then he or she has to register by creating a new account.

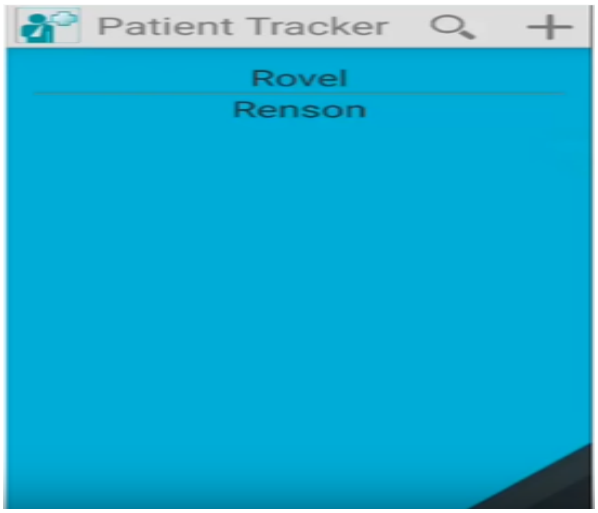

Fig. 7: Home Page

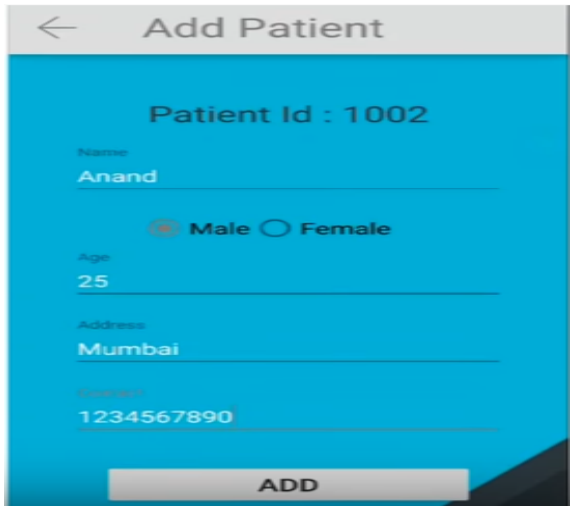

Fig. 8: New Patient Details

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The Fig. 7 shows the home page of the application before the user creation of the account. The new patient details are added to the application by giving the name, gender, age, address and phone number. The new patient's details are being added and sent to the server.

Results and Discussions

The Fig. 9 shows a patient is added to the application and stored in the cloud.

The Fig. 10 shows the initial location of the patient traced through the phone number of the patient.

The Fig. 11 depicts the patient movement and the surrounding area captured.

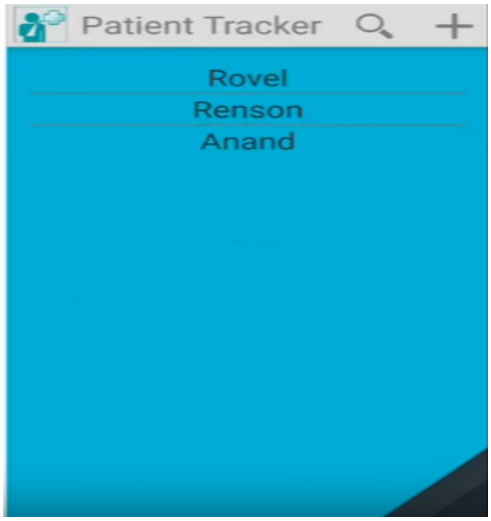

Fig. 9: Patient Details

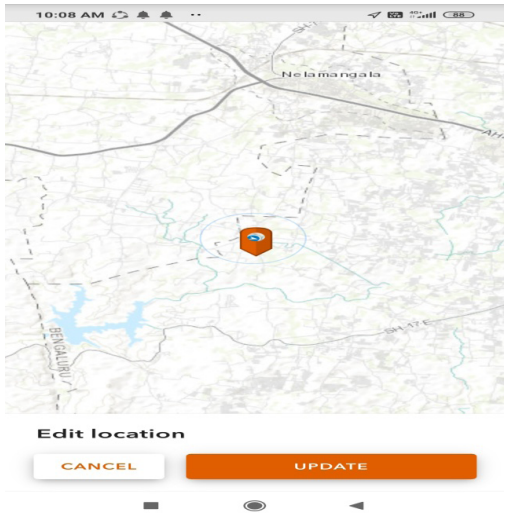

Fig. 10: Initial Location

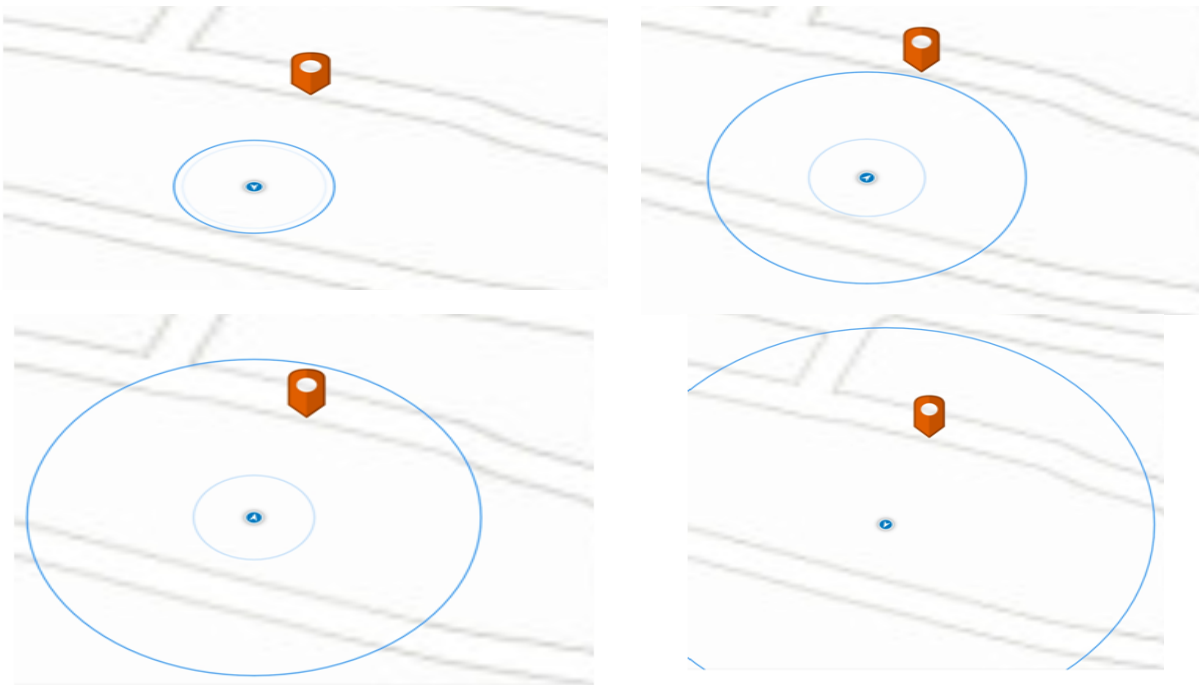

Fig. 11 Movement of Patient

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Conclusion

The health care application is useful to the administrator to keep track of the patient movement as it causes spread to the community. A patient's movement can be tracked through a registered mobile number in this application. The admin can track the patient and suggestions can be recorded. The application is deployed in the private cloud of an organization to get the benefit of low cost and minimal infrastructure to set up the cloud. This application consumes energy in the range 200 to 400 MB based on the movement of the patient within 5 km radius.

References

[1] You, X., Li, Y., Zheng, M., Zhu, C., & Yu, L, "A Survey and Taxonomy of Energy Efficiency Relevant Surveys in Cloud-related Environments" IEEE Access, 5, http://doi.org/10.1109/ACCESS.2017.2718001, pp. 14066–14078, 2017.

[2] Jalali, F., Khodadustan, S., Gray, C., Hinton, K., & Suits, F. "Greening IoT with Fog: A Survey", Proceedings IEEE 1st International Conference on Edge Computing, EDGE 2017, http://doi.org/10.1109/IEEE.EDGE.2017.13, pp. 25–31, 2017.

[3] Mahmud, S., Iqbal, R., & Doctor, F. (2016). "Cloud Enabled Data Analytics and Visualization Framework for Health-shocks Prediction", *Future Generation Computer Systems*, 65, 169–181.

[4] Manogaran, G., Varatharajan, R., Lopez, D., Malarvizhi, P., Sundarasekar, R., & Thota, C. (2018)" A New Architecture of Internet of Things and Big Data Ecosystem for Secured Smart Healthcare Monitoring and Alerting System" Future Generation Computer Systems, 82, 375–387.

[5] Fabian, B., Ermakova, T., & Junghanns, P. "Collaborative and Secure Sharing of Healthcare Data in Multi-Clouds" Information Systems, (2015) 48, 132–150.

[6] Paper, P. (n.d.). "The Case for Designing Data-Intensive Cloud-Based Healthcare Applications" CEUR-WS.ORG, 1–6.

[7] Calabrese, B., & Cannataro, M. "*Cloud Computing Healthcare in Biomedicine*s" ISSN 1895-1767, 16(1), (2015) 1–18.

[8] Bahga, A., Madisetti, V. K., & Tech, G. Integration and Informatics in the Cloud, *Cover Feature Computing in Healthcare*, 2015

[9] Jemal, H., Kechaou, Z., Ayed, M. Ben, Alimi, A. M., Computing, A. C., & Healthcare, I. Cloud Computing and Mobile Devices Based System for Healthcare Applications, (2015). Application. 2015 *IEEE International Symposium on Technology and Society* (ISTAS), 1–5.

[10] Lq, V., Hdowkfduh, R. I. R. U., Lq, L., Grpdlq, K., Lpsuryhg, L. V, Sdwlhqw, D. V, Vwuhdplqj, V. 6hfxulw\ ,vvxhv lq &orxg &rpsxwlqj iru +hdowkfduh, "*Security Issues in Cloud Computing for Healthcare*" (2016) 1231–1236.

[11] Singh, I., Kumar, D., & Khatri, S. K. "Improving The Efficiency of E-Healthcare System Based on Cloud" 2019 *Amity International Conference on Artificial Intelligence* (AICAI), 930–933.

[12] Taher, C., Mallat, I., Agoulmine, N., & El-mawass, N. (n.d.) "An IoT-Cloud Based Solution for Real-Time and Batch Processing of Big Data : Application in Healthcare" 3rd International Conference on Bio-Engineering for Smart Technologies (BioSMART), 2019, 1–8.

[13] Daman, R., Tripathi, M. M., & Mishra, S. K. Cloud Computing for Medical Applications & Healthcare Delivery : Technology , Application, *Security and Swot Analysis*, (2016). 155–159.

[14] Hanen, J., Kechaou, Z., & Ayed, M. Ben.,"An Enhanced Healthcare System in Mobile Cloud Computing Environment" *Vietnam Journal of Computer Science*, 2016, 3(4), 267–277.

[15] Pouladzadeh, P., Vijay, S., Peddi, B., Kuhad, P., Yassine, A., & Shirmohammadi, S. A "Virtualization Mechanism for Real-Time Multimedia-Assisted Mobile Food Recognition Application in Cloud Computing", Cluster Computing, (2015). 18(3), 1099–1110.

[16] Aamir Shahzad , Yang Sun Lee, Malrey Lee, Young-Gab Kim ,Naixue Xiong " Real-Time Cloud-Based Health Tracking and Monitoring System in Designed Boundary for Cardiology Patients" *Hindawi Journal of Sensors,* Volume 2018, 1-15.

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Mobile Phone Stand with Bluetooth Connectivity Applications

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ABSTRACT

As the usage of smartphone is increasing day by day, we have moved into the world of information technology. It is sure that, with the increase in smartphone requirement, its auxiliary accessories will also be needed, so to crash this market, UNICO is basically a new product which includes the Bluetooth based technology and Internet of Things (IoT) in amalgamation with mobile phone stand. Now a days there are many mobile phones stands available but all are either supposed to be integrated with the device or are separate ones which holds the mobile phones when idle. Our objective is to design a stand that holds the mobile phone while it is being operated. UNICO can also be used being in positions like resting on bed or leaning against a wall. The dimensions of UNICO are designed in such a way that it is adjustable or expandable so that all sized people can fit into it as it fits around the chest part while resting making it user friendly and does not exceed the medically required minimum distance between the eyes and mobile screen. It also features a Bluetooth connectivity with your mobile phone connected to the doorbell response system at your main door where you can respond to the doorbell being at your place. UNICO can also be used for small size tablets. The product development process is followed step by step to develop our product, and initially the fundamentals of the used technologies are explained briefly in this paper.

Keywords:

1. Introduction

Cell phones are a continuously evolving technology and an integral part of modern life. Just about everything can be done with cell phones. However, as technology changes and cell phones evolve, there has always been one constant, "Cell phones are always hand held". Our idea is to design an integrated system that carries a cell phone on a stand like structure on which we can use the cell phone while resting on bed or sitting anywhere even on a floor so that it provides an easy access apparatus for cell phone use. We have named this apparatus as UNICO.

The doorbell response system is a Bluetooth-connected replacement for a traditional doorbell. You can communicate with anyone at your front door, like the mailman. The feature of this system is to respond to the person standing outside your main door or even your personal office cabins in any language. Here we have preferred English, Hindi and a local language so that the message should be understood to everyone.

2. Literature Survey

There has been a substantial amount of survey done on these topics. According to the MEMS 411 senior design final report [1] a forearm mobile phone holder was introduced in the market which can be worn around the wrist just like a watch. Another research is made where the mobile phone stand is worn around the neck [2] just like an earphone and one can place the phone just in front of eyes supported by the stand. The literature gap here was both these designs were connected to the physical human body making it to work and may be irritating. Therefore, UNICO provides no involvement of human physical body to hold the stand in position. Now a days, mobile phone use is common in children while attending online lectures. Therefore, a 3D printed mobile stand is proposed [5] but its design is also held around the neck of the children. According to research made by university of California [3], smart doorbells used in homes where the person can see the visitor via a camera. This is all supported by IoT. But our idea is to make the device less costly by eliminating the IoT and introducing the Bluetooth connectivity. Also, the IoT devices are fixed to only one place, whereas this doorbell device is mobile and can be carried to any other places.

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3. Objectives

1. To maintain the medically required eye to screen distance (~24 inches) and simultaneously avoid hand pain
2. To avoid the use of laptops placing it on our laps, therefore avoiding the risks of testicular cancers
3. Responding to the person standing outside the door ringing the doorbell

4. Methodology and Operation

UNICO is designed keeping in mind the versatility of a human physical appearance. We have used PVC pipes of 5,3- and 2-inches in diameter so that these get integrated in the 5-inch pipe. The manufacturing is done based on the design of an antenna so that the dimensions are adjustable upon extension and contraction just like prolong and protract. We have manufactured the UNICO in a U-shape so that it fits around the chest part of the user say while resting on bed. There are 2 vertical lengths connected to each other through a horizontal length forming the U-shape. There are two tighteners on each length for locking the adjustments if found familiar anywhere intermediate. At the exact centre of the horizontal length, there is a pop-up holder for holding the mobile phone which has got 60 degrees rotating angle approximately. Due to use of a pop-up involved, we can rotate the mobile phone 360 degrees depending on our requirements. The pictures below show the entire design.

Coming to the Bluetooth-connectivity part, there is an application available in the google play store by name "Bluetooth terminator HC05". This application is used here. An electric circuit device is kept at the place where the response has to be given. It will have a 2-pin plug which has to be plugged in a switch therefore avoiding the use of batteries. The circuit includes a transducer, a Bluetooth device, an input device and Arduino, a speaker or a transmitter and a memory card for storing the responses in different languages. A programme is made to run in the Arduino and through the input device having the input messages in the memory card, the voice message is transmitted through the speaker. The Bluetooth terminator HC05 is paired with the Bluetooth of your mobile phone and after pairing you can send the messages to the device thereby sending the messages to the person standing at your main door. In order to make it more effective we have given the option to respond in three different languages

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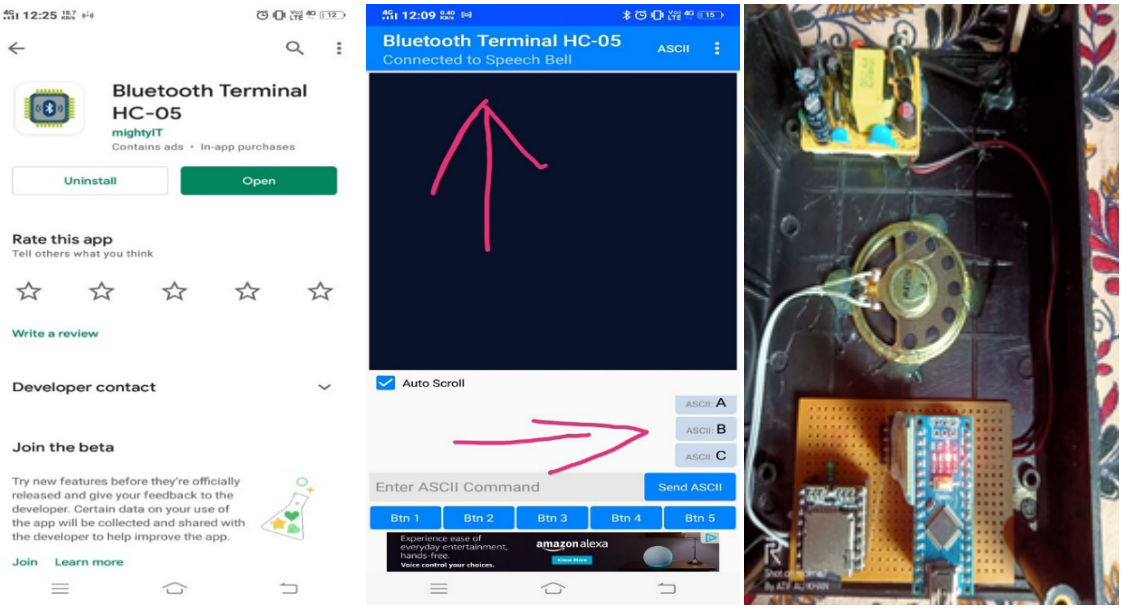
coded as A for English, B for Hindi and C for the state language so that anyone can understand it. There are many more evolved technologies than this available in the market but we have preferred this because all other technologies involve the physical or audio appearance of the user. But here just one finger touch is required. Pictures below show the application and the electric circuit.



Results and Discussions

UNICO finds itself as a user-friendly device demanding no physical support to it. As well as the doorbell response device is very simple in use and involves no usage of battery or internet connection. The future scope of these two ideas is that UNICO may have a charging socket supported from a battery or a power bank holder from which the mobile phone battery is always kept in use. Also, the doorbell response device may provide access to the man waiting outside to open the door and come inside in case of any emergency situations. This can be done by smart door lock system. As it is said that "Necessity is the mother of invention", may be these two ideas can grow being fully automated.

Conclusions

This UNICO will be a user friendly and highly a flexible design. Through this the burden on eyes can be reduced to some extent and the risks of testicular cancer is also reduced. It is light in weight and easy to carry also making it advantageous with less cost. Therefore, we prefer this UNICO and the bell response system to be the best in segment.

References

[1] MEMS 411 Senior design final report, Washington University in St. Louis May 2016.

[2] Use of mobile phone by students: practices and attitude, by Mr. Ravi Kant, Maulana Azad Urdu University, Bihar, India.

[3] Dashbell: A Smart doorbell system for home use by Bradley Quadros, Ronit Kadam Devendra Lavaniya, and Muhammad Mukhtar Department of EECS, University of California, Irvine Irvine, CA92617, USA.

[4] Smart Doorbell Security System Using IoT by AISSMS's Institute of Information Technology Pune, India.

[5] 3D Printing Process of Making a Smartphone Holder by Department of Creative Multimedia Technology, Politeknik Elektronika Negeri Surabaya, Jl. Raya ITS-Sukolilo, Surabaya 60111, East Java, Indonesia.

[6] Effect of mobile phone usage before sleep R. Haripriya, S. Preetha, R. Gayatri Devi.

ISBN: 978-93-91355-21-0 (e-Book)

[7] Door Surveillance with Smart Bell Manaswi Shimpi , Kamran Zikre , Daawar Latif,Deepali Shrikhande. 1, 2, 3 Student, Department of Information Technology, VIT, Mumbai, India.

[8] IJSRD - International Journal for Scientific Research & Development-Communication over Internet and GSM using Smart Doorbell by Preeti Godabole, Akhil Menon, Prashant Singh, Pramit Yadav, Department of Computer Engineering, S.I.E.S, Nerul, Navi Mumbai, India.

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Prevention of Potholes in Bengaluru

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ABSTRACT

Potholes on road causes hindrance to driving traffic, reduces the driving comfort and sometimes lead to accidents. Pot holes occur during all seasons, however pothole formation during rainy season is predominant. Causes for pothole formation is reviewed from road user perspective using design thinking approach. Various types of solutions for the problem is ideated. Locus trees are seen along the side of roads in Bengaluru city. Use of Locust fruit gum in the bituminous mix used in the surface layer of road thought to reduce the water infiltration in road during rains, hence pot hole formation is reduced and durability of road is increased.

Keywords: *Locust Bean Gum, Potholes, Asphalt, Binders*

1. Introduction

Pot holes are bowl shaped cavities of varying sizes in a bituminous surface or extending in to a binder / base course caused by local disintegration of material. The most common cause of pot hole formation is loss of adhesion in bituminous wearing course due to ingress of water in to pavement or due to higher voids in surface. The pavement gets softened as a result of loss of cohesion and under the action of traffic. If not attended in time properly aggregates in the surface get progressively loosened to result in a pothole. Lack of proper bond between bituminous surfacing and underlying water bound macadam base layer can also cause formation of pothole. A thin bituminous surface which is unable to withstand heavy traffic and improper, inadequate camber can also cause pot holes. In dense mixes pot holes can be caused by too much fine or too less fines

Pot holes can be repaired by various methods like i) Cold mix for immediate use ii) Hot mix for immediate use iii) Storable cold mixes and iv) Readymade mixes

Potholes has been a significant issue to street clients across the globe. It is such a significant issue that few associations and a few nations do drop the information of what Potholes cost them every year. The American Automobile Association had assessed that around 16 million drivers had experienced harm Potholes over the recent five years before the year 2016 inside the United States. England made their assessment of the expense of fixing the Potholes on their streets to sum as much as 12 billion pounds every year (1).

While India had a record of more than 3000 passing in street mishaps brought about by Potholes on their streets every year. It may be accepted that each country across the globe has a remark concerning the impacts of potholes to them. Potholes are a quiet financial executioner, both to the nation and to those utilizing the streets.

The yearly expense of mishaps due to Potholes is about 3 billion USD every year that cost is coming from the harmed vehicles from the mishaps, penetrated tires twisted wheels, and harmed vehicle suspensions (2).

2. Potholes in Bengaluru

A whopping 5,435 instances of potholes, bad stretches of roads and footpaths have been reported by citizens through WhatsApp chat to the Karnataka State Legal Services Authority (KSLSA), which conducted a random survey to ascertain the status of the city's roads and footpaths on the directions of the Karnataka High Court (3). The honourable high court of Karnataka after analysing inputs from citizens and random inspection of several stretches of roads by para-legal volunteers. While directing the Bruhat Bangalore Mahanagara Palike (BBMP) to come out with an action plan to fill potholes, repair bad roads and footpaths and also explain the court the technique that would be adopted to fill up potholes. The typical pot hole seen in Bengaluru is presented in Fig.1.

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Fig. 1: Pothole on the Road Surface of Bengaluru (3)

The Newspaper brought up that of the 5,435 reactions from residents, 437 were identified with potholes and awful street issues, and the leftover 4,998 are identified with pathways. The KSLSA got these reactions from residents inside 20 days starting from January 11 through the chatbot, made in relationship with Reap Benefit, a NGO, to only get inputs from residents on the situation with streets and pathways in their territory. Of the 4,998 pathway related sources of info, 3,531 were about obstructed trails, 1,443 were of harmed pathways, and the excess 24 were of not building a pathway, the report expressed while pointing those contributions from residents demonstrated that trash, road merchants and leaving of vehicles are the fundamental driver for impeding of pathways (3).

On BBMP's claim made in February 2020 that 74 roads are free from potholes, the report stated that its volunteers inspected 25 of these roads, and majority of them were not free from potholes.Only four stretches – Bannerughatta Road to Bilekalli Kodichikkenahalli Main Road; K.R. Road to 9th Cross Chamarajpet; Uma theatre signal to BEMS College; and Ashrama Junction to National College Circle – were found to be pothole-free during an inspection conducted on February 1, 2021, the report pointed out.

The report by The Hindu (3) mentioned that the BBMP did not furnish documents sought on road maintenance due to which KSLSA could not assess quality of roads with the assistance of officials of the National Highways Authority of India. It was not possible, due to non-submission of documents, to ascertain whether BBMP is really invoking the Defect Liability Period (DLP) clause in contracts, and compelling the contractor concerned to carry out repair of damaged roads within the DLP.

BBMP counsel submitted that a majority of complaints related to newly added areas to BBMP where works of laying underground drainage and drinking water supply pipes are under way. The bench replied that the BBMP can give many excuses, but the fact remain that all the areas are under its jurisdiction.

3. Public Survey

A survey was carried out and various responses were obtained by public who use road transport daily. 9 in every 10 respondents come across potholes regularly in Bengaluru. According to respondents major reasons for pot hole are i) use of low quality material, ii) frequent drainage works being carried out, iii) rain water penetrating into the base material of road and iv) movement of heavy vehicles. The rain water was root cause in majority of responses. The responses are presented in Fig.2

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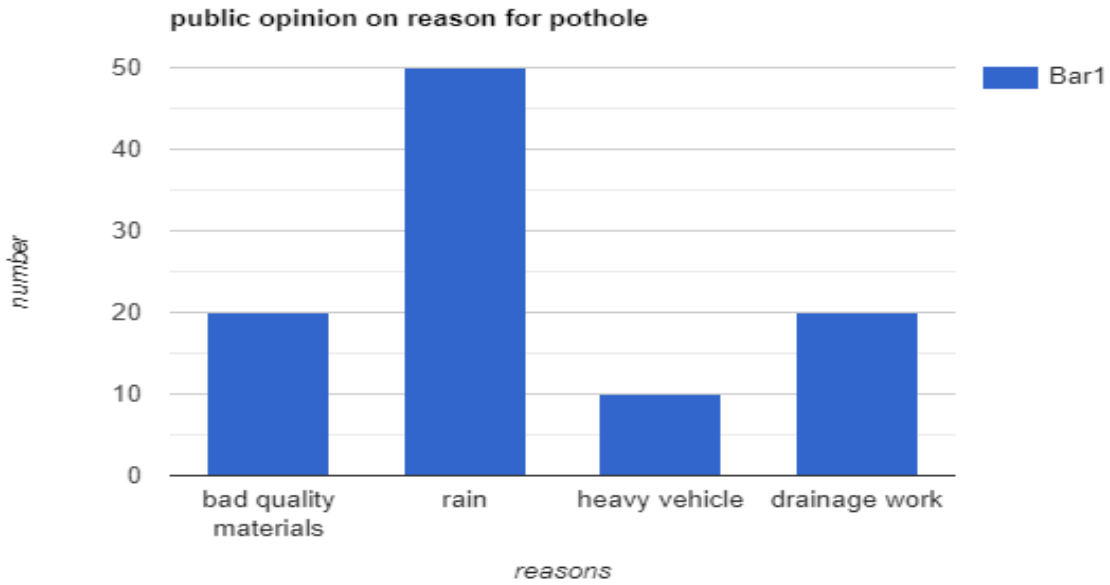

Fig. 2: Public Responses

4. Additives to Bituminous Mixes Used for Pot Hole Patching

The use of Locust bean gum seeds or crushed powder in the bituminous mxi is seen as an promising additive to reduce the Pot hole formation. If lot of locust trees are planted on the side of roads, naturally the fruits and seeds will fall on the road and make the surface of road nonporous for water and make the top layer of road more durable and seen as one of the potential biological ingredient for durable bituminous pavement. The Locust bean gum seeds is presented in Fig. 3.

Fig. 3: Locust Gum Seed (8)

5. Locust Gum

Locust gum or carob gum is a galactomannan acquired from seed endosperm of carob tree. It is generally used as an added substance in different enterprises like food, drugs, paper, material, oil well boring and beauty care products. Mechanical uses of Locust bean gum are because of its capacity to shape hydrogen holding with water atom. It is also found valuable in the control of numerous medical conditions like diabetes, defecations, coronary illness and colon malignant growth because of its dietary fibre activity.

The seeds contained inside the long cases that develop on the tree are utilized to make this gum. First the cases are kibbled to isolate the seed from the mash then the seeds skins eliminated by a corrosive treatment; the deskinned seed is then parted and delicately processed. This makes the fragile microorganism separate while not influencing the stronger endosperm. The two are isolated by sieving. The isolated endosperm would then be able to be processed by a roller activity to produce the final locust gum (8).

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5.1 Chemistry

Locust bean gum comprises mostly of high molecular-weight hydro colloidal polysaccharides, made out of galactose and mannose units consolidated through glyosidic linkages, which might be portrayed synthetically as galactomannan. It is dispersible in either hot or cold water, shaping a sol having a pH somewhere in the range of 5.4 and 7.0, which might be changed over to a gel by the expansion of modest quantities of sodium borate. The substance structure comprises a polymeric mannose chain fanned with galactose units. The primary chain comprises of (1-4) connected beta-D mannose build-ups and the side chain of (1-6) connected alpha-D galactose (5). Locust bean gum has a general proportion of mannose to galactose of around 4:1. The galactose sugars are not uniformly dispersed along the chain yet will in general be bunched together in blocks. The chains have an unpredictable construction with rotating "smooth" and subbed zones. The locust tree is shown in Fig. 4 belong to Fabaceae family and Legume sub family. The botanical name of tree is Caesalpinioideae (6).

Fig. 4: Locus Tree (4)

Locust bean gum is just dissolvable in the wake of warming up to 80 - 90°C, contingent upon time and mechanical treatment. Being non-ionic, beetle bean gum isn't influenced by ionic strength or pH however will corrupt at higher temperatures. The chemical structure of the gum is presented in Fig.5.

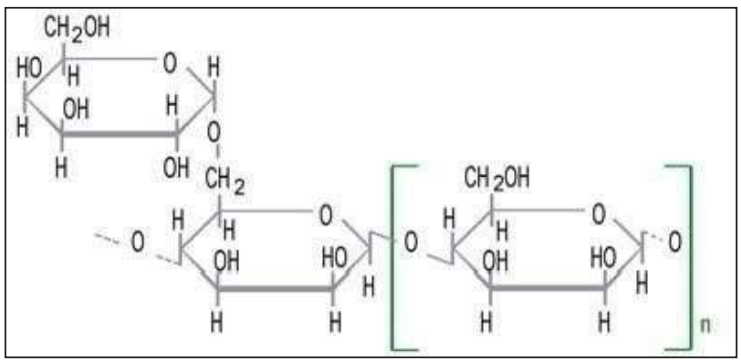

Fig. 5: Chemical Structure of Locust Bbean Gum (4)

5.2 Properties of Locust Bean Gum

Locust gem are sold under the name carob or locust bean gum and available in verities based on color,gel strength, particle size, cloudy (standard grade) or clear (high grade/expensive),intended use as technical or food grade, protein content and ash content (7).

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Properties of Locust Bean Gum:

1. Locust bean gum is to some extent dissolvable in cool water.
2. The mannan areas of the polymer chain can tie together to form a crystalline region that is thermodynamically steadier than the solution state.
3. When in the arrangement at surrounding temperature there is a tendency for the polymer chains to wish to total. This makes the precise estimation of molecular weight troublesome because of the presence of amassed species in the arrangement.

Conclusion

A few locales offer sites or portable applications for pothole patching. Countless mishaps are occurring and many individuals are losing life. The solution for this difficult issue is vital. Trusting that our thought of using Locust bean gum in the bituminous mix or spraying of powder on the freshly laid bituminous surface will reduce water penetration and increase the life of pavement. It is belived that the approach may reduce the pothole formation, however need to be checked both in laboratory and in the field.

References

[1] Carob bean gum. Prepared at 53rd JECFA [1999] and published in FNP 52 add 7[1999].

[2] Specifications prepared at the 51st JECFA [1998] and published in FNP 52 add 6[1998].

[3] https://www.thehindu.com/news/cities/bangalore/bengaluru-citizens-report-5435-potholes-poor-footpaths/article33974138.ece?utm_campaign=article_share&utm_medium=referral&utm_source=whatsapp.com

[4] https://www.cargill.com/personal-care/hydrocolloids/locust-bean-gum

[5] https://textilestudycenter.com/polysaccharide-thickeners/

[6] https://sites.redlands.edu/trees/species-accounts/carob-tree/

[7] https://en.wikipedia.org/wiki/Pothole

[8] https://www.takemetonaija.com/2017/05/cool-facts-about-african-locust- bean.html

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New Way Assistance for Desktop

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ABSTRACT

The proposed work, entitled "New Way Assistance For Desktop" is a personal voice assistant that can execute tasks and give various services to the user based on the user's spoken orders. This is accomplished by a synchronous process that involves the recognition of speech patterns and then the production of synthetic speech in response. These assistants allow users to automate operations such as mailing, task management, and media playing, among others. People are growing increasingly reliant on technology as it advances, and one of the most widely utilized platforms is computer and these computers are more pleasant. The usual way to provide a command to the computer is to type it in, but a more convenient approach is to speak it. Giving input by speech is useful not just for normal individuals, but also for those who are visually challenged and cannot offer input via a keyboard. This necessitates the use of a voice assistant that can not only receive voice commands but also carry out the desired instructions and provide output in the form of speech or text.

Keywords: *Artificial Intelligence, Desktop Assistant, Python, Virtual Assistant, Voice Recognition*

1. Introduction

Artificial Intelligence (AI) systems are becoming increasingly widespread that are capable devising a machine which is both human knowledge and a machine at the nature interface (via speech, communication, gestures and expression). One of the most investigated and popular directions of interaction based on the machine's interpretation of natural language by the machine. It is no longer a human who learns to speak with a machine, but rather a human who learns to interact with a human, researching his behaviours, habits, and behaviour in the hopes of becoming his personal assistant.

Human interaction is rapidly being supplanted by automation in the twenty-first century. Performance is one of the primary reasons behind this shift. Rather than progress, technology has undergone a significant shift. In today's world, we use technologies like artificial intelligence, machine learning, neural networks, and virtual assistants to teach our machines to do their jobs on their own or to think like people. Companies such as Google, Apple, Microsoft, and others have virtual assistants such as Google Now, Siri, and Cortana that allow users to manage their machines just by speaking to them. The voice assistants we've created are desktop-based and based on Python modules and libraries. This assistant is only a basic version that can do all of the essential functions.

2. Literature Survey

The primary goal of voice assistants should be to decrease the usage of input devices. Related to this, Dhiraj Pratap Singh [1] *et al.* operate in three modes: supervised, unsupervised, and reinforcement learning, which will change depending on the demands of the users. Ravivanshikumar [2] *et al.* adopted dynamic base Python py for spoken questions are synthesized, the average of sBNF representations is taken, and then the average query is employed. pyttsx is a text to speech conversion library in python and unlike alternative libraries, it works offline, and it integrated with technologies like gTTS, AIML (Artificial Intelligence Mark-up Language). Luis Javier Rodríguez-Fuentes [3] *et al.* also consider Google Text To Speech – Electric Hook Up (GTTS-EHU) technologies for Query-by-Example. For displaying audio files and spoken requests as a frame level acoustic representation, stacked bottleneck features (sBNF), Qbe-STD are utilized. The use of smart assistants may lead to the development of a smart home system that uses Wireless Fidelity (Wi-Fi) and the Internet of Things. Keerthana S [4] *et al.* used the CC3200MCU, which has Wi-Fi and temperature sensors integrated in. The temperature measured by the temperature sensor is communicated to the micro controller unit (MCU), which is subsequently uploaded to a server, where it is used to monitor and manage the state of electrical equipment such as fans and lights. The mobile users may accomplish daily tasks using voice commands rather than typing or using buttons on

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their phones. Sutar Shekhar [5] *et al.* apply predictive technologies to offer suggestions depending on the user behaviour.Rishabh Shah [6] *et al.* use Natural language processing (NLP) in voice assistants is a must-have feature that will also result in the construction of a trend-setting assistant. They addressed how NLP may help develop assistants smart enough to interpret orders in any native language, allowing every segment of society to benefit from its benefits. Nil Goksel [7] *et al.* explains intelligent personal assistants (IPAs) that use advanced computing technologies and Natural Language Processing (NLP) for learning is examined. Patrick Nguyen [8] *et al.* apply direct modelling technique for voice recognition, which eases out the measure of consistency in the phrases uttered. This method is known as the Flat Direct Model (FDM). This work did not use the traditional Markov model not a sequential model. A significant challenge of specifying characteristics has been solved using their method. Furthermore, the template-based features reduced sentence errors by 3% in absolute terms compared to the baseline.

2.1 Critical Thinking

With the help of voice-activated desktop assistants you won't have to type extensive codes to accomplish a task. With only one platform we can control numerous things around us alone. All you have to do is to give the assistant a command and the rest is carried out by the helper.

These types of desktop helpers are highly valuable to individuals of old age, who are blind and physically difficult, children, etc. by making sure that interaction with the computer is no longer a struggle for people who can't see the machine solely through their voice.

The desktop assistant assists the end user with daily tasks such as general human conversation, searching queries in a variety of search engines such as Google, Bing, or Firefox, searching for videos, retrieving images, real-time weather conditions, word definitions, searching for music, scheduled events, and tasks.

2.2 Proposed Model

The capacity of the existing system such as Cortona, Siri, Bixby, Google assistant are limited to specific tasks. User can't modify the system for his requirements and if the input voice is not clear the assistants asks for the voice command again and again. The proposed system can perform various operations as per the user requirements. If the voice of the user is not recognized it suggests us to type the command in terminal.

The functionalities of proposed model shown in the below Fig. 1.

The system will continue to listen for orders, and the duration of the listening period is adaptable to the user's preferences. If the system is unable to extract data from the user's input, it will either prompt the user to restart the process or accept input as text, requiring the user to type the command into the terminal.

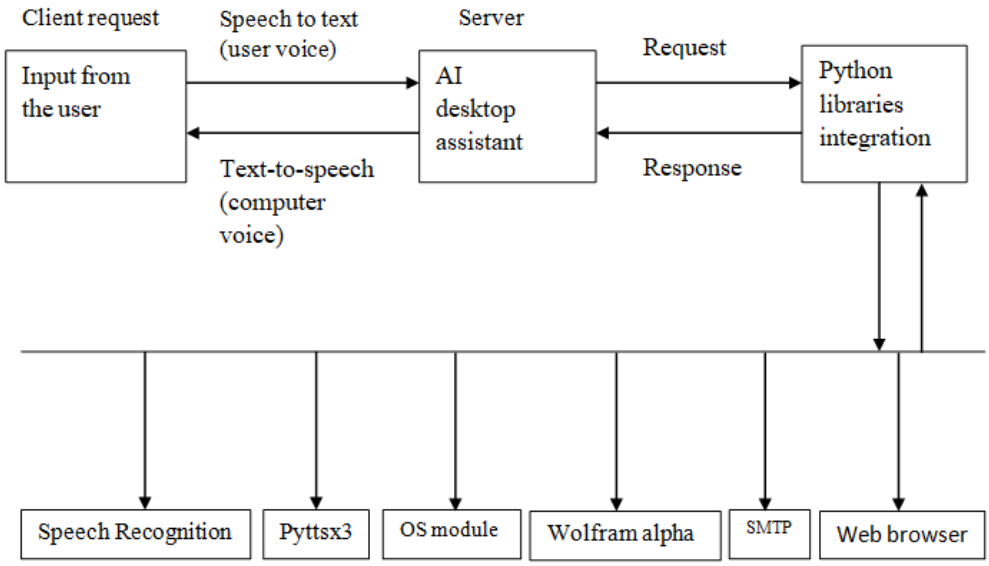

Fig. 1: Proposed Model

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Flow of the proposed model:

1. Firstly speaking the voice command and implemented assistant can open the program (if it is installed on the system), search Google, Wikipedia, and YouTube for information about the query, and calculate any mathematical question
2. Second check the voice function by giving some text input and it will be converted into voice. The system can incorporate both male and female voices, depending on the user's preferences
3. Next, Install the speech recognition model and then import it
4. Define a new function for taking command from a user. Also mention class for speech recognition and input type like microphone etc. Also mention pause_threshold
5. Then set a query for voice recognition language and use the Google engine to convert voice input to the text
6. Also install and import some other packages like pyttsx3, Wikipedia etc. Pyttsx3 helps you to convert text input to speech conversion
7. User can ask any information then it will display the result in textual format as well as voice format
8. Then install a web browser package and import it to open any web applications like YouTube, Google, Wikipedia, etc.
9. Install OS package and import it to perform queries within the system like Play music, Shutdown system, Open files, Write note and read note, etc.

2.3 Integration of Proposed Work Modules

In our proposed work, the related modules are integrated. These modules can define function, class and variables. Modules are accessed by using the import statement.

2.2.1 Pyttsx3 Module

The Pyttsx3 Python offline module is used to convert text to speech and is supported by Python 2 and 3. This module also contains running and waiting routines. It high technology determines how long the system will wait for next input or the time interval.

2.2.2 Datetime Module

The DateTime module supports date and time functions. For instance, the user may want to know the current date and time or arrange a job for a certain time. This module provides only classes on which date and time can be manipulated and actions carried out.

2.2.3 Webbrowser Module

This module allows the system to display user information on the web. For instance, if a user wants to browse any website, he can put "Open Google" in the search field. The user receives a Google-opened browser after the Web browser module processes the input.

2.2.4 Wikipedia Module

Wikipedia module is a Python library that enables the virtual assistant to process and present Wikipedia-related queries to users. Due to the fact that this is an online library, you will require an internet connection to view the materials. The user can explicitly specify the desired number of lines as a result.

2.2.5 OS Module

The OS module offers operating system-dependent functionality. All these kinds of functions can be accessed through an OS module if action needs to be taken on files like reading, writing or altering paths. Any fault, such as unworthy names, routes or arguments, can result in a "OSE-error" error reporting all conceivable actions, which may be wrong or correct, but is simply not recognized by the operating system.

2.2.6 Smtplib Module

This module is part of Python's standard library and is used to communicate with emails and email servers. The SMTPLIB defines an object named "SMTP client session object" that the user uses to send emails. Three stages are

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necessary: initialise(), sendmail(), and quit(). When the optional host and port parameters are given, the connect method is invoked during the setup stage with these inputs.

2.2.7 Wolframalpha Module

Wolfram Alpha is an engine for computers. The UI appears like a conventional search engine, however searches in the search box give answers to certain questions rather than showing websites that may be relevant to the topic. The Wolfram Alpha search box allows keywords, sentences or sentences and mathematical equations in the natural language input. The findings are calculated dynamically.

3. Experimental Results

The proposed work is highly beneficial for the elderly, blind and physically challenged, children and so on, by ensuring that the interaction with the machine is no longer a barrier for those who cannot see the machine may only communicate with it by using their speech. In a proposed work user should take care of listed command he should follow those commands then only user can receive efficient result. The experimental result use the following commands

3.1 Mandya Weather Report

User send a voice command as “Weather report of Mandya” and it displays result such as temperature, fog, cloudy, humidity in terminal.

```
Windows PowerShell
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Try the new cross-platform PowerShell https://aka.ms/pscore6

PS C:\Users\Pavan.R\Desktop\desktop assistant\jar> python -u "c:\Users\Pavan.R\Desktop\desktop assistant\jar\main.py"
Initializing jarvis...
2020-12-22 21:10:04
Listening....
Command: weather report of Mandya

temperature | 25 °C
conditions | fog, cloudy
relative humidity | 79% (dew point: 21 °C)
wind speed | 3.1 m/s
(40 minutes ago)
(using weather station VOTR: 279 km SE and 580 meters below Mandya, Karnataka, India)
```

Fig. 2: Weather Report

3.2 YouTube

User send a voice command as “Open YouTube” then it opens the YouTube page.

```
Windows PowerShell
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Try the new cross-platform PowerShell https://aka.ms/pscore6

PS C:\Users\Pavan.R\Desktop\desktop assistant\jar> python -u "c:\Users\Pavan.R\Desktop\desktop assistant\jar\main.py"
Initializing jarvis...
2020-12-22 20:13:14
Listening....
Command: YouTube
```


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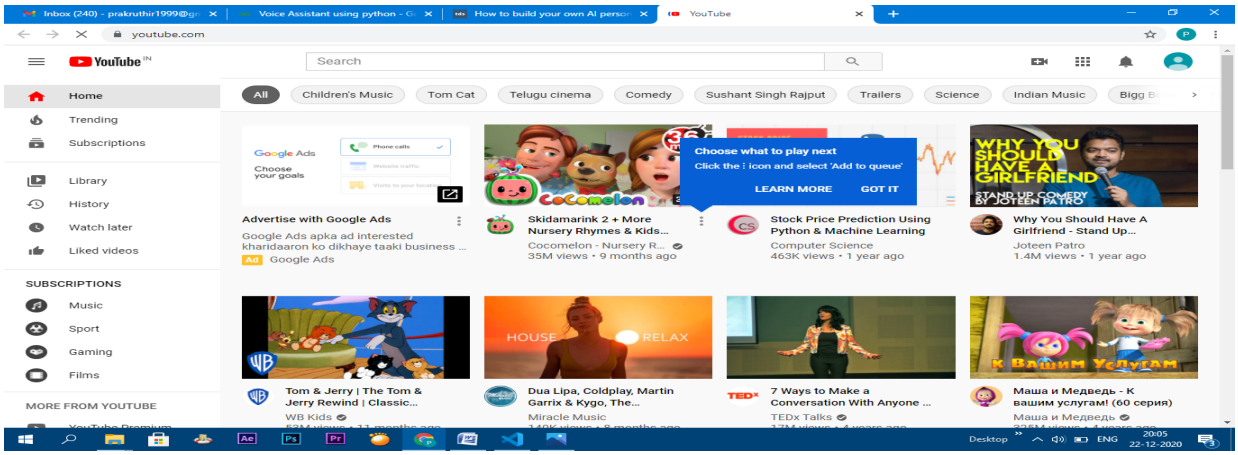

Fig. 3: Open YouTube

3.3 Search on Wikipedia about Narendra Modi

User send a voice command as “Wikipedia Narendra Modi” it displays information in terminal and speak about Narendra Modi.

```
Windows PowerShell
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Try the new cross-platform PowerShell https://aka.ms/pscore6

PS C:\Users\Pavan.R\Desktop\desktop assistant\jar> python -u "c:\Users\Pavan.R\Desktop\desktop assistant\jar\main.py"
Initializing jarvis...
2020-12-22 20:35:47
Listening....
Command: Wikipedia Narendra Modi

Narendra Damodardas Modi (Gujarati pronunciation: ['nəɾendɾə domodəɾ'dəs 'modiː] (listen); born 17 September 1950) is an Indian politician serving as the 14
th and current Prime Minister of India since 2014. He was the Chief Minister of Gujarat from 2001 to 2014 and is the Member of Parliament for Varanasi.
Listening....
Command: play music

["Audience choice mashup 2020 Multilingual 15 tracks Nithyashree Caveman's Studio.mp3", 'studentdatabase.xlsx']
Listening....
command:
```

Fig. 4: Search on Wikipedia

3.4 Location of Mandya in Google Map

User send a voice command as “Location of Mandya” it displays the location of Mandya in Google Map.

```
Windows PowerShell
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Try the new cross-platform PowerShell https://aka.ms/pscore6

PS C:\Users\Pavan.R\Desktop\desktop assistant\jar> python -u "c:\Users\Pavan.R\Desktop\desktop assistant\jar\main.py"
Initializing jarvis...
2020-12-22 21:03:48
Listening....
Command: where is Mandya
```

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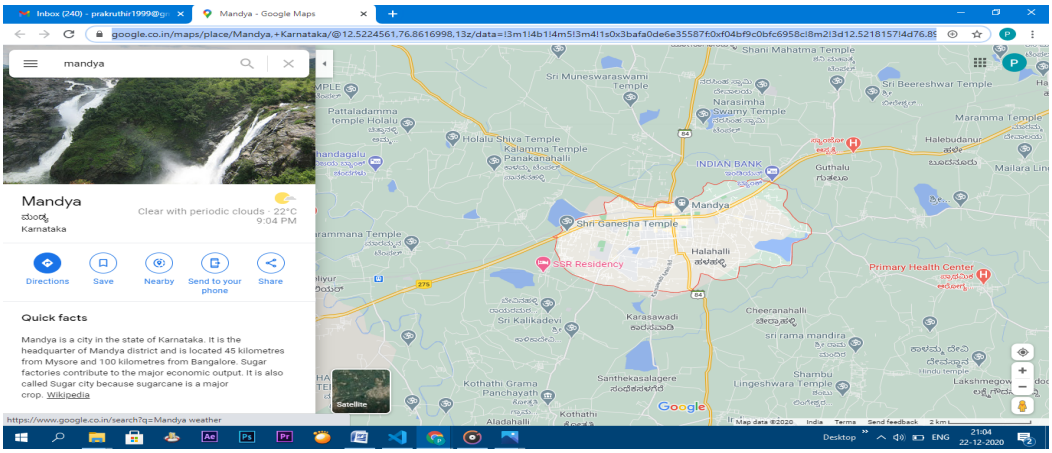

Fig. 5: Displaying Location

3.5 Play Music

User send a voice command as “Play Music” it opens local music list and play.

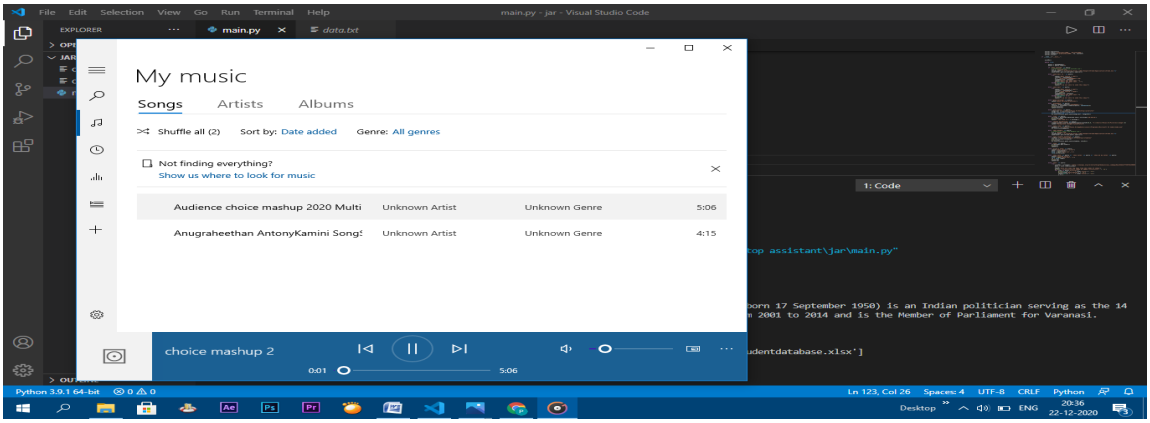

Fig 6: Play Music

3.6 Sending Email

User send a voice command as “Send Email to Prakruthi” then message will be added after that it will send a mail to Prakruthi.

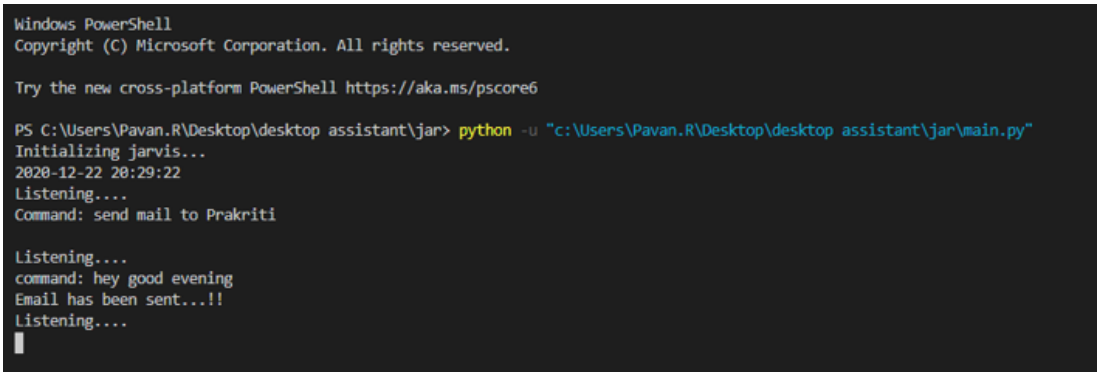

Fig. 7: Sending Mail

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Conclusion

The proposed work is completed by using Python. This assistant only works online, does basic actions such as weather updates, streaming music, Wikipedia search, desktop launching programmes, etc. This desktop assistant are highly valuable to individuals of old age, who are blind and physically difficult, children, etc. by making sure that interaction with the computer is no longer a struggle for people who can't see the machine solely through their voice. It is straight forward to use and may be used as a voice to satisfy the user's requirements.

References

[1] Dhiraj Pratap Singh, Deepika Sherawat, Sonia, "Voice activated desktop assistant using Python", proceedings of High Technology Letters, ISSN: 1006-6748, 2020.

[2] Ravivanshikumar, Sangpal, Tanvee, Gawand, Sahil Vaykar, "JARVIS: An interpretation of AIML with integration of gTTS and Python", proceedings of the 2019 2nd International Conference on Intelligent Computing, Instrumentation and Control Technologies (ICICICT), Kanpur, 2019.

[3] Luis Javier Rodríguez-Fuentes, Mikel Peñagarikano, Aparo Varona, Germán Bordel, "GTTS-EHU Systems for the Albayzin 2018 Search on Speech Evaluation", proceedings of IberSPEECH, Barcelona, Spain, 2018.

[4] Keerthana S, Meghana H, Priyanka K, Sahana V. Rao, Ashwini B "Smart Home Using Internet of Things ", proceedings of Perspectives in Communication , Embedded -systems and signal processing, 2017

[5] Sutar Shekhar, P. Sameer, Kamad Neha, Prof. Devkate Laxman, "An Intelligent Voice Assistant Using Android Platform", IJARCSMS, ISSN: 232-7782, 2017.

[6] Rishabh Shah, Siddhant Lahoti, Prof. Lavanya. K, "An Intelligent Chatbot using Natural Language Processing", International Journal of Engineering Research , Vol.6 , pp.281-286, 2017.

[7] Nil Goksel, Canbek Mehmet , Emin Mutlu, "On the track of Artificial Intelligence: Learning with Intelligent Personal Assistant", proceedings of International Journal of Human Sciences, 2016.

[8] Patrick Nguyen, Georg Heigold, Geoffrey Zweig, "Speech Recognition with Flat Direct Models", IEEE Journal of Selected Topics in Signal Processing, 2010.

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Critical Thinking in Model Based Simulation of Simple Harmonic Oscillator Using Scilab: Xcos

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ABSTRACT

In the new era of online teaching and learning process, digital learning and critical thinking are the two vital components. This could be effectively augmented in an online environment by combining theoretical knowledge with the basic dynamics of teaching and learning. In engineering curriculum, in accordance with Bloom's taxonomy levels, higher order critical thinking such as analysis, evaluation and model making are the backbone of Outcome Based Education. The present work uses Scilab as a teaching / learning tool. It is an open source software tool which facilitates to develop higher order critical thinking and analysis skill.

The fundamental concepts of Physics could be understood effortlessly using simulating model Xcos tool. This tool helps students to develop analysing, computing and model building skills through critical thinking. In this paper, a step by step constructivist approach is used to perform simulation of the simple harmonic oscillator. The constructivist approach makes active learning process better by constructing the knowledge rather than acquiring it. Initially, modelled simple harmonic oscillator and time period of the oscillator is visualized by computing angular frequency in the model and results are validated by conducting real time experiment. Similarly different conditions of damped harmonic oscillator and forced harmonic oscillator are computed and visualized.

Keywords: *Critical Thinking, Simulation, Constructivism, Simple Harmonic Oscillator, Xcos*

1. Introduction

Physics learning in particular is far perceived to be complex. Teaching does not appear to have the expected effect, with students possessing only a vague memory of unconnected ideas and a hazy mental picture of equations, symbols and graphs. As real learning that enables to understand, predict and verify ideas is glaringly absent, students' resort to the next possible option of the rote memorization of facts which has short term relevance but will not provide any learning experience to students. Research has shown that traditional classroom lectures fail to make any tangible impact which only accomplishes simple transmission, hence often referred as a *transmissionist model*. This being the case, a new area of research that probes into the details of how a learner processes information has become the central focal point of the new area of education Research [1-2].

Research has shown that students do not attain the expected level of proficiency in understanding concepts when trained by the traditional teaching methods. It has also looked into the outcome of pedagogy and the use of transformed course for improving student learning. The pedagogical adaptations range from escalating active engagement of students in large lecture class to reconfiguring of the instructional environment [3]. Reformed courses demonstrate improved conceptual understanding as students are actively engaged in constructing their own knowledge. The studies on the influence of transformed course approach describe how a pedagogical strategy promotes in the advancement of physics drives students to be creative in implementing Physics concepts in real life applications. Whereas, traditional teaching methods, are less encouraged in the direction of developing thinking skills. In Physics conceptual understanding is influenced by a principles and physical laws. In this direction, to train students in developing critical thinking (CT) skill is most important in science education. Critical thinking entails the skill to identify relationships, illustrate inferences, analyze and solve problems [4].

The aim of the paper is to examine the use of computational teaching approach in the study of harmonic oscillations [5-6]. The conceptual understanding of oscillatory motion requires the coherence of physics with mathematics. Computational teaching approach uses Xcos of Scilab tool dedicated to the modeling and simulation of dynamic systems. Xcos includes a graphical editor which allows to easily representing models as block diagrams by connecting the blocks. Differential equations are used to model a problem with various independent variables. The study focused on modeling of harmonic oscillator (example mass-spring system). To execute thinking tasks

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involve predicting, analyzing and reasoning which necessitates teaching of critical thinking skills in coherence with the concept of harmonic oscillations [7].

2. Methodology

The present work uses computational approach in the domain of linear harmonic oscillator using Scilab open source software tool [8]. This performs numerical computation, data analysis, plotting, system modeling and simulation. The first step involves modeling of second order differential equation of motion using Xcos . The modeling created to study the dynamics of the motion of a particle of mass for free oscillations, damped oscillations and forced oscillations necessitates Newton's equation of motion [9]. Xcos consist of two windows ie., edit window and pallet browser. The model of harmonic oscillator designed in edit window as block diagram helps in learning of underlying concept of harmonic oscillation. The model built on edit window step by step by starting with simple sine wave, free, damped and forced harmonic oscillator. This helps to create their own mental model which helps to enrich critical thinking skills such as analyzing and reasoning based on output waveforms such as displacement – time and velocity – time graph [10-11].

2.1 Model Formulation

To model Simple Harmonic Oscillator (SHO), consider second order differential equation as given below.

$$m\frac{d^2y}{dt^2}+ky \tag{1}$$

Where 'm' represents oscillating mass, 'y' represents displacement, 'k' represents spring constant and d^2y/dt^2 represents acceleration of the oscillating mass.

Re-arrange the equation (1) and express in terms of acceleration

$$\frac{d^2y}{dt^2}= -\omega^2 y \tag{2}$$

Where $\omega^2= k/m$ is the natural angular frequency in rad/s

The equation (2) pictorially represented is shown on Fig 1.

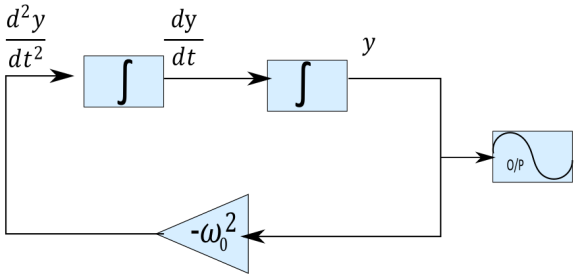

Fig. 1: Pictorial Representation of SHO

The two solid blocks shown in the above figure represents integral operation steps. The output wave form can be visualised using oscilloscope. The natural angular frequency $\omega = 2\pi f$ should be computed by considering natural frequency *'f'* as an input variable and observed the output wave form by running the simulation.

2.2 Damped Harmonic Oscillator (DHO) Modelled using Xcos Tool Using the Differential Quation Given Below.

$$m\frac{d^2y}{dt^2}+r\frac{dy}{dt}+ky=0 \tag{3}$$

Where 'r' is damping constant and 'k' is spring constant.

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Rearranging equation (3) will get equation (4).

$$\frac{d^2y}{dt^2} = -2b\frac{dy}{dt} - \omega^2 y. \tag{4}$$

Where 'b=r/2m' is damping coefficient and 'ω^2=k/m' is the natural angular frequency.

The pictorial representation of damped harmonic oscillator is shown in Fig.2 clearly explains the equation (4).

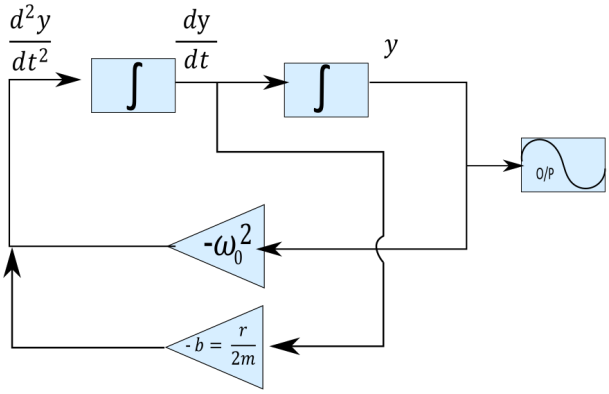

Fig. 2: Pictorial Representation of DHO

2.3 Forced Harmonic Oscillator (FHO) Modelled using Xcos Tool Using the Differential Equation Given Below

$$m\frac{d^2y}{dt^2} + r\frac{dy}{dt} + ky = F_o \sin\omega_d t \tag{5}$$

The applied external periodic force is represented by ($F_O \sin \omega_d t$)

Where 'r' is damping constant, 'k' is spring constant, F_o is the maximum force and ω_d is the angular frequency of the driving force.

Rearranging equation (5) will get equation (6).

$$\frac{d^2y}{dt^2} = -2b\frac{dy}{dt} - \omega^2 y + F_o \sin\omega_d t \tag{6}$$

Where 'b=r/2m' is damping coefficient and 'ω^2=k/m' is the natural angular frequency.

The pictorial representation of the forced harmonic oscillator is shown in Fig. 3 clearly explains the equation (6).

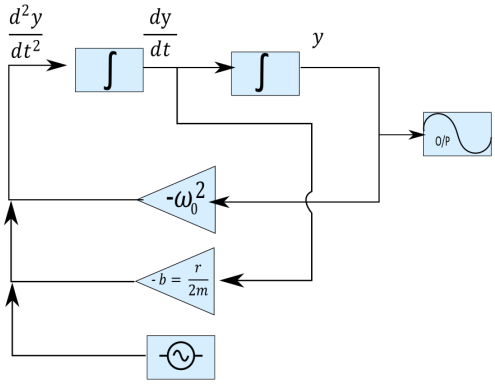

Fig. 3: Pictorial Representation of FHO

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3 Results and Discussion

3.1 Simulation of Sine Wave

As a first step to visualise the sine wave in Xcos platform, sine wave generator, cscope and clock are imported from palette browser to edit window. Sine wave model is built using building blocks of oscilloscope, sine wave generator and clock shown in Fig. 4a. Frequency of 1 rad/s and magnitude of displacement 1m is set in signal generator. Refresh period is set for 30 s in single scope and simulation time is set for 30 s and run the simulation.

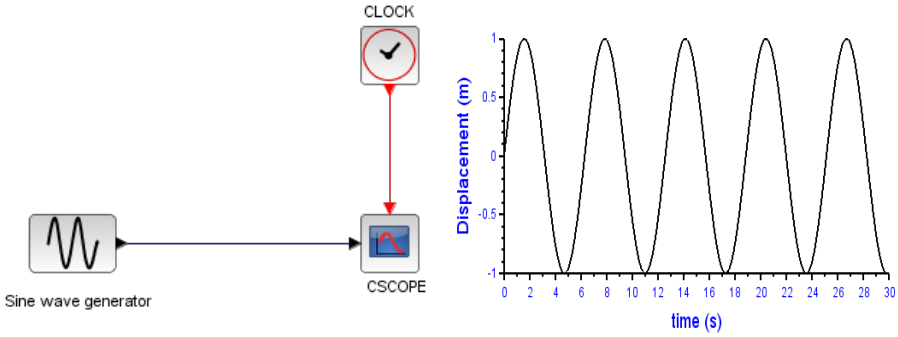

Fig. 4: Xcos Model for Sine Wave (4a) and its Wave Form Simulation (4b)

The output sine wave is shown in Fig. 4b. The wave form shows displacement 1m matches the input data fed to sine wave generator. It can also be observed that the time period of 6.28s on the output wave form matches with the input frequency 1 rad/s fed to sine wave generator.

3.2 Simple Harmonic Oscillator (Free Oscillator)

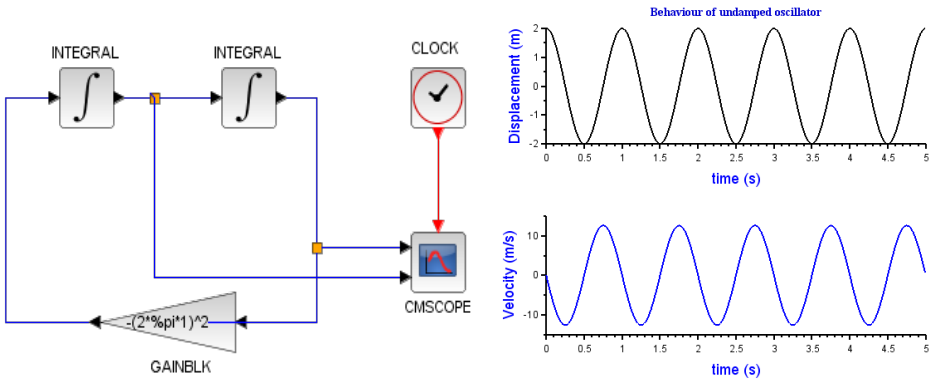

Fig. 5: Xcos Model for Simple Harmonic Oscillator (5a) and Its Output Wave Forms (5b)

Xcos model for simple harmonic oscillator and its output wave forms are shown in Fig. 5a and 5b respectively. Frequency of 1 Hz is fed to the gain block as shown in the Fig. 5a and initial condition is set in the second integrator block as 2 (Amplitude). The displacement – time graph (channel 1) is observed in Fig. 5b . The displacement- time graph clearly show the time period 1s due to input frequency 1Hz in gain block which validate the model. By setting the amplitude value A = 2m in second integral block, at time t=0s it is observed that displacement is maximum (y = A) and the velocity is minimum (v = 0) as shown in the Fig. 5b. The maximum velocity is calculated using the formula $v=\omega\sqrt{A^2-y^2} = A\omega = 12.56$ m /s observed and validated in the output waveform. This stimulate the critical thinking in the learner to correlate the mathematical equation and the graph, which helps to identify as simple harmonic oscillation based on output waveform of displacement - time and velocity –time graph.

3.3 Damped Harmonic Oscillator (Under Damped Condition)

Xcos model for damped harmonic oscillator and its output wave forms for under damped condition are shown in Fig. 6a and 6b respectively.

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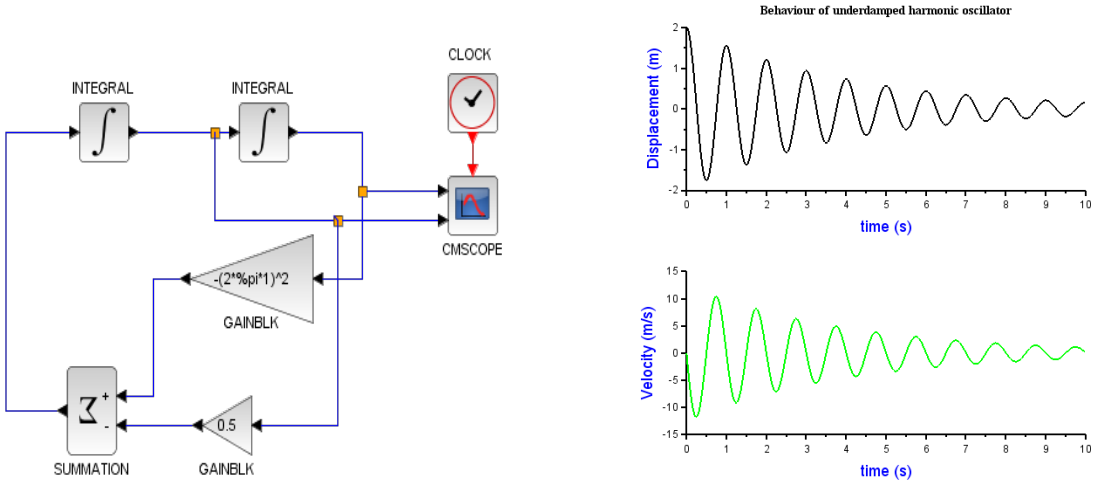

Fig. 6: Xcos Model for Damped Harmonic Oscillation 6(a) and its Output Waveform 6(b)

In the damped harmonic oscillator natural frequency is set for 1Hz in the first gain block and damping coefficient 'b' as 0.5 in second gain block which is connected to middle position of two integrator blocks. Since natural frequency is 1Hz and natural angular frequency 'ω' is 6.28 rad/s, and the damping coefficient 'b' is 0.5, the condition is b <<< ω executes under damped oscillation. The exponential decay of displacement and velocity validates the under damped harmonic oscillation shown in Fig.6b. To understand the behaviour of critical and over damped harmonic oscillation, the value of damping coefficient 'b' is computed using the condition b = ω and b >>> ω respectively. The observed output wave forms are shown in Fib. 6c and 6d respectively.

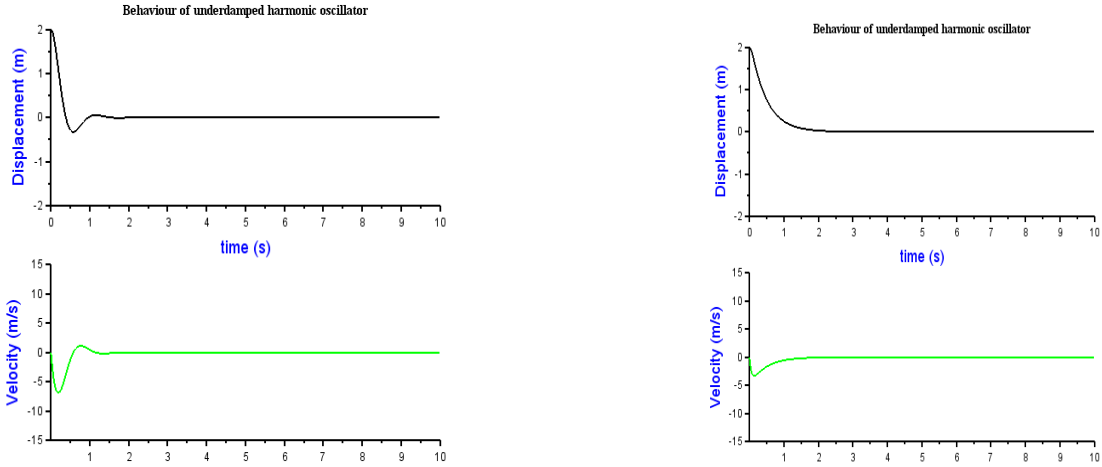

Fig. 6: Output Wave Forms for Critical (6c) and Over Damped (6d) Harmonic Oscillator

It can be observed from Fig. 6c and 6d that the oscillating mass comes to rest position without performing oscillation. But it is clearly indicate that the oscillating mass takes longer time to reach mean position (y=0) in over damped condition when compared to critical damping condition. This is very much essential condition required in design thinking of automobile industry where the fabrication of spring damper system places a major role locomotive system. This inculcates the concept in the learner through critical thinking by analysing the output waveforms of underdamped, critically damped and overdamped condition of damped harmonic oscillator.

3.4 Forced Harmonic Oscillator (Resonance Condition)

Xcos model for forced harmonic oscillator and its output wave forms are shown in Fib. 7a and 7b respectively. Forced harmonic oscillator is used to sustain the oscillation by applying external period force. We have added external source block (sine wave generator) and shown in Fig. 7a.

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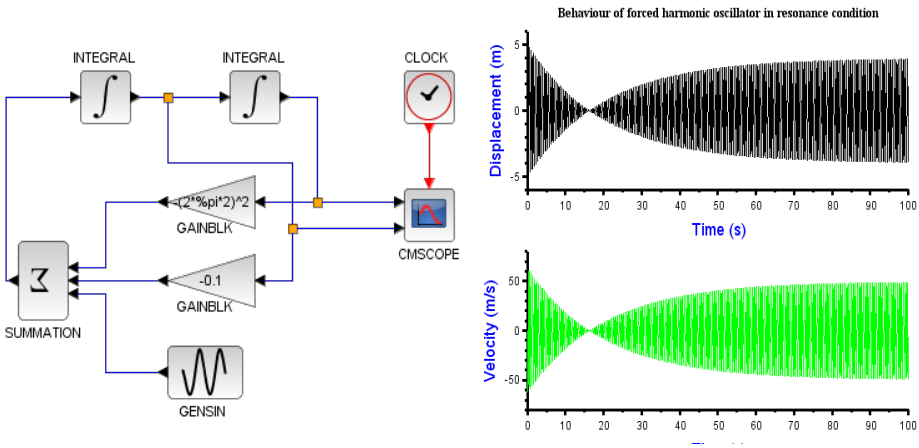

Fig. 7: Xcos Model for Forced Harmonic Oscillator (7a) and its Output Wave Form (7b)

In the case of damped oscillations, the amplitude of oscillations decrease with the time exponentially due to dissipation of energy and the body eventually comes to mean position. When a body experiences vibrations due to the influence of an external driving force the body can continue its vibration without coming to a rest. Such vibrations are called ***forced vibrations/oscillations***.

The forced harmonic oscillator is set for resonance condition where the natural frequency (ω) is equal to the applied frequency (ω_d). Natural frequency and applied frequency is set for 2Hz in gain block and sine wave block and both the amplitudes to be set as 5. In cmscope, y-axis scale at channel 1 is set as 5 and at channel 2 is set as 70 because displacement ($y = A = 5m$) and velocity ($v = A\omega = 62.8m/s$). The observed output waveforms displacement-time and velocity-time given in the Fig. 7b shows that the amplitude of oscillator decreases initially in the transient region due to damping force observed for short duration (17 s) and further oscillating mass picks up the frequency (ω_d) due to external periodic force reaches steady state condition and vibrates with constant amplitude. This helps to visualise the output waveform that how oscillating mass picks up the external periodic frequency and vibrates with the constant amplitude.

3.5 Validation of Simple Harmonic Oscillator Model using Spring-mass Experiment

Simple harmonic oscillator model is validated by using the spring-mass experimental data instead of giving arbitrary values. An optimised mass of 0.350 kg is attached to a mass less spring and set for oscillation. Time period is noted using stop watch and calculated the spring constant 'k' and angular natural frequency (ω). The value of angular natural frequency is fed to gain block in the model and run the simulation. The output wave form is observed and the time period is noted. The model is validated by comparing the experiment data with the Xcos model data is shown in Table 1.

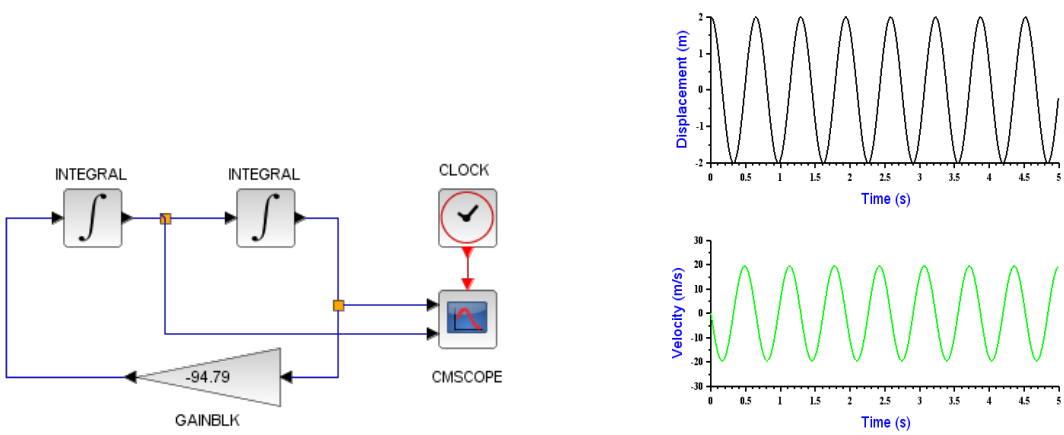

Fig. 8: Xcos Model for Simple Harmonic Oscillator (8a) and its Validation of by Computing Experimental Data from Spring Mass System(8b)

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Table 1: Validation of Simple Harmonic Oscillator Xcos Model with Experimental Data

Parameters	Theoretical Data	Simple Harmonic Oscillator Xcos Model Data
Time period (T)	T=0.645 s (By experiment)	T= 0.65 s
Mass M=0.350 kg Spring constant (k) = 33.17 N/m	Natural angular frequency of the oscillator $\omega^2 = \frac{k}{m} = -94.79, \omega = 9.73$	Natural angular frequency of the oscillator $\omega^2 = \frac{k}{m} = -94.79, \omega = 9.73$
Displacement (y)	y = Acos(ωt) = 1.97m	y = Acos(ωt) Diplacement/magnitude = 2m (computed)
Velocity (v)	v = -Aωcosωt v_{max} = Aω=19.48m/s	v = -Aωcosωt v_{max} = Aω (when y = 0) v_{max} = 2 x 9.736= 19.47 m/s (observed)

Conclusion

Learner can understand the basic concepts of oscillations by analysing Xcos model for simple, damped and forced harmonic oscillation. The Xcos harmonic oscillator model formulated by applying suitable initial parameters such as natural angular frequency, damping coefficient and external periodic force and the corresponding output waveforms can be visualised by running the simulation model. The identification of correct input parameters and critical thinking skills which are most vital to recognize and analyse the nature of oscillation. To validate, we fed the experiment data to Xcos simple harmonic oscillator model and observed the output waveform for simple harmonic oscillation. Similarly repeated for damped and forced harmonic oscillator which extend to analyze engineering problem such as filter circuits, tuning circuits and real life applications through learning by doing.

Acknowledgement

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References

[1] R. R. Hake, Interactive-engagement vs traditional methods: A six-thousand student survey of mechanics test data for introductory physics courses, *American Journal of Physics*, 66, 64-74 1998.

[2] Guadalupe Martinez, Francisco L. Naranjo, Angel L. Perez, and Maria Isabel Suero, Comparative study of the effectiveness of three learning environments: Hyper-realistic virtual simulations, traditional schematic simulations and traditional laboratory, Physical Review Special Topics-Physics Education Research, 7, 020111,1-12, 2011.

[3] Stephanie V. Chasteen, Steven J. Pollock, Rachel E. Pepper, and Katherine K. Perkins, Transforming the junior level: Outcomes from instruction and research in E&M, *Physical Review Special Topics-Physics Education Research*, 8, 020107(1-18), 2012.

[4] Dawit Tibebu Tiruneh , Mieke De Cock, Ataklti G. Weldeslassie, Jan Elen, Rianne Janssen, Measuring Critical Thinking in Physics: Development and Validation of a Critical Thinking Test in Electricity and Magnetism, *Int J of Sci and Math Educ*, 15:663–682, 2017. DOI 10.1007/s10763-016-9723-0.

[5] Sarantos Psycharis, The computational experiment and its effects on approach to learning and beliefs on physics, *Computers & Education,* 56, 547–555, 2011.

[6] Fitri Wardani , An analysis of student's concepts understanding about simple harmonic motion: Study in vocational high school, *Journal of Physics: Conference Series*,1511 012079, 2020. IOP Publishingdoi:10.1088/1742-6596/1511/1/0120792.

[7] H D Ayu, A Jufriadi, S E Mustika, M Kurniawati, H Y Pratiwi, C Sundaygara and M N Hudha, How to learn oscillation and wave in SAMR framework?, *J. Phys.: Conf. Ser*. 1869, 012160, 2021.

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[8] O. S. K. S. Sastri, Model Based Simulation of Forced Oscillator using Open Source Application Xcos: A Constructivist Paradigm, *International Journal of Innovative Science, Engineering & Technology*, 1 (8), 2014.

[9] S Sujito, L Liliasari and A Suhandi, Differential equations: Solving the oscillation system, Journal of Physics: Conference Series, 1869 (2021) 012163 IOP Publishing .doi:10.1088/1742-6596/1869/1/0121631.

[10] Henrik B Pedersen , John E V Andersen,Torsten G Nielsen, Jens Jacob Iversen, Folmer Lyckegaard and Frank K Mikkelsen, An experimental system for studying the plane pendulum in physics laboratory teaching, *Eur. J. Phys*. 41, 015701, 2020. https://doi.org/10.1088/1361-6404/ab4b29.

[11] R. K. Thornton and D. R. Sokoloff, Assessing student learning of Newton's laws: The force and motion conceptual evaluation and the evaluation of active learning laboratory and lecture curricula, *American Journal of Physics*, 66, 338–352, 1998.

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Verifico: A Digital Platform to Store and Verify Student Certificates using Blockchain Technology

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ABSTRACT

Every academic year, lakhs of students finish their graduate education and set goals to accomplish higher studies or to start careers in employment sectors. The certificates obtained after the graduation is the sole representation of human capital of these candidates. These certificates play a vital role in deciding the individual's progress in respective domains they aspire to join. These certificates are subjected to verification of their integrity which is the premise of this paper. The educational institutions lack infrastructure to store the documents for verification further along the timeline. The high academic value of these certificates is one of the main reasons that the certificates are forged, manipulated for the benefit of the holder. Counterfeit certificates and manual overhead have caused problems for institutions to verify certificate integrity.Using Hyperledger Blockchain technology, we offer an end-to-end solution to provide an automated verification procedure as well as a reliable, immutable infrastructure for keeping granted certificates in this article. The proposed solution solves the problem of counterfeit certificates and provides colleges and institutions an automated digital infrastructure to verify student certificates.

Keywords: *Certificates, Integrity, Malpractice, Lack of Infrastructure, Blockchain, Hyperledger*

1. Introduction

Today's world has seen a surge in technological advancement along with the good and bad that follows it. The research and applications of these advancements have changed the world for the better in many ways as well as an has an increase in its use for malicious intent. In the domain of education, these advancements have created vulnerabilities in the scope of hard copy certificates, as they are forged, changed for the benefit of the holder. With the use of rising digitalization and the concept of decentralized ledgers, this particular vulnerability revolving around the academic certificates can be resolved. In this paper an end-to-end digital platform called Verifico is proposed to solve the problem of certificate verification using these advancements and also curb the downside caused in the process because of counterfeit certificates.

To tackle the problems in verification we trace back the process all the way to the storage phase of these certificates. Educational institutions are provided with access to the private permissioned blockchain to upload the certificates to this network. Since we cannot store the entire certificate in the block of a blockchain we utilize a decentralized storage system IPFS which used content addressing to store data around the world in a decentralized fashion. A blockchain is a decentralised database made up of blocks that are linked together by a hash number. Each block has an address that records ownership and is updated on a regular basis when it has been confirmed. Blockchain is a distributed ledger, which implies that anybody may see and modify the information as long as it is confirmed by the people concerned.The Interplanetary File System (IPFS) is a peer-to-peer network and distributed file system protocol for storing and distributing data. IPFS uses content-addressing to uniquely identify each file in a global namespace that connects all computing devices. We store the hash, which is the IPFS protocol's content addressing key, in the blockchain network, allowing for immutability of the material and access to the certificates. Colleges are trusted entities and are members of the private permissioned blockchain network Hyperledger. They upload the certificates to the network which are stored as assets in the network. When the verifier demands verification of integrity for any of these, the automated system pulls the hash of the blockchain protected asset and issues a link with the access to this certificate in the IPFS network. The verifier can view this certificate which can be trusted because its content addressable key was retrieved from the blockchain and is immutable from its storage phase

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itself. This mechanism provides trust between the verifier and the verification system and also fastens the entire verification process to a matter of minutes.Using IPFS and the private permissioned blockchain Hyperledger, we tackle two key challenges in verification process infrastructure and trust.

2. Literature Survey

This section contains the results of the literature review conducted at the inception phase. Pavitra Haveri, *et al.* [1] proposes an Edu Block: Securing Educational Documents using Blockchain Technology. A private Ethereum blockchain to which the document q-hash derived from IPFS is stored for the validation and retrieval of respective document. This system has some limitation as a reliable method for transfer of document hash from the document holder to the verifier is not discussed within the paper.

A. Gayathri, *et al.* [2] proposes, Certificate validation using blockchain. Using sampling and quantization, the certificates are transformed to digital certificates. The certificates are then combined with the digital certificates' hash values and stored in blocks. Limitation: To generate hash values, a chaotic method is employed.

Muhammad Aamir, *et al.* [3] proposed Blockchain Based Academic Records Verification in Smart Cities. An immutable records storage on a distributed ledger that can be verified anytime anywhere in a trusted automated process using the Hyperledger Fabric Blockchain. Some limitations: The proposed system involves a CA which is at a deadline in current trends. Only URI is required to access the certificate in the blockchain which has security concern

Ahmed Badr, *et al.* [4] suggested A permissioned blockchain-based system for academic record verification. The approach used is a mix of on-chain and off-chain record storing system with private permissioned Hyperledger. Limitation: The verifier still needs to generate hash and compare it with the decrypted hash from digital signature which creates overhead again

Chuyang Li, *et al.* [5] proposes an a Blockchain System for E-Learning Assessment and Certification. A combination of public and private blockchain referred as BlockNet along with use of four distinct smart contracts. Limitations: In the architecture ECN is a public Blockchain which raises security concern for sensitive academic documents. In this architecture, because of public Blockchain in a large scale there is possibilities of malicious nodes posing as legitimate EA's.

Ajay Kumar Shrivastava, *et al.* [6] suggests using a private blockchain to store and authenticate educational documents in a decentralised manner. University, student, and third-party users will all be stakeholders in a government-owned private blockchain.. Limitation: the key stakeholder can implement modifications without taking the views of his mine nodes, this aspect contradicts to the objective of creating a distributed ledger

Arshad Jamal, *et al.* [7] proposed, Blockchain-Based Identity Verification System. A system that makes advantage of blockchain's decentralised features to retain personal records and provide a function that allows others to access them for registration and verification reasons.

Dipti Ashok Belurgikar, *et al.* [8] proposes an Identity Solutions for Verification using Blockchain Technology. The methodology includes the Ethereum Blockchain implemented in the DecentID web platform and. Limitation: Fusing biometrics and cryptography as a layer for blockchain access causes problem for consensus and also may cause blockchain forks.

Jiin-Chiou Cheng, *et al.* [9] proposed, Blockchain and Smart Contract for Digital Certificate. The method proposes the use of Ethereum Blockchain and implements Smart Contracts for document storing. Limitation: The single encryption technique instead of the double encryption and concept of Qr-code infuses vulnerabilities in document security.

Sthembile Mthethwa, *et al.* [10] Proposing a Blockchain-based Solution to Verify the Integrity of Hard Copy Documents. Implemented by four techniques namely OCR, Cryptographic hashing (SHA-256), Digital Signature and 2D barcode. Limitation: This paper doesn't discuss the specific blockchain used for implementation. The verification process on the verifier side is tedious.

Gunit Malik, *et al.* [11] proposed, Blockchain Based Identity Verification Model. IPFS (Interplanetary File system) with asymmetric encryption and along with the Hyperledger for specific functionalities to provide efficient and secure system. Limitation: The security concerns in the communication between the document management system IPFS and the Blockchain layer is not discussed within the paper.

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Sebastian Friebe, *et al.* [12] DecentID is a decentralised, privacy-preserving identity storage system based on smart contracts. DecentID is a decentralised identifying data storage system based on smart contracts. DecentID is a smart contract-based decentralised identification data storage system.Limitation: Since Ethereum is a public blockchain the system poses insecurities in case of sensitive documents.

Nicolas Buchmann, *et al.* [13] proposes an Enhancing Breeder Document Long-Term Security using Blockchain Technology. Bitcoin Blockchain technology, also referred as blockchain 2.0 and 2D barcodes is used to store breeder document and biometrics. SHA-256 hash function is used for hash generation.

Omar S. Saleh, *et al.* [14] proposed, Blockchain Based Framework for Educational Certificates Verification. Implementation of Hyperledger Fabric with the feature of Membership Service Provider, Chain code, Peers, Channels, Shared Ledger, and Gossip Network Protocol and along with encryption and decryption techniques.

Osman Ghazali, *et al.* [15] proposes a Graduation Certificate Verification Model by Utilization of the Blockchain Technology. A digital signature system is created using hashing and public key cryptography methods to authenticate the validity of information delivered over the Internet

3. Methodology

This section includes the three-step methodology we deployed for an end-to-end system implementation.

3.1 Blockchain Design and Administration

The very first module that is the foundation the system is BLOCKCHAIN. In this module we define all the actions involved in setting up various entities that compose a Blockchain network. Blockchain technologies can be categorized based on their access and identity rules into Public, Private and Permissioned. If the identities are unknown or anonymous and no restricted access, a Blockchain network is considered Public, in another case if the identities are known and private to an entity and the access is till unrestricted it is considered Private, for our project we having implemented the third category with private, known identities and access restricted to trusted entities only, categorized as Private Permissioned Blockchain Network. A Blockchain network is more than just a chain of blocks, within the system it has many entities such as shared ledger and world state database, orders, peers, and many more. This operation is handled by a submodule Network Setup.

3.1.1 Network setup

In this sub module all the entities required to run a blockchain network are initialized and a complete network structure is deployed. We have implemented the private permissioned blockchain network Hyperledger. We have utilized the Unix platform Hyperledger Fabric which provides us with tools and binaries to setup and interact with a private permissioned blockchain. The main attraction or advantage of using Hyperledger fabric is the availability of MSP (Membership Service Provider) which handles all the private key-public key operations and authorizations for us.

Hyperledger Fabric provides us with binary files such as cryptogen and Certificate Authorities which generate the cryptographic signatures or keys that are required by the MSP. This allows us to create entities with different functions and roles within the network. Such as Peers to handle the computational operations or logic transactions in the network, Orderers to perform the operations of block ordering once they are mined by the peers and the consensus operations, CA's to generate the cryptographic materials and many more. Hyperledger provides us with a business function entity called Organizations, by assigning roles and affiliations to organization entities and policing peers under organization we provide the Permissioned feature for our blockchain network. Also, a Channel feature provides policing between organizations.

For Certificate Based use case we have implemented the Private Permissioned blockchain network using Hyperledger Fabric. Our network structure consists of two peer organizations with one peer per organization, one MSP per organization and one CA per organization and also, we have an orderer organization with one orderer employing the RAFT consensus mechanism and an CA for the orderer organization. Both the organization are enrolled in a channel "mychannel" to carry out transaction operations.

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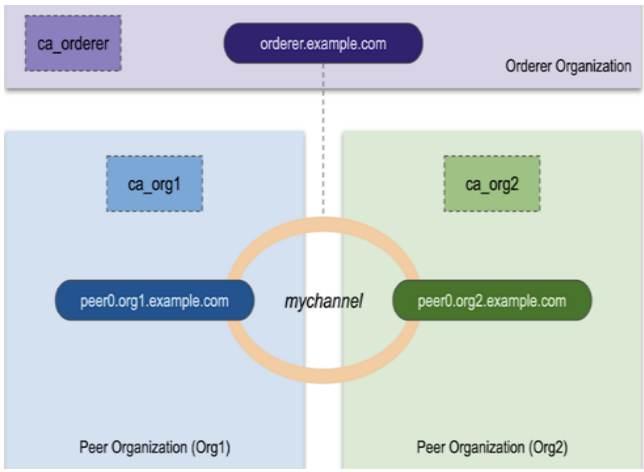

Fig. 1: Blockchain Structure

All these entities are run as containers in the network with different endpoints conversing to each other using a docker containers network "test_network". Using tools Docker Engine and Docker Compose we configure the required parameters and connection endpoints in a doker-compose.yaml file and run the docker-compose up command in our shell script "network.sh" to build our network from scratch. Once all the networks are up, we can view them using a "docker ps" command to verify.

3.1.2 Chaincode deployment

Chaincode is the smart contract that runs on the peers and produces transactions in Hyperledger Fabric. Developers utilise chaincode to create business contracts, asset definitions, and decentralised apps that are collaboratively managed. The ledger state is managed by the chaincode through transactions initiated by apps.We implement our chaincode using the JavaScript Programming Language and implement all our logical functions and interactions with the blockchain in the chaincode script. Chaincode has to be processed through a series of steps called lifecycle before it is operational in the network. Before a chaincode may be utilised on a channel, numerous companies must agree on how it will be operated. We may create this lifecycle using CLI commands from a shell script using the peer binary, which is an utility supplied by Hyperledger Fabric.

Before it can be installed on your peers, Chaincode must be packed in a tar file. Every peer that will execute and approve transactions must have the chaincode package installed. A chaincode definition governs the chaincode. The acceptance of a chaincode definition by channel members works as a vote by an organisation on the chaincode parameters that it accepts.One organisation can contribute a chaincode definition to the channel if a sufficient number of channel members have accepted it. The chaincode container will launch on all peers where the chaincode has been installed when the chaincode definition has been committed to the channel, allowing channel members to begin utilising the chaincode. The chaincode algorithm for uploading a certificate (asset) to the blockchain network.

Step 1: Fetch the X509 certificate form ctx.stub

Step 2: if X509.mspID == org1 then

goto **Step 3**

else **exit**

Step 3: Check if Asset Exists in network, if true then

exit

else goto **Step 4**

Step 4: Create an asset (JSON) from the parameters

assetid,issuerid, holderid, hash (from IPFS)

Step 5: Add the asset to the stateDB ctx.putState()

return true

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3.2 Back-end Modules Deployment

Once our main module blockchain network is set up, we build the necessity functions in our backend server to interact with the blockchain network and perform various operations. Using the node.js framework and the SDKs available for the node.js framework by the Hyperledger Fabric Framework, we have implemented the backend connections to the application. In this module we make use namely two SDKs fabric-contract-api and fabric-shim-api. These two node.js framework classes developed and provided by the Hyperledger platform allows us to perform operations such as transaction invoking and also connecting to the blockchain network and performing registration of users to the blockchain network.

In our system we maintain a set of identities and their roles as follows: The users registered under organization 1 are our trusted college entities and only our Admin of the network can register new college users under organization 1 using his admin cryptographic credentials. The first task in the backend is creating directories for wallet. A wallet is the folder in which we store the cryptographic identities of different entities in the network. And for these functions we have the sub module Blockchain interactions.

3.2.1 Blockchain Interactions

In this module, we implement the blockchain network interactions such as registering the users and enrolling the users to their specific organizations using fabric-contract-api. In order to contact the different entities of our Blockchain network we first build a connection profile for both organizations and create CA entities using the fabric-contact-api class methods. Using the member methods provided by this framework we register and enroll users to organization 1 and organization2 using their respective admins. Also using the methods submitTransaction() and evaluateTransaction() we execute different logic sections of our chaincode and perform business operations.

3.2.2 API Endpoints

We implement REST API's using node.js express framework and define specific API endpoints that perform various actions like logins, register, upload, verify, fetch etc. Each operation that can be performed by our actors Admin, College and Verifier are backed up by the specific API endpoint functions in our backend server. Using Http server module of the node.js framework we start an HTTP server listening at port 4000 waiting to service API Calls.

3.3 Front-end Modules Deployment

The final module that is visible to the actors in our system. We have implemented our front-end module using HTML, CSS and JavaScript. Using HTML, CSS to build and design static web pages and JavaScript to make them dynamic and using the XHR module of the JavaScript framework to make API calls we have provided an interactive and dynamic User Interface in our Frontend module to all the actors in our system. We have also provided application level, server level and blockchain network level securities. For our application level and we are using JWT (Json web tokens).JSON Web Token (JWT) is an open standard (RFC 7519) for securely transmitting information as a JSON object between two parties.This information can be examined and trusted since it is digitally signed. JWTs can be signed using a secret (using the HMAC technique) or with an RSA or ECDSA public/private key combination. At the server level, we're using CORS (Cross Origin Resource Sharing) to ensure that material is only provided to and received by the right people.CORS (Cross-Origin Resource Sharing) is an HTTP header-based technique that lets a server identify any extra sources (domain, scheme, or port) from which a browser should accept resource requests.

4. Experimentation and Results

The setup of the system, experimentation, and discussion of the results are all included in this part.

We have run our application on the Ubuntu 20.04 release operating system with many requirements installed such as docker engine, NodeJS, and so on, with an memory of 20GB HDD and 4GB RAM. All the actors use dynamic webpages to perform their operations.

We have implemented Blockchain Design and Administration through a shell scrip named "network.sh" and we have various operations within the shell script that calls various other CLI commands such as cryptogen to generate crypto keys, Peer CLI for chaincode deployment and docker-compose commands to run multiple container environments. Once all our containers are up and running and chaincode deployed we can view all the running containers in the terminal using docker ps command.

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We have implemented the Backend module using various .js files such as app.js for API endpoints and helper.js for backend interactions with blockchain and CAUtil.js and AppUtil.js files for other miscellaneous purposes. We start our backend server using command “nodemon app.js” in terminal.

We have implemented the Front module using HTML and CSS static documents and respective .js files for all pages for respective actor functions to derive a complete user interface. We can access the document directly from our web browser.

Besides the modules we also have to start up Mongo DB using command “>mongo” and IPFS daemons using command “>ipfs daemon”.

We have identified three actors in our system: The blockchain administrator to enroll trusted entities, the College user to upload certificates and the verifier who requests verification.

The admin must login using the credentials and register the trusted colleges to the network and the system shares their credentials via automated email to the registered college email.

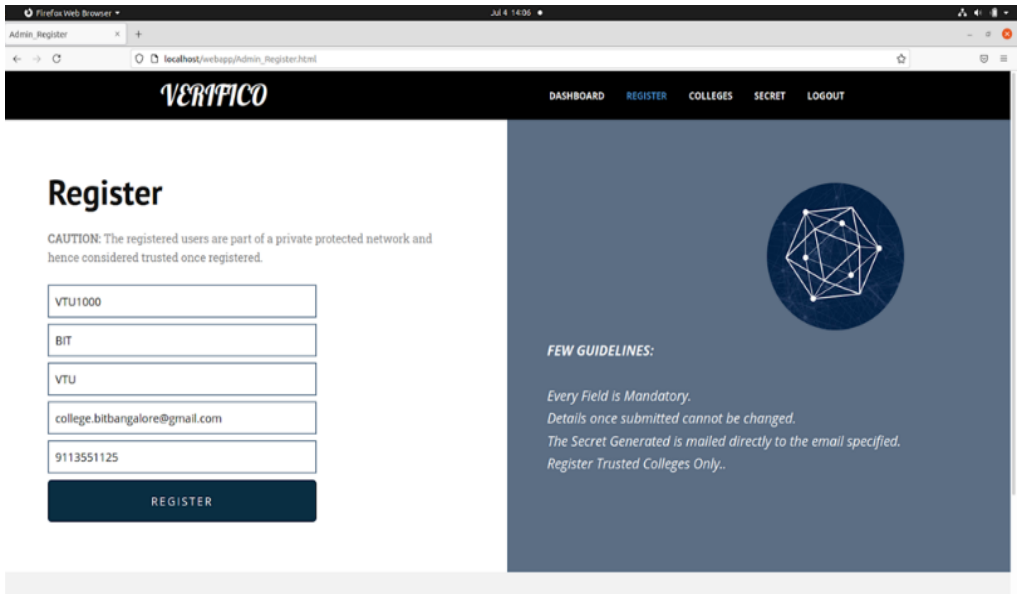

Fig. 2: Admin’s College Register Page

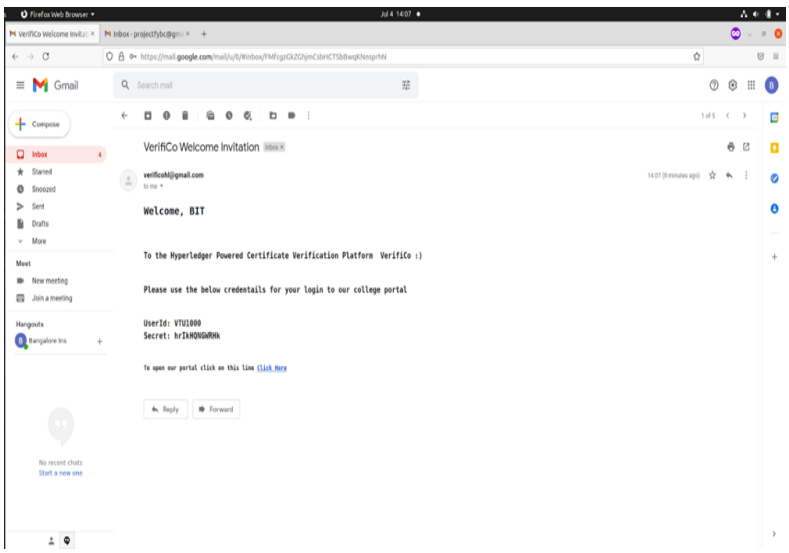

Fig. 3: Automated Email Received by College

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The college must use these credentials to login to the network and then upload the certificate to the network. The system check s for duplicity and later uploads the certificate to the system and produces access codes (QR and Bar) for the college to print on the hard copy of certificate for easier access.

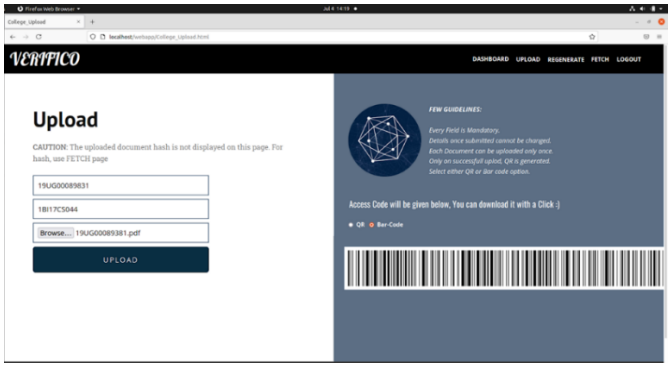

Fig. 4: Certificate Upload Portal

The final actor scans the access code on hard copy and is redirected to the verification portal where an email request is prompted, the verifier receives an automated reply email with the link to the blockchain verified certificate through which he can view this certificate form IPFS.

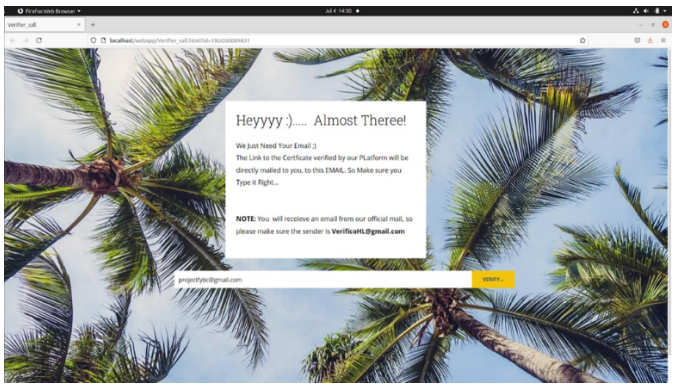

Fig. 5: Certificate Verification Portal

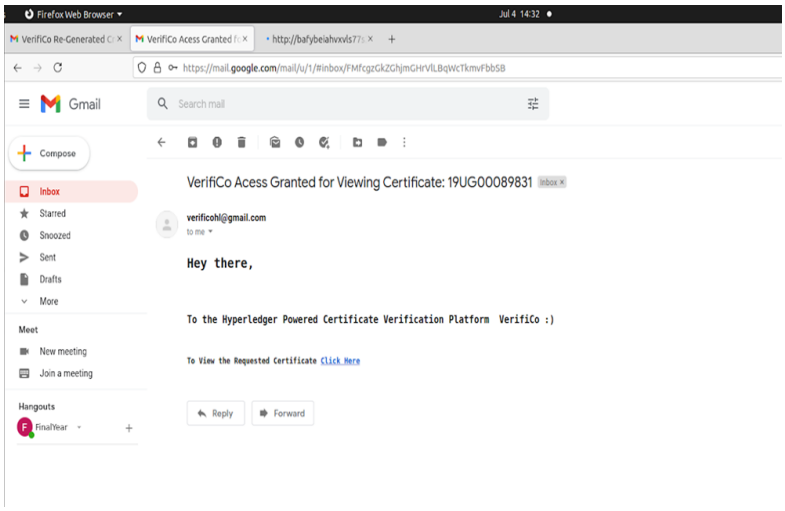

Fig. 6: Automated Email Received by Verifier

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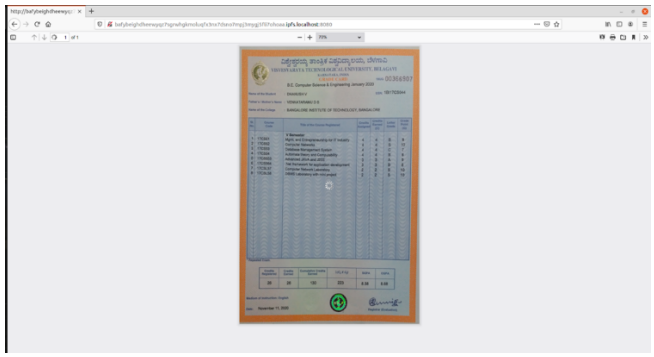

Fig. 7: Verified Document

The system has registered 10 valid users to the network and uploaded more than 20 valid certificates without any system disruption. The system has been used for more than 60 hours as college, student and verifier, executing as each role and the system performed without disruption and carries out error handling on user mistakes. The proposed system carries out all the required functionalities swiftly and without any errors.

Conclusion

The proposed solution provides and end-to-end digital platform to store and verify student certificates for all the actors within the system. The proposed system provides an automated certificate verification platform and a trusted environment for handling academic certificates using Blockchain Technology. The system aids the students to accelerate their ventures, the college to digitalize their infrastructure and the institutions to minimize their overhead and incurring loss due to delayed background checks. Further the system can be scaled to a complete e-Learning platform. Future scope to the system would be Migrating operations to a cloud platform like the IBM Blockchain platform to handle high intake and avoid hardware exhaustion. Implementing IPFS as a service or a private IPFS cluster to provide faster data access rates. Further expand the system to provide more operations for each actor in the system.

References

[1] Pavitra Haveri, Rashmi U B, “EduBlock: Securing Educational Documents using Blockchain Technology”, School of Computer Science & Engineering, KLE Technological University, Hubballi, IEEE – 2020

[2] A.Gayathri, J.Jayachitra, “Certificate validation using blockchain”, IEEE 7th International Conference on Smart Structures and Systems ICSSS, 2020

[3] Muhammad Aamir, Rehan Qureshi, Furqan Ali Khan, Muhammad Huzaifa, “Blockchain Based Academic Records Verification in Smart Cities”, Department of Telecommunication Engineering, Sir Syed University of Engineering and Technology, Karachi, Pakistan, Springer – 2020

[4] Ahmed Badr, Laura Rafferty, “A Permissioned Blockchain-Based System for Verification of Academic Records”, Ontario Tech University Oshawa, Ontario, Canada, IEEE – 2019

[5] Chuyang Li, Junqi Guo, Guangzhi Zhang, Yunchuan Sun, “A Blockchain System for E-Learning Assessment and Certification”, International Conference on Smart Internet of Things (Smart IoT), IEEE – 2019

[6] Ajay Kumar Shrivastava , Chetan Vashisht, “A Decentralized Way to Store and Authenticate Educational Documents on Private Blockchain”, 2nd International Conference on Issues and Challenges in Intelligent Computing Techniques, IEEE – 2019.

[7] Arshad Jamal, Rabab Alayham Abbas Helmi, “Blockchain-Based Identity Verification System”, IEEE 9th International Conference on System Engineering and Technology, 2019

[8] Dipti Ashok Belurgikar, J Kanak Kshirsagar, “Identity Solutions for Verification using Blockchain Technology”, Dept. of Computer Science and Engineering, BMS College of Engineering Bengaluru, IEEE – 2019

ISBN: 978-93-91355-21-0 (e-Book)

[9] Jiin-Chiou Cheng, Narn-Yih Lee, "Blockchain and Smart Contract for Digital Certificate", IEEE International Conference on Applied System Innovation, 2018

[10] Sthembile Mthethwa, Dr. Graham Barbour, "Proposing a Blockchain-based Solution to Verify the Integrity of Hard Copy Documents", Council for Scientific and Industrial Research (CSIR), IEEE – 2018

[11] Gunit Malik, Kshitij Parasrampuria, "Blockchain Based Identity Verification Model", International Conference on Vision Towards Emerging Trends in Communication and Networking (ViTECoN), IEEE – 2019

[12] Sebastian Friebe, Ingo Sobik, "DecentID: Decentralized and Privacy-preserving Identity Storage System using Smart Contracts", 17th IEEE International Conference on Trust, Security and Privacy in Computing and Communications, 2018

[13] Nicolas Buchmann, Christian Rathgeb, "Enhancing Breeder Document Long-Term Security using Blockchain Technology", IEEE 41st *Annual Computer Software and Applications Conference*, 2017

[14] Omar S. Saleh 1, Osman Ghazali, "Blockchain Based Framework For Educational Certificates Verification", *Journal of Critical Reviews*, ISSN- 2394–5125, 2020

[15] Osman Ghazali and Omar S. Saleh, "A Graduation Certificate Verification Model by Utilization of the Blockchain Technology", *Journal of Telecommunication, Electronic and Computer Engineerin*g, 2019

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Mind Storming Application using Critical Thinking

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ABSTRACT

Augmented reality (AR) gives a collaborative involvement of the present physical world overlaid with that of the computer generated graphic image. AR application is believed to influence to a great extent on most important industries which includes Medical Training, Education at different levels, Designing complex models, Helpful in Business, Tourism industry, Service industry, Entertainment, public safety and many more. Critical thinking comprises of combined skills of scrutinising arguments, creation inferences using inductive or deductive reasoning, calculating and constructing decisions or solving problems.

This paper proposes a pedagogical approach for solving problems using critical thinking through Augmented Reality. The method is developed on the persuasion that children require modern experience along with traditional notions of knowledge to meet the changes of the present upcoming skill. It helps to improve different kinds of skills like coordination, cognition skills, mathematical and logical thinking. The pedagogical approach is enabled with the software developed specifically for the application with wide-ranging set of rules, where players manipulate game pieces on a grid to support logical thinking and investigation, with a view to develop critical literacy skills needed for solving problems in the digital age.

Keywords: *Augmented Reality, Critical Thinking, Critical Literacy, Logical Thinking, Pedagogical Approach*

1. Introduction

Using AR skills the digitised images created can be overlapped on the objects that are present in the real world. In AR (i) the user's existence will be in the real world where an augmented image is placed. (ii) The user can interact with the augmented image. (iii) The digital image created mergers into the user's observation of the physical world this is attained with the help of digital visual elements, sound or other sensory stimuli conveyed via technology, which are recognised as natural parts of an environment.

Applications of AR can be extends to several fields among which modern day education plays an important role where the user can have a class room type of environment using their smartphone or tablet. The gaming industry has seen a significant increase in AR application. The fascinating gaming effect that can be created by AR attracts the players to a very great extent. Some of the AR games allow the user to use their surrounding environment example Pokémon Go which allows users to catch virtual Pokémon that are hidden throughout the map of the real world. Other AR applications also include app's to help users in repair works, public safety, map reading, advertising, amusement, tourism etc.

The proposed paper put frontward limitless options for educating mathematical and logical thinking to solve puzzle games. The player will be able to acquire many skills along with playing puzzle in a real environment interaction. The paper is an application of AR which internally uses critical thinking for gamming application. The application internally helps to improvement different kinds of skills like coordination, cognition skills, mathematical and logical thinking. There are different types of puzzle games the paper focuses on block puzzle games. The game contains different types of puzzle based on total number of grids. It contains different levels, and the level of difficulty increases with increase in level.

2. Literature Review

Paper M.Norton *et al.* [1] discusses about the Butterfly for which effect is an AR 3D puzzle game. The Game was developed keeping in mind to provide the design of the real world during gameplay. The participant has access to wide distribution of virtual butterflies. The participant introduce with a widely allocated collection of virtual butterflies in a 3D image. The player travels their respective environment, collecting the butterflies. Many of the

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traditional games are implemented using AR technology. In paper Woan Ning Lim *et al.* [2] 3D cubes Puzzle Bingo game is developed using a combination of Rubik cubes and bingo board game features. ARPinGo is an AR game that includes virtual and real components.

An AR outdoor game Kaidan is discussed by Yong Li *et al.* [3]. The user can start the game in the mobile and carry out other activities also parallel. The device pops up with remainders and hints to solve the game. The hints displayed in the application are done using AR technology, sensors are used for interactive games and GPS location related to the environment of game scene is used.

A lot of mobile application games are developed to monitor health behaviours, paper Daehyoung Lee *et al.* [4] introduces an AR game known as puzzle walk game. The game is fully interactive user-centred and designed in such a way that the user can set daily target, which can also set remainders at regular interval. A prototype of the design will also be available for further reference.

Puzzles are being more frequently used in medical activity like psychomotor activity therapies includes sequence of importance like spatial orientation, visual-motor coordination and visual perception. The medical activity uses medicinal tool to build the game called Tangram by using AR. The therapy gives importance to play game in traditional physical pieces by patient during exercises. Therapist get to know the patient's exercises by AR technology by Begona Garcia Zapirain *et al.* [5].

Paper by Joao Paulo Lima *et al.* [6] project an AR application used to solve complex jigsaw where the parts are of irregular shapes and non-textured. The parts are detected and locations are assessed using the Depth-Assisted Rectification of Contours (DARC) method. Finally the puzzle is properly assembled are highlighted.

Puzzle game are played by most of the children to increase the skills where joining and manipulating real blocks using numerical game called Voxar Puzzle. The game interpret the feature and functionalities of Blue Ocean strategy. The functionality uses the platform like FPGA board, connected to a simple monitor and software running under windows Vinicius Emanuel Silva *et al.* [7].

Paper by Gunnar Liesto *et al.* [8] explore different type of game using digitized historical photographs by AR technology. The game combine the components of 3D-build of historical place dynamically, as well as get access to baground information of that city and includes additional photos of historical places and related information of that place.

Paper by Juan Garay *et al.* [9] is a real world game developed using AR. It uses GPS enabled devices which can be used for outdoor games such as treasure hunt or encourage the user to discover their surrounding by enabling landmark activates in the game that leads to get next clue. These types of applications are used in other fields like entertainment, physical activities and teaching. An AR is booming up as a popular technology in different fields. Depending on Serious Games (SG) application new opportunities can be incorporated like teaching aids can be developed, training can be conducted, or information delivery can be done in a more effective manner. Paper by Marco Aurelio Pellens *et al.* [10] highlights Systematic Literature Mapping (SLM) which allows AR application, along with the identification of different tools, devices and techniques used.

3. Existing and Proposed System

Puzzle game is a different type of gaming genre that focuses on puzzle solving. It helps to gain the skills like problem-solving, pattern recognition, world completion, sequence solving and most important is to think logically. There are some games which give time limit and limited moves for every puzzle, while other puzzle games players can play the game with unlimited time and unlimited moves. Many puzzle games, such as Tetris, combine simple puzzles with time pressure and can really based on skills like hand and eye coordination and logic or lateral thinking.

Most of the puzzle game are played on handheld devices like android phones, tablets, laptops etc. The paper implements the puzzle game played using Markerless augmented reality (AR). Markerless augmented reality done by scanning and observing surrounding environment by camera and scanned image retrieve the augmented reality object. Mind Stroming application that helps the user to solve different type of puzzle game that consists of blocks with a different shape. The blocks are detected and place it to correct position, their positions are evaluate and ones that are correctly arranged are highlighted and forms the image.

4. Architectural Design

Fig 4.1 represents an Architectural design for AR application. The player attract by the GUI presented in the game and data related to the game is stored in Vuforia database.

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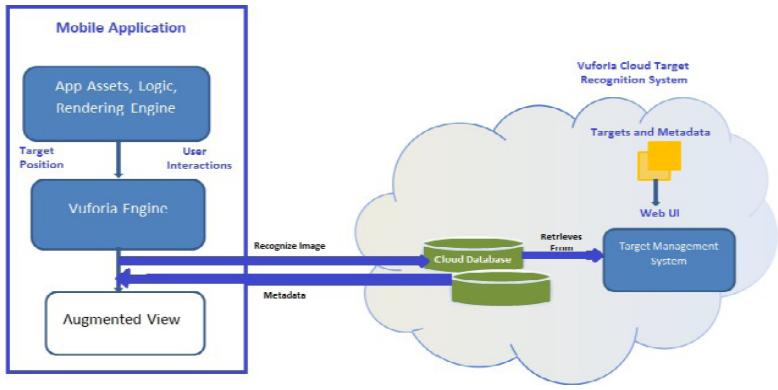

Fig. 4.1: Architectural Design for AR Application

AR application uses C# as the programming language. This component is responsible for controlling the view of the camera for scanning image target, recognition of image target, sending requests on the scanned AR image target, sending those requests to the Vuforia Cloud Target Recognition System (VCTRS) for identification to obtain gaming object on the phone's display. The user operate function like selecting different type of puzzle, arrange block by using hint and reset button and get reward coins.

5. Block Diagram

Fig 5.1 represents a block diagram for AR application. AR image target can be an image or an image descriptor. A camera is used with AR software to detect AR image target as the location for virtual objects.

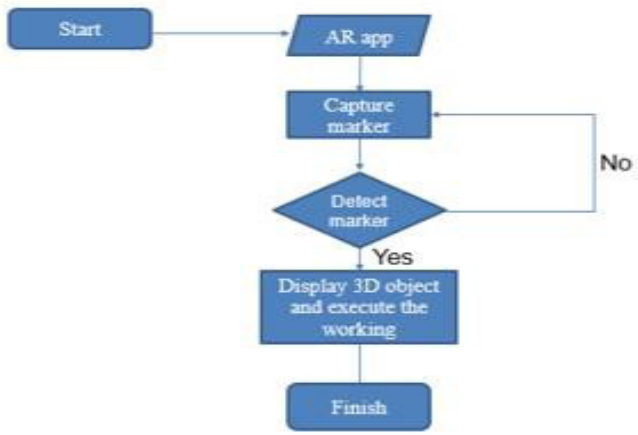

Fig. 5.1: Block Diagram for AR Application

AR uses computer vision, location and cameras to collect, process and send features in gaming object. The image target captured by the camera and recognizes it by processing using computer vision. Then, the C# program executes and process takes every time when the user hold the camera in front of target image and the result will be displayed on phone's device.

6. Implementation

The target image need to be set when the AR application is started and the camera is ready to focus on the target image, the 3D image of the puzzle is popped up and the puzzle game can be started. Fig. 6.1(a) displays the different set of puzzle of which any one can be selected. Each puzzle type contains different levels and different number of shapes. The player has to complete the first level in order to unlock the next level. Each different levels contains different number of shapes. Fig. 6.1(b) uses reset button to remove all blocks on the grid. Use hint button to get help to place the block on the grid.

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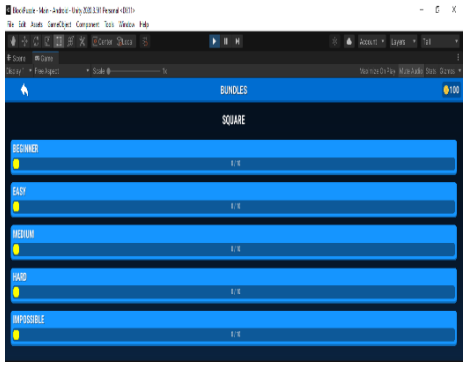

Fig. 6.1: (a) Puzzle Type

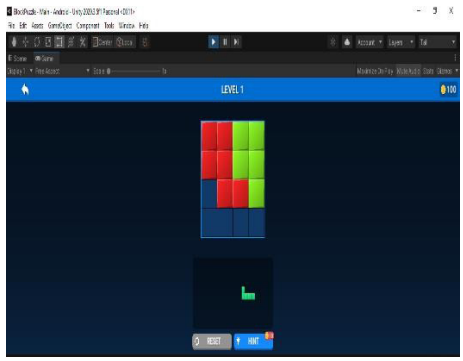

Fig 6.1: (b) Game UI Along with Reset and Hint Button

Fig. 6.2(a) and 6.2(b) shows different levels which contains different number of shapes. Blocks are in different shapes and colour, some blocks are placed for different puzzle based on total number of grid. The game is played by moving the set of blocks on the grid until the blocks create a specified image. Once a level is completed pop-up message is displayed as shown in Fig. 6.2(a) along with reward points, and a star mark on completed level. After completing the level automatically the next level is unlocked. Hint option is provided to solve the puzzle if the user is not able to solve, or reset can be used to take back all the blocks from the grid which are already placed.

Fig. 6.2: (a) Level Complete

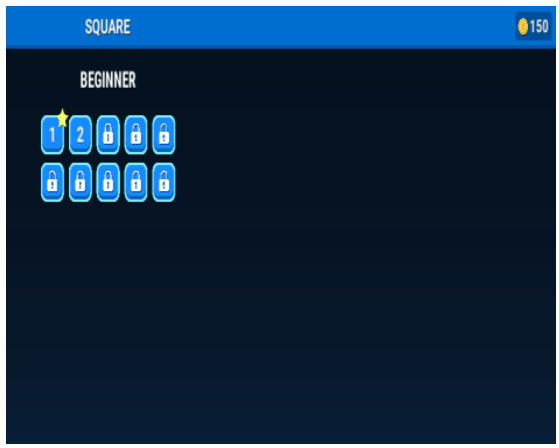

Fig. 6.2: (b) Star Mark on Completed Level

Conclusion

The game is greatly enhanced on an electronic device because the device has the ability to keep track of a high score and introduce multiple level to have as the basis of the puzzle. The advantage of playing and solving puzzle games is that to develop all kinds of skills like coordination, cognition skill, logical thinking etc. Additionally, the pedagogical approach is facilitated through the use AR technology which give the feel of playing video games with never ever experienced with comprehensive set of rules, where players is provided with an hint option to solve the puzzle if the user is not able to solve, or reset can be used to take back all the blocks from the grid which are already placed. Manipulate game pieces on a grid to support the logical thinking and analysis, to develop the given image.

References

[1] M.Norton and B.Maclntyre. Butterfly effect: an augmented reality puzzle game. Fourth IEEE and ACM International Symposium on Mixed and Augmented Reality (ISMAR'05), 5–8 Oct. 2005.

[2] Woan Ning Lim, Yunli Lee and Ivan Anggoro. Augmented Reality 3D Cubes Puzzle Bingo Game for the Elderly. 2019 IEEE International Symposium on Haptic, Audio and Visual Environments and Games (HAVE). 3–4 Oct. 2019.

ISBN: 978-93-91355-21-0 (e-Book)

[3] Yong Li, Dongdong Weng, Haiyun Zhou, Jianying Hao and Lu Zhao. Kaidan: An outdoor AR puzzle adventure game. 2013 IEEE International Symposium on Mixed and Augmented Reality - Arts, Media, and Humanities (ISMAR-AMH). 1–4 Oct. 2013.

[4] Daehyoung Lee, Georgia Frey, Allison Cheng and Patrick C.Shih. Puzzle Walk: A Gamified Mobile App to Increase Physical Activity in Adults with Autism Spectrum Disorder. 2018 10th International Conference on Virtual Worlds and Games for Serious Applications (VS- Games). 5–7 Sept. 2018.

[5] Begona Garcia Zapirain, Amaia Mendez Zorrilla and Sabin Larranaga. Psycho-stimulation for elderly people using puzzle game. 2010 2nd International IEEE Consumer Electronics Society's Games Innovations Conference. 21–23 Dec. 2010.

[6] Joao Paulo Lima, Joao Marcelo Teixeira and Veronica Teichrieb. RGB-D Based Detection of Texture-Less Planar Objects Applied to an AR Jigsaw Puzzle. 2014 IEEE Virtual Reality (VR). 29 March–2 April 2014.

[7] Vinicius Emanuel Silva, Caio Lins and Andre Silva. Voxar Puzzle: An Innovative Hardware/Software Computer Vision Game for Children Development. 2015 XVII Symposium on Virtual and Augmented Reality. 25–28 May 2015.

[8] Gunnar Liestol. The Photo Positioning Puzzle. 2018 3rd Digital Heritage International Congress (DigitalHERITAGE) held jointly with 2018 24th International Conference on Virtual Systems & Multimedia (VSMM 2018). 26–30 Oct. 2018.

[9] Juan Garay – Cortes and Alvaro Uribe – Quevedo. Location-based augmented reality game to engage students in discovering institutional landmarks. 2016 7th International Conference on Information, Intelligence, Systems & Applications (IISA). 13–15 July 2016.

[10] Marco Aurelio Pellens, Marcelo Da Silva Hounsell and Andre Tavares da Silva. A Systematic Literature Mapping. 2017 19th Symposium on Virtual and Augmented Reality (SVR). 1–4 Nov. 2017.

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Application of Quality Control Tools to Eliminate Defects in 3D Printing Machine

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ABSTRACT

With the introduction of additive manufacturing technology, 3D printing has become an essential part of engineering it has found applications in industries like automobile , aerospace, medical , civil constructions to name a few. Some of the widely used 3D printing technologies are Stereolithography (SLA), Selective Laser Sintering (SLS) and Fused Deposition Modeling (FDM) which constitutes almost 70% of the total 3D printing that is used today. Every technology comes with its own set of problems, one such problem that is focused on in this paper is the weak or no adhesiveness between the layers of the material and the print bed of the FDM based 3D printer which could lead to undesired shape of the part and cause other defects like warpage. To eliminate these problems, the process improvement methodologies which include the quality control tools such as Fish-Bone Diagram, Failure Mode Effect Analysis (FMEA) and Fault Tree Analysis (FTA) had been implemented. It was found that calibration, orientation and cleaning of the print bed could eliminate the problem in most of the cases in which the material used for printing was Polylatic Acid (PLA) plastic , it is recommended to use adhesive like hairspray, glue sticks or Dimafix which could be applied on the print bed before printing materials like Acrylonitrile Butadine Styrene (ABS) plastic , or in general maintaining the bed temperature of 60°C to 70°C while printing PLA and 100°C to 120°C while printing ABS, increasing the print bed contact area in the design of the part could eliminate this problem.

Keywords: *Warpage, Stereolithography, Failure Tree Analysis, Fused Deposition Modelling, Cause and Effect Diagram*

1. Introduction

3D Printing also known as additive manufacturing is one of the rapidly developing technologies in the world of manufacturing. In this process the object is created by the method of addition of the material as opposed to the conventional manufacturing method where the material is removed or subtracted from the main material in order to get the desired object [1]. The major cause of such an expansion of additive manufacturing technology is the easy learning and implementation of the 3D printing, and an object can be developed in a faster pace and if any design changes are required it can be done almost immediately. It is also easy to produce complex geometries in 3D printing, otherwise a special step up would be required every time in conventional manufacturing. [2]

There are many types of 3D technologies that used and many are in development stage, few of the popular and most widely used 3D printing technologies are, Stereo lithography (SLA), Selective Laser Sintering (SLS), Digital Light Process (DLP).This work focus on Fused Deposition Modeling (FDM) type 3D machine. 3D ting machine from Global 3D Labs as shown in Fig 1. Below, is been used for the quality control process.

Fig. 1: FDM Machine

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In FDM based 3D printers, the fibres of plastics such as Ploly Latic Acid (PLA) or Acrylonitrile Butadine Styrene (ABS) are put together layer-by-layer onto each other and later when the fibres are cooled the layers form a strong bond between them [3]. One of the problem that arises in FDM based printers is the non-adhesiveness of the first layer of the plastic to the print bed of the machine shown in Fig. 2, which leads to warping problem. To eliminate the problems caused due to non-adhesiveness, quality control tools such as Cause and effect diagram, Failure Mode Effect Analysis (FMEA) and Fault Tree Analysis (FTA) are used.

Fig. 2: Sample Before Implemention of 7 Quality Control Tools

2. Cause and Effect

Cause and effect diagram also known as fish bone diagram is used to identify all the possible causes that lead to the already defined problem. [4]

The steps involved in creating a cause and effect diagram are:-

- Identifying the problem (effect)
- Identifying the major factors
- Identifying the causes
- Analysis of the diagram

In this work the main effect was warping or filament not sticking to the bed. After knowing the problem a brainstorming session was conducted with the stake holders. The main aim of the brainstorming session was to formulate the major categories for the causes of the problem.

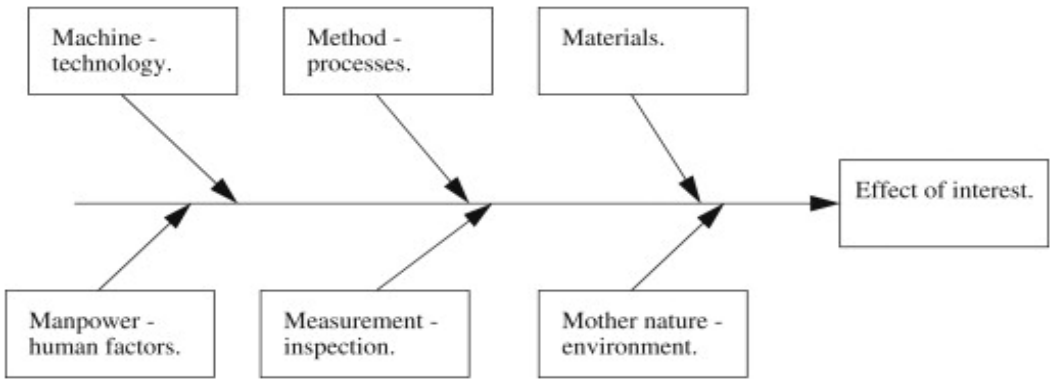

Fig. 3: General Cause and Effect Diagram

These are the major categories among these machine, materials and environment where applicable to problem statement. To find the root cause of warpage a new cause and effect diagram was built by considering only three parameters viz Machine, Materials and Environment shown in Fig. 4.

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- **Machine:** In machine the causes include cooling fan, bed temperature, bed alignment, nozzle height.
- **Material:** In material the causes include bed temperature needed for PLA and ABS materials, which is 60-70° C for PLA and 100-120°C for ABS material.
- **Environment:** In environment the causes include heated enclosure, direct cooling, dust, grease or oil surface.

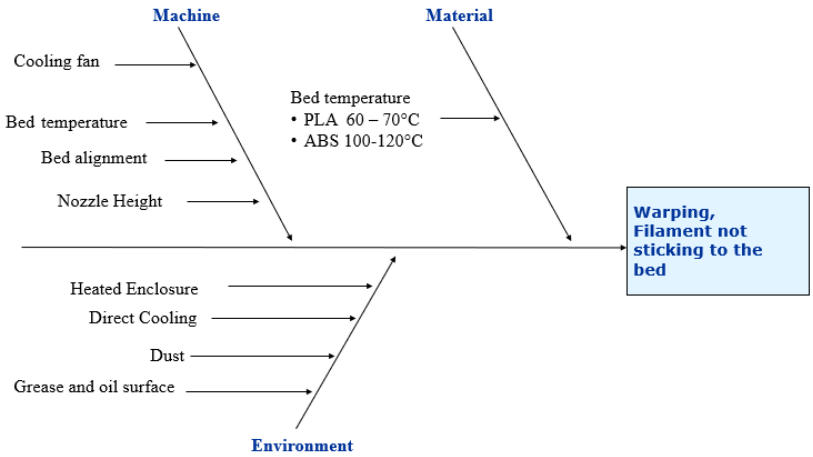

Fig. 4: Cause and Effect Diagram for Warpage

3. Failure Mode and Effect Analysis

Failure Mode and Effect Analysis (FMEA) is a method which is designed to identify and fully understand Potential Failure Modes and their Causes and effect of failure on the system and end user for a given product or process [5]. FMEA chart for warpage problem is shown in Table 1

Table 1: FMEA Chart for 3D Printer

Item/Function	Potential modes of failure	Potential effects of failure	SEV	Potential cause of failure	OCC	Prevention	Detection	DET	RPN	Recommended actions
3D printing machine/ formation of an object through 3D printing machine	1.Machine a. Cooling Fan b. Bed temperature C. Bed alignment d. Nozzle height	1. a. effects in the deposition of filament in the upcoming iterations. 1 .b. The first layer does not stick to the bed. 1. c. improper deposition. 1. d. Improper position of filament.	8	excess and unwanted material remains on object after printed. And is called Stringing because excess and unwanted material resembles strings. And finished part doesn't have exact dimensions.	6	Proper Maintenance Of machine.	Through Improper deposition of the filament.	5	240	Regular checkup and proper maintenance
	2. Environment a. heated enclosure b. dust	2. a. Leads to accident. 2. b. Causes weak joints.	6	Overheating leads to accident in the process	5	Should maintain room temperature	Over and under extrusion	4	120	Proper maintenance of surrounding and room temperature
	3. Adhesion Problems a. 1st layer printing too fast	3. improper deposition of filament	10	First layer of the part will not be sticking to the bed.	4	Surface of the bed should not be smooth.	By seeing filament deposition in the initial stage	4	160	Consideration of proper material for bed and proper support should be given for overhanging structure

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Some of the potential failure modes that observed in this case were due to flaws in machine; caused due to environment, or due to adhesion problem. In machine the failure may take place by various parameters such as cooling fan, Temperature and alignment the bed and Nozzle height. When considering environment as failure mode it is due to heated enclosure and dust. If the cooling fans in the machine undergoes failure it effects in the deposition of filament in the upcoming iterations. Similarly if there is a variation in the temperature the first layer does not stick to the bed and improper bed alignment will lead to improper deposition. If there is any fluctuations in the nozzle height then it would lead to improper filament position. If there are any variations in the environment it leads to accident and may lead to formation of weak joints. The severity ranking number is given as 8 for machine and 6 for failure caused due to environment. Adhesion parameter plays a key role here so severity value is assigned as 10.

Excess and unwanted material remains on object after print is called stringing as they resemble strings. Finished part which don't have exact dimensions and overheating leads to accident in the process. If there is adhesion problem then first layer of the part will not be sticking to the bed. The occurrence rank value is assigned as 6, 5 and 4 for the respective failure modes.

All these parameters which lead to failure of a product can be prevented by Proper Maintenance of machine and by maintaining the room temperature and also by smoothing the surface of the bed. Detection is carried out through improper deposition of the filament and also by over and under extrusion and by seeing filament deposition in the initial stage. With regard to it the values 5, 4, 4 are assigned for respective failure modes. The risk priority number (RPN) is obtained by taking product of the severity, occurrence and detection value. Suitable recommended actions are taken in order to prevent failure of the product. Some of the recommended actions that is considered here are to carry out regular check-up and proper maintenance of machine and which also includes maintenance of surrounding and room temperature followed by consideration of material for bed and proper support should be given for overhanging structure.

4. Failure Tree Analysis

Failure Tree Analysis (FTA) is a systematic method to identify undesired events (faults) in a system. Often these faults are safety and reliability issues [6]. FTA is a top downl approach. It starts at top with undesired event and

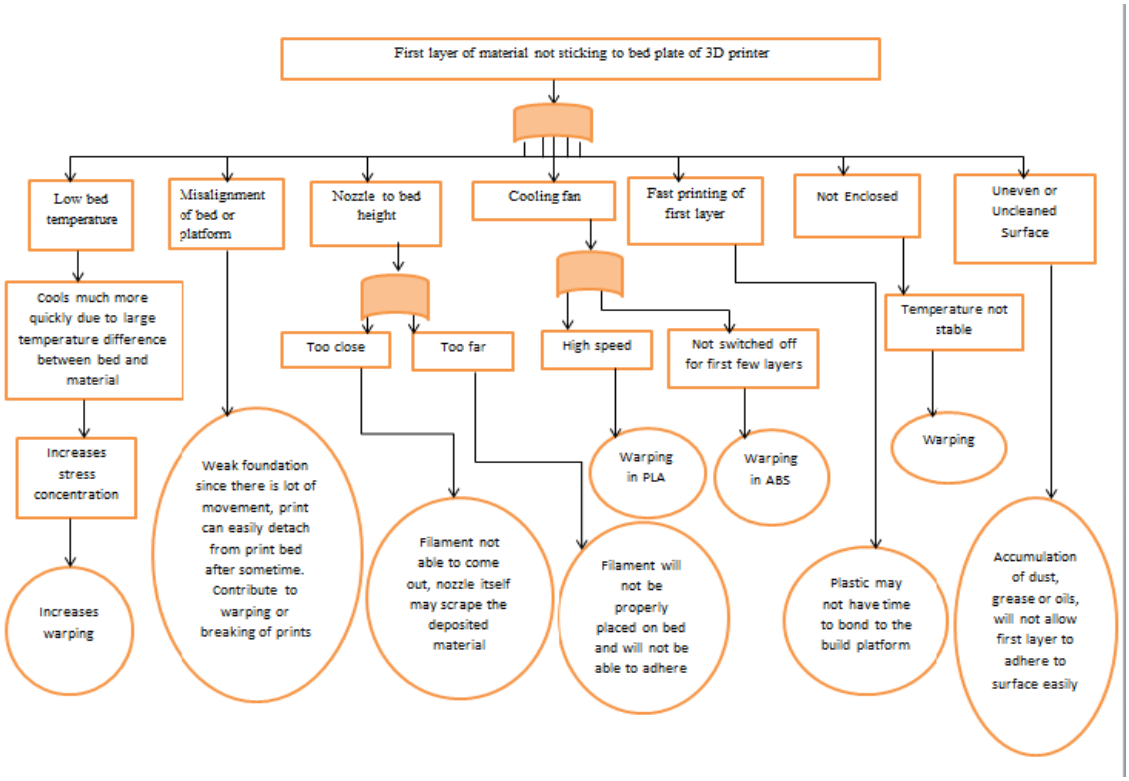

Fig. 5: Failure Tree Analysis Diagram

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develops in a tree-like fashion all potential causes for that event. It considers component failure, sub-assembly failure, operating conditions and human errors. It is basically a logic diagram in which logic gates are used to determine relations between input and output events [7]. Fig. 5 is FTA of adhesiveness problem related to first layer of 3D printed object. It starts with defining of undesired event. In this case, it is first layer of material not sticking to bed. There are primarily 7 main causes for the above undesired event viz. Low bed temperature, misalignment of bed or platform, nozzle to bed height, cooling fan, fast printing of first layer, and not enclosed, uneven or uncleansed surface. These are output or intermediate event. So, they are placed in rectangular boxes. The intermediate events are further scrutinized into sub-events as shown in FTA chart. These events if terminate to failure, they are represented by independent event symbol. If they are still having further events or sub-causes, they are represented by intermediate symbol as shown in FTA chart. It is important that the first layer of the print is strongly connected to the printer bed or platform, so that the reminder of the part can be built on the foundation. If first layer has adhesive problem with the platform, it is going to create the problem for rest of the print and can result in warping. Some ways to cope up with this issues are:

- Printer comes with adjustable bed with several screws or knobs that control the position of the bed. If the print bed in not horizontal, one side of the bed will be too close to the nozzle and the other side will be too far, which could result in the improper printing of the first layer. Therefore it is very much necessary to maintain the position of the printing platform.
- Once the bed platform is adjusted, care to be taken to make sure nozzle starts from the optimum height relative to the build platform. For good adhesion of first layer to the built platform filament has to be slightly squished against the build plate.
- Providing rafts when printing the smaller parts would provide proper area for adhesion at the interface eliminates the problem of warping.
- Different plastic tends to adhere better to different materials. Kapton tape provide good adhesion at higher temperature. It is recommended to use these tapes while printing ABS material. Likewise buildtak Flex plate would provide proper adhesion while printing PLA material.

The Implementation of above solution resulted in elimination build platform adhesion problem. Fig. 6 shows the product with little warpage compared to high warpage in Fig. 2 .

Fig. 6: Sample after implemention of 7 Quality Control Tools

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Conclusions

The warpage of the component leading to defective product fabricated by 3D printing was studied using quality control tools viz. Cause and effect diagram, Failure mode effect analysis and Failure tree analysis. Based on the study the following conclusions are drawn:

- Filament tends to shrink as it cools from a higher temperature. For ABS material, the extruder would be printing it at 230°C to 240°C, if the print platform is maintained at room temperature, it would result in shrinking of the filament as and when the material comes in contact with the platform resulting in the improper adhesion and ultimately leading to the warping. So it is important to maintain the initial bed temperature of the platform to avoid immediate shrinkage. 60°C to 70°C bed temperature while printing PLA material and 100°C to 120°C bed temperature while printing ABS material is recommended.
- Printer comes with the cooling fan, it is important to keep the cooling fan off for the initial time of print so as to ensure the proper adhesion between print bed and the first layer of the print.
- Uncleansed or the left overs of the previous prints would create problem for the first layer of the print. The dust or grease or oil doesn't allow the filament to bond perfectly with the platform. So it is recommended to clean the surface after each print.

References

[1] Dudek, P. F. D. M. FDM 3D Printing Technology in Manufacturing Composite Elements. Archives of Metallurgy and Materials 58.4 1415-1418,2013

[2] Kopsacheilis, Charalampos, et al. In Situ Visual Quality Control in 3D Printing. VISIGRAPP (3: IVAPP). 2020.

[3] Chua, Chee Kai, Chee How Wong, and Wai Yee Yeong. Standards, quality control, and measurement sciences in 3D printing and additive manufacturing. Academic Press, 2017.

[4] Magar, Varsha M., and Vilas B. Shinde. Application of 7 quality control (7 QC) tools for continuous improvement of manufacturing processes. *International Journal of Engineering Research and General Science,* 2.4, 364-371,2014

[5] Kim, Hoejin, Yirong Lin, and Tzu-Liang Bill Tseng. A review on quality control in additive manufacturing, *Rapid Prototyping Journal,* 2018

[6] Huang, Tingting, Shanggang Wang, and Ketai He. Quality control for fused deposition modeling based additive manufacturing: Current Research and Future Trends, 2015 First International Conference on Reliability Systems Engineering (ICRSE). IEEE, 2015.

[7] Zagidullin, R., *et al.* Development of a Methodology for Eliminating Failures of an FDM 3D printer using a failure tree and FMEA analysis. *Journal of Physics: Conference Series*. Vol. 1925. No. 1. IOP Publishing, 2021

[8] Baş, Hasan, Sermin Elevli, and Fatih Yapıcı. Fault Tree Analysis for Fused Filament Fabrication Type Three-Dimensional Printers, *Journal of Failure Analysis and Prevention* 19.5, 1389-1400, 2019

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A Critical Thinking for Gen Z -Multidisciplinary Approach

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ABSTRACT

Gen Z first of all we must be clear about the meaning of this word, so basically Generation-Z which is mostly known by its alternate name i.e., GEN Z comprises the people between 15 years to 25 years. As in this growing era where everything is running with the 5G speed in fact this generation also, where talents are countless, but the infrastructure of education is not as per the demand. We know that lack of deep knowledge causes a weak base so it's must for the education fraternity to make a big change and take an initiative of teaching students in such a way that impairs their critical thinking. Their capacity of doing something innovative is losing in the entertainment of passive visual platforms (You Tube, Instagram). GEN Z's some of the characteristics are- read elaborate learning, do not keep attention for long periods. We cannot deny that critical thinking is the core of something new. Critical thinking develops self-directed learning and confidence, independence as well as the interest towards learning new in the students. We have many examples in history which describe the importance of deep thinking. One of the credits goes to Buddha who described about the truth of the life. Buddha has also given many theories that were accepted by great psychologists in the world. Serious thoughts are necessary courses for the secure, capable and clever nursing practice. The health learning courses ought to accept attitudes that endorse grave thinking and assemble the skills of a significant way of thinking (*Papathanasiou et al., 2014*). And for science and engineering, grave thinking is at the mind of systematic query. A high-quality scientist is solitary who not at all stops asking why things happen, or how things happen. Knowledge adapts development while collecting information with the intention of contradicting our existing technical thoughts. Decisive thoughts can be formed by absorbed education behavior and it has been proven by many formalists of the historic era. The capacity to feel gravely about a topic- to investigate a problem, location, or dilemma losing to its nearly all vital parts - what finds us appraising the truth in addition to frankness of statements, blames, and data we study and pay attention to. Deep philosophy is measured elastic ability, which resources its cleverness natural in private Trade Analyst. Analytical people stand out at what time they're capable of decisively inspecting matter in addition to approach up by means of an explanation - an input procedure in the position of a Market analyst, Accountant, Criminologist, Logistics Manager, Legal Secretary etc. Hence it is very important and needs time to relate the study of everything in education with the critical sense, problem-based learning, culture and perseverance.

Keywords: *Critical thinking, Medical Thinking, Research, GEN Z, Education Sector, Management, Social Media*

1. Introduction

The **objective of this study is to suggest some ideas to implement serious thinking in GEN Z and actions to be taken in reducing the gap in the present education system to enact the critical thinking in GEN Z**. Generation Z is the base of the upcoming future world of our society. The growth of different competences in young groups of ages 15 to 25 depicts a certain face because it is the period when they are aggressively making their corrective competencies. In COVID-19 virulent disease, the nursing employees have established bravery, firmness and dedication in the face of challenges. To prepare the students of nursing about the workforce environment and make them learn proper nursing, the nurse educators handled all these tasks in a better way. Most of the students are GEN Z now (*Hampton & Keys, 2017).* Some of the core points to make this education system better for the GEN Z are as follows:

2. Decisive Thoughts

Deep thinking is "a program of curious, analysis, fusion, reading, supposition and empirical way of thinking, perception, submission, and originality". GEN Z needs basics of consideration: rationale and dilemma discovery,

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thought illumination *(Hawkins, Paul and Elder, 2010)*. Precise attitude are fundamentals for improving critical thinking. Nurses GEN Z group in development to be trained and relate decisive thoughts are supposed to extend self-determination of attention, equality, perceptiveness in special and public level, modesty, religious bravery, reliability, firmness, assurance, concern for exploration and snooping. The word Critical Thinking refers to the ability to understand writing and absorb in sequence plus create judgments based on the information by the lens of impartiality and one's possessive consideration processes as an alternative of beliefs on others to create the result of realistic thoughtful opinion paying attention on deciding what to judge or carry out.

2.1 Trouble Based Education (TBE)

It is a scholar-focused training where student be taught regarding a theme by solutions of an open-ended problem established in activated substances. The TBE process is effective in little groups of learners. In this, a small category of scholars examines a trouble, depict appropriate essentials, and examine presented information and occurrence to resolve a trouble (Alexander *et al.*, 2002).

2.2 Technological Challenges in Entry-level Jobs vs Gen Z

As Generation Z outward the challenges of the technological jobs in this running era, how can they step into this fast-changing world? So, it's the need of the present time to give the education system techno-based services also. GEN Z has a lot of talent which only needs a better direction with the required resources.

2.2.1 Traditions

To one side from reconsidering the aptitude plan and processes. GEN Z ought to recompense vigilant awareness to how the civilization may need to develop account for shifting labor force fondness and principles and stay paying attention on constructing a comprehensive and broad civilization.

2.2.2 Recognised Progress

Formal development programs should be included in the through manners of the study. It is described as in cooperation obtainable talent barrier with the intention of GEN Z can contain, generate, implement communications that organization desires to quickly move satisfied outlook requests.

2.2.3 Talent

It is the duty of the education fraternity to highlight the talent from the crowd of students. Each student has a various talents but it's must for the teachers to let it out. Do not think the weak students out of the race but to make them ready for the future world with the substance learning and challenging environment.

2.2.4 Tasks

The tasks handling activity and challenge handling nature should be in the learning of the GEN Z study to prepare them for the future challenges in their work area. It is mandatory to keep them aware about the surrounding nature of the challenging society and teach them sharp mind.

Result and Discussion

In this paper, we have suggested some of the techniques like TBE, Talent and Tasks etc to give better ideas to the present education fraternity and can reduce the gap between the current education systems in implement critical thinking in GEN Z. Some renowned scientists provided a vision about incorporating critical thinking across the curriculum in higher education. Trouble based learning can have the power to impark the idea of a new innovation in the young generation; it has the ability to learn new things and think critically (*Ennis, 2018*). The majority of researchers and cycologists therefore declare with the intention of unite serious thoughts by the prospectus (*Hatcher, 2013*). At hand it is alike example in the middle of GEN Z who think seriously in various domains, might carry out in a various way in originality for the reason that of dissimilar thoughts fads (*Haller and Courvoisier, 2010*)

Conclusion

GEN Z highlighted some of the skills like forward-thinking, gadget-freak and the wide-ranging age group (*Chicca et al., 2018*). In contrast, instructors should seek that GEN Z has skills to learn differently from the past generations. The ideas outlined in this paper like TBE, Tasks etc. depict some of the changes needed in the education system

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while teaching GEN Z. Government must focus on the changes needed by the new generation in education to take benefit of their rising talent (*Jones M et al., 2008*). Numerous, well-life form and elasticity, appear a normal result of practices that institutions have initiated to accept above the history decade. In each crate, this paper emphasizes the benefit of this utilization in the education of GEN Z.

References

[1] Adesina, P (2019). Why sustainability really matters to Millennials and GenZ even during Christmas.The Telegraph. Retrieved from https://www.telegraph.co.uk/christmas/0/sustainabilty-really-matters millennials-gen-z-even-Christmas/.

[2] Aich TK (2013). Buddha philosophy and western psychology. Indian J Psychiatry. 55; (2): 165-70. https://www.indianjpsychiatry.org/text.asp?2013/55/165/105517.

[3] Alexander J.G., McDaniel G.S., Baldwin M.S., Money B.J (2002). Promoting, applying and evaluating problem-based learning in the undergraduate nursing curriculum. Nursing Education Perspectives. 23(5):248-253

[4] American Association of Colleges of Nursing [AACN] (2008). The Essentials of Baccalaureate Education for Professional Nursing Practice. http:/www.aacn.nche.edu/educationresources/ [Pub Med] [Google Scholar].

[5] Chicca J, Shallenberger T (2018). Connecting with Generation Z: Approaches in nursing education. Teaching and Learning in Nursing. 13(3):180-184. doi:10.1016/j.teln.2018.03.008. [Cross Ref] [Google Scholar].

[6] C.S. Haller, D.S. Courvoisier (2010). Personality and thinking style in different creative domains. Psychol. Aesthet. Creat. Art. 4(3): 149.

[7] D.L. Hatcher (2013). Is critical thinking across the curriculum a plausible goal? OSSA. 69. http://scholar.uwindsor.ca/ossaarchive/OSSA10/papersandcommenta.

[8] Hampton D., Keys Y (2017). Generation Z students: Will they change our nursing classrooms? Journal of Nursing Education and Practice. 7(4):111-115. doi: 10.5430/jnep.v7n4p111.

[9] Hawkins D., Paul R., Elder L (2010). Foundation for Critical Thinking Press. The Thinker's Guide to Clinical Reasoning. www.criticalthinking.org.

[10] Hodges H.F (2011). Preparing new nurses with complexity science and problem-bases learning. Journal of Nursing Education. 50(1):7-13.doi:10.3928/01484834-20101029-01.

[11] Jones M (2008). Developing clinically savvy nursing students: An evaluation of problem-based learning in an associate degree program. Nursing Education Perspectives. 29(5):278-283.

[12] Klunnklin A., Subpaiboongid P., Keitlertnapha P., Viseskul N., Turale S (2002). Thai nursing student's adaption to problem-based learning: A qualitative study. Nurse Education in Practice. 11(6):370-374. doi: 10.1016/j.nepr.2011.03.011. [Pub Med][Cross Ref][Google Scholar].

[13] Litman-Ovadia H., Lavy S (2016). Going the extra mile: Perseverance as key character strength at work. Journal of Career Assessment. 24 (2): 240-252.doi:10.1177/1069072715580322.

[14] Papathanasiou IV, Kleisiaris CF, Fradelos EC, Kakou, Kourkouta L (2014). Critical thinking: the development of an essential skill for nursing students. Acta Inform Med. Aug; 22(4): 283-6. doi: 10.5455/aim.2014.22.283-28613. Epub 2014 Aug 21. PMID: 25395733; PMCID: PMC4216424.

[15] R.H. Ennis (2018). Critical Thinking across the curriculum: A vision. Topoi. 37(1): 165 – 184.

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Cost of Medicines, a Sheer Effect of Marketing Strategy

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ABSTRACT

Medicine/Drug prices are majorly governed by the expenses behind it. What if the marketing expenditure is more than that of the development costs? GlaxoSmithKline invested 11,402 million dollars on Marketing and Sales and a mere $4568 million on the actual R&D of the medicines. Similar with Pfizer spending 14,350 million dollars on marketing and just $8650 million on R&D. Another pharma giant Novartis doing the same with a heavy investment of 14,369 million dollars on marketing and just $9,402 million on actual research and development costs. In every case marketing cost is thrice the development costs and a similar pattern is followed by most of the pharma companies on the planet. Pharma companies tend to spend millions on just marketing the medicines and a reaction to which is the increased costs. The concept of lobbying doctors by the pharma giants has by far always proven to be the biggest reason behind the costly medicines. To ensure government support for approvals and pricing, and to enforce patent laws across the world, the pharmaceutical industry spends a fortune on lobbying. IMS, a firm specializing in pharmaceutical market intelligence, does analysis on pharmaceutical promotional expenditures whereas CAM as a global company which does auditing of expenditures on promotions and marketing of pharmaceutical companies. IMS, a firm specializing in pharmaceutical market intelligence, does analysis on pharmaceutical promotional expenditures whereas CAM as a global company which does auditing of expenditures on promotions and marketing of pharmaceutical companies. Data from IMS and CAM both hint that the average expenditure on cost of a sales representative's visit to a physician, the cost of the training, and the cost of detail aids such as brochures and advertising material is too high and has a direct impact at the overcall costs of medicines that can easily be brought down by these company, if they reduce such costs on advertisements and medical representatives. use of an application to promote and educate doctors on the medicines would be a big step towards reducing the cost incurred by the companies on such endorsements and expenditure on medical representatives which would thus result to lowering of the cost of drugs manufactured by them. And the that a standardized availability of medicines of all companies would have transparency in their costs and would also affect the marketing strategies of pharma giant

Keywords: *Drug Prices, Pharmaceutical Exploitation, Medical Marketing, Medicine Price Inflation*

1. Introduction

How do doctors decide what to prescribe? This is a surprisingly complicated issue, and to feel our way through it we need to think about the four main players exerting pressure: the patient, the funder, the doctor, and the drug company. The exciting future, for evidence-based medicine, is an information architecture that can get the right evidence to the right doctor at the right time. Does this happen? The simple answer is no. Although there are many automated systems for disseminating knowledge, for the most part we continue to rely on systems that have evolved over centuries, like the long, meandering essays in academic journals that are still used to report the results of clinical trials.

The amount spent on pharmaceutical promotion versus research and development is central to the debate around whether the pharmaceutical industry is primarily driven by innovation or marketing. Medicine prices are majorly governed by the expenses behind it. What if the marketing expenditure is more than that of the development costs? [3]

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Pharmaceutical Company	2019 Annual Revenue (in millions)	Money (in millions) Spent on Research & Development	Money (in millions) Spent on Marketing and Sales
Eli Lilly	$22,320	$5,595	$6,204
GlaxoSmithKline	€21,891	€4,568	€11,402
Pfizer	$51,750	$8,650	$14,350
Novartis	$34,252	$9,402	$14,369
AbbVie	$33,266	$6,942	$7,439

IMS, a firm specializing in pharmaceutical market intelligence, does analysis on pharmaceutical promotional expenditures whereas CAM as a global company which does auditing of expenditures on promotions and marketing of pharmaceutical companies.

Type of Promotion	IMS (US$ Billions)	CAM (US$ Billions)	New Estimate (US$ Billions)	Per cent of Total of New Estimate
Sample	15.9	6.3	15.9 (IMS)	27.7
Detailing	7.3	20.4	20.4 (CAM)	35.5
DTCA (Data provided by CMR)	4	4	4 (CMR)	7
Meetings	nd	2	2 (CAM)	3.5
E-promotion, mailing, clinical trials	nd	0.3	0.3 (CAM)	0.5
Journal advertising	0.5	0.5	0.5 (CAM/IMS)	0.9
Unmonitored promotion (estimate*)	nd	14.4	14.4 (CAM)	25
Total	**27.7**	**47.9**	**57.5**	**100**

*Includes incomplete disclosure and omissions by surveyed physicians, promotion to unaudited physician categories, promotion in unmonitored journals and could possible include unethical forms of promotion funded out of the firms' DTCA direct-to-consumer advertising; nd, no data

Data from IMS and CAM both hint that the average expenditure on cost of a sales representative's visit to a physician, salary, benefits, costs for the area and regional managers, the cost of the training, and the cost of detail aids such as brochures and advertising material is too high and has a direct impact at the overcall costs of medicines that can easily be brought down by these company, if they reduce such costs on advertisements and medical representatives. [2] Should physicians interact with pharmaceutical sales representatives or not is a question that is required to be undergone careful ethical analysis. Data suggests that dealings with pharmaceutical reps will affect the impaired services that the doctor had to offer to the patients.[5] In an accounting study Lauzon and Hasbani one of the largest global pharmaceutical firms globally spent a total of US$739 billion on marketing and administration. Medical representatives are employed to market their company's products, whilst health professionals need to be most concerned about providing services to the patients.

Year	Total R&D Spending ($000)	Promotion spending ($000)			
		Detailing and Journal Advertising Top 50 Drugs	Estimated Total Promotion Based on Data form 2002–2005	Promotion for top 50 Drugs	Estimated Total Promotion
2013	798,300	550,871	912,000	1.45	0.88
2014	792,200	552,797	916,000	1.43	0.86
2015	869,100	562,926	932,000	1.54	0.93
2016	918,200	421,434	697,000	2.18	1.32

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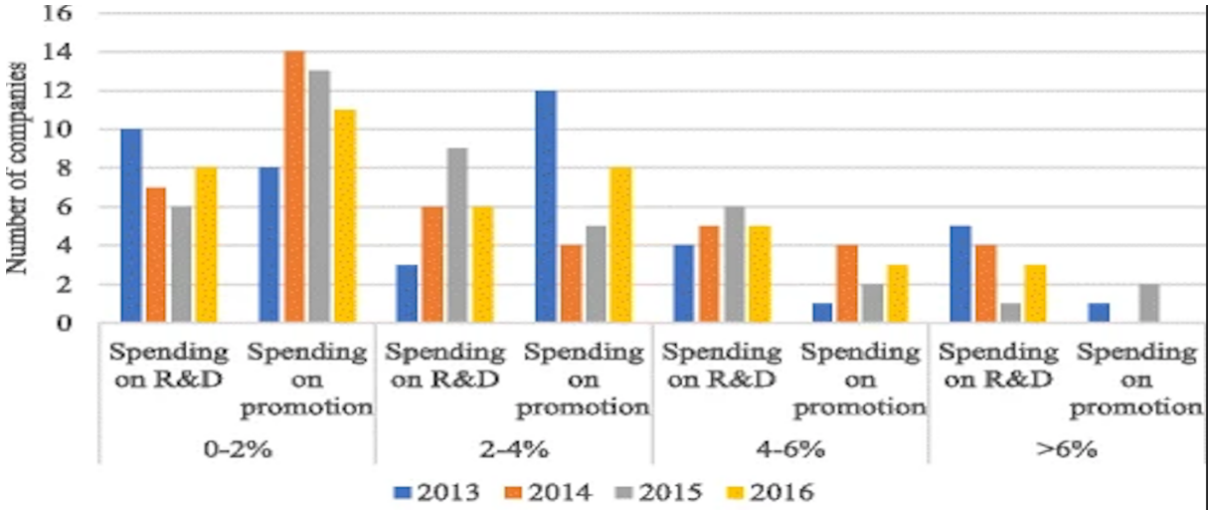
The data in the above chart clearly depicts the fact that the net expenditure on promotions of these companies is far more than the actual R&D of the companies and definitely that is a reason of increase in prices.

2. Findings

An industry combining all the companies with a patented drug, total expenditure ranged from $792,200,000 to $918,200,000. Out of which expenditure on medical representatives and doctor pooling for the promoted drugs was from $421,434,000 to $562,926,000 and the ratio of R&D to promotion spending was 1.43 to 2.18.

As from the results from [1]

All the above results prove that the medical prescriptions are biased and generally are based on the dealings of the doctor with the medical representative.



2.1 Problem Statement

- How to bring down the cost of the companies on promotions and advertisements and thus reducing the overall cost of medicines
- How to enable the common man to not fall into this trap of buying overpriced medicines even when the same formula is available at a much cheaper price
- How to increase the outreach of the doctors and thus enabling them to not fall into the trap of doctor pooling and still benefiting them with the best trades and all under the table offers
- And midway if all above points happen then how to keep the medical representatives in the chain so that there is no loss of employment in the representative industry

3. Solution

The solution to this is as always 'communication'. Any modern day application be it Ola, Uber, Swiggy, Zomato, Udaan, Dunzo, Razorpay, Pharm Easy all unicorn Indian start-ups have one and only one thing in common and that is that they have built a business over a communication gap. Similarly a gap between the company and the doctors currently being fulfilled by the medical representatives is taking up a whole lot piece of bread in the involvement of the cost of the medicine. And this is being solved here using design thinking methodologies to understand everyone's need and present a way where neither the companies have to spend much nor the doctors cut down their earnings and neither the common man should end up in paying ₹100 for a ₹10 medicine.

And the only weapon that we have in hand is the design thinking stages and methodologies

that have a set pattern to solve complex problems like these in hand .The steps involve the following stages.

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- Empathy Phase
- Definition Phase
- Ideation Phase
- Prototyping & Testing Phase

3.1 The Empathy Phase

This stage marks the start of the process where teams conduct research to get personal grasps of their user's needs.

In a small scale research of asking around 10 medical representatives and about 5 doctors and an owner of a pharmaceutical company , the results were as follows.

- 8 out of 10 medical representatives were in line with the thought process of the reduction of the medicinal cost but they were all worried with the fact that what would happen to their jobs
- 3 doctors were satisfied with the idea of not having the pain to meet medical representatives and still be in touch with the companies and getting the same deals and other benefits of recommending medicines of that particular company
- 2 doctors were literally not okay with the idea of things going online as they were in the fear that the percentage of the earnings would go down if the market becomes all open, contradictory to what it is currently
- The owner of the company **GMD pharmaceuticals**, **Mr. Dilip Gupta** who himself once was a medical representative in various companies and by sheer hard work and perseverance he now owns this company having over 200 products and over 50 employees, based in Allahabad gave the best insight about this stating that – "No doctor would want his cut to go down by allowing all the companies to have a cut throat competition over an open online market. And the small-scale companies would literally die in coping up the rates that the pharma giants can easily quote the doctors. And the Medical Representatives job would be lost which would be a blow from the back to the pharma industry"
- These statements clearly depict that the problem in hand is the pharma giants who have the monopoly and the power to manipulate the market and can easily dominate and kill the small-scale companies resulting in a much bigger loss than gain to the end beneficiary users
- One more fact that could be identified out of the statements of all people was that they all were happy with the concept that the unnecessary wastage of the money in a commodity like medicine that can be put to a better use and thus could be targeted to bring down medicine prices

Pharmaceutical Companies

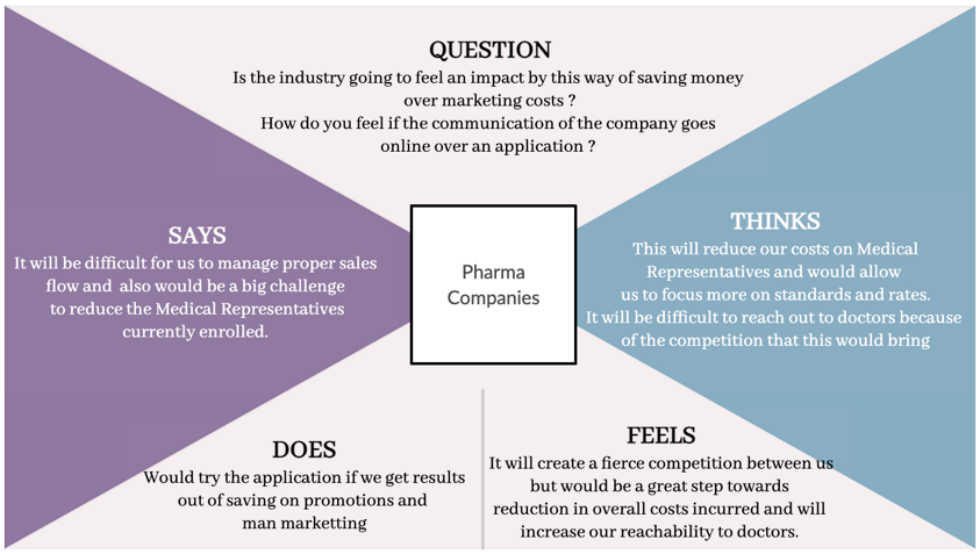

Fig. 1

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Doctor

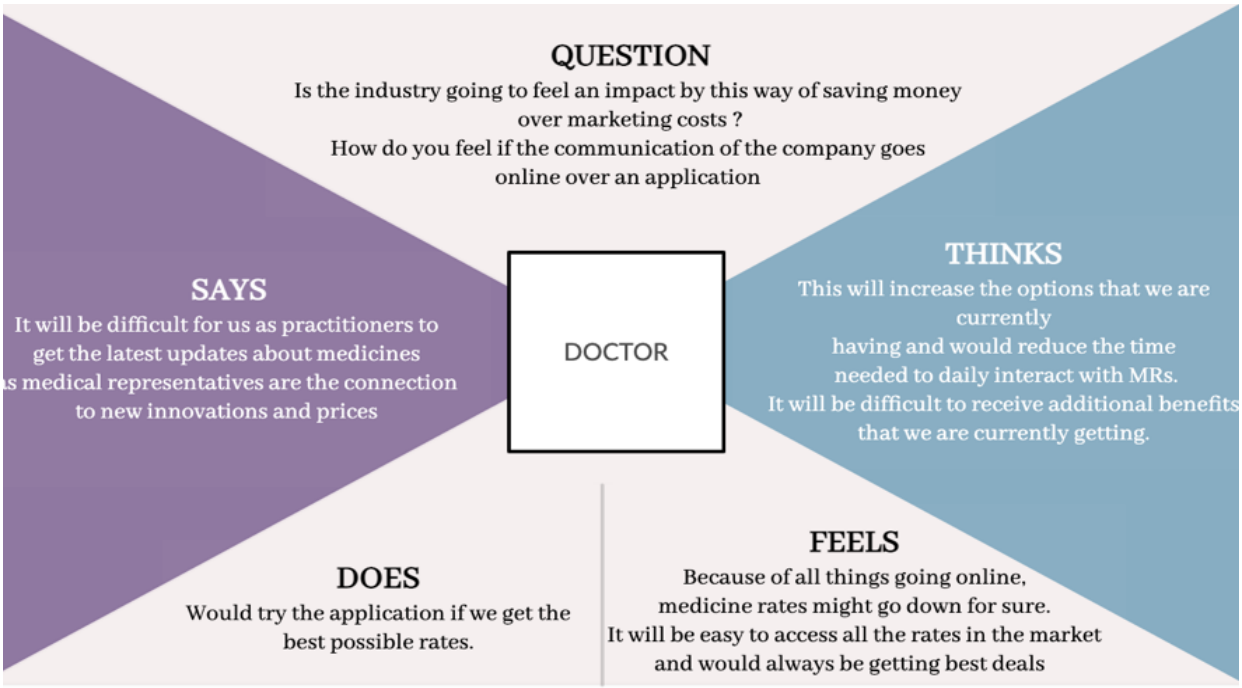
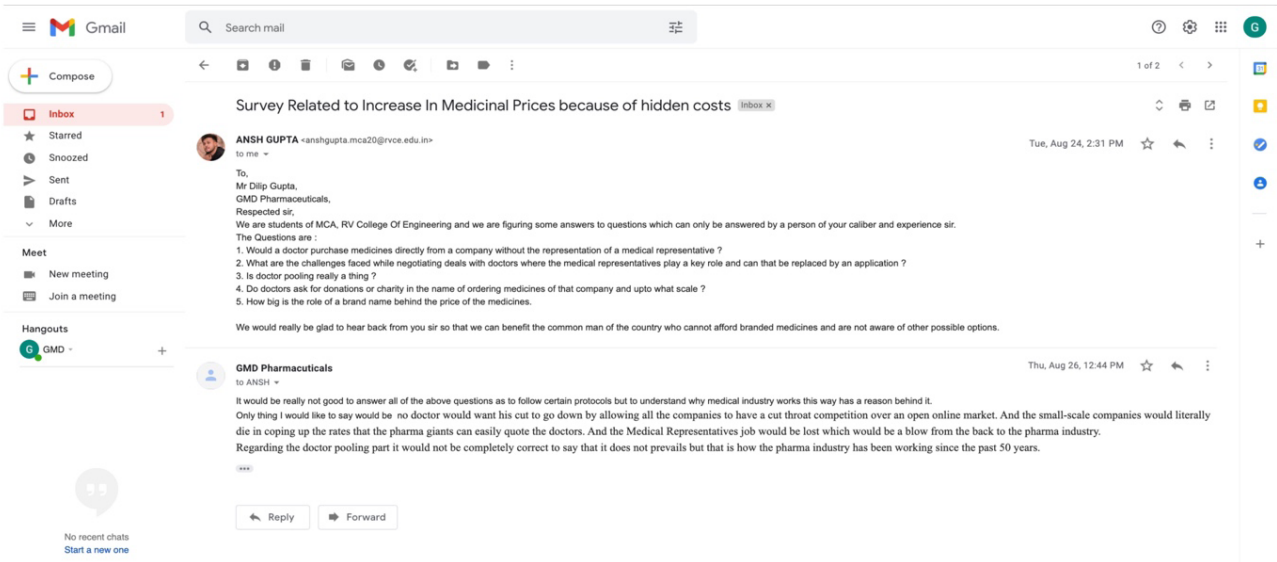


Fig. 2



3.2 The Definition Phase

After taking all the above reactions into consideration I had now reached and upgraded my problem statement. The new problem after the empathy stage was that companies would let go of the medical representatives if the doctors started responding to the efforts made online (Figure 1). Secondly how would I make the doctors to come to the online mode when currently it's all readily available for them and how would I make them believe that by going online the current benefits that they were getting would still be prevailing (Fig. 2).

So to analyse it better I created an Empathy map of the two major entities that I had in my empathy stage which is as follows:

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3.3 *Ideation Phase*

Below I have identified the prime challenge and have addressed problems related to the main four entities of the model i.e. Doctors, Medical Representatives, Pharmaceutical Companies and the Users in Brainstorming to properly identify creative solutions to previously identified problems in Figure

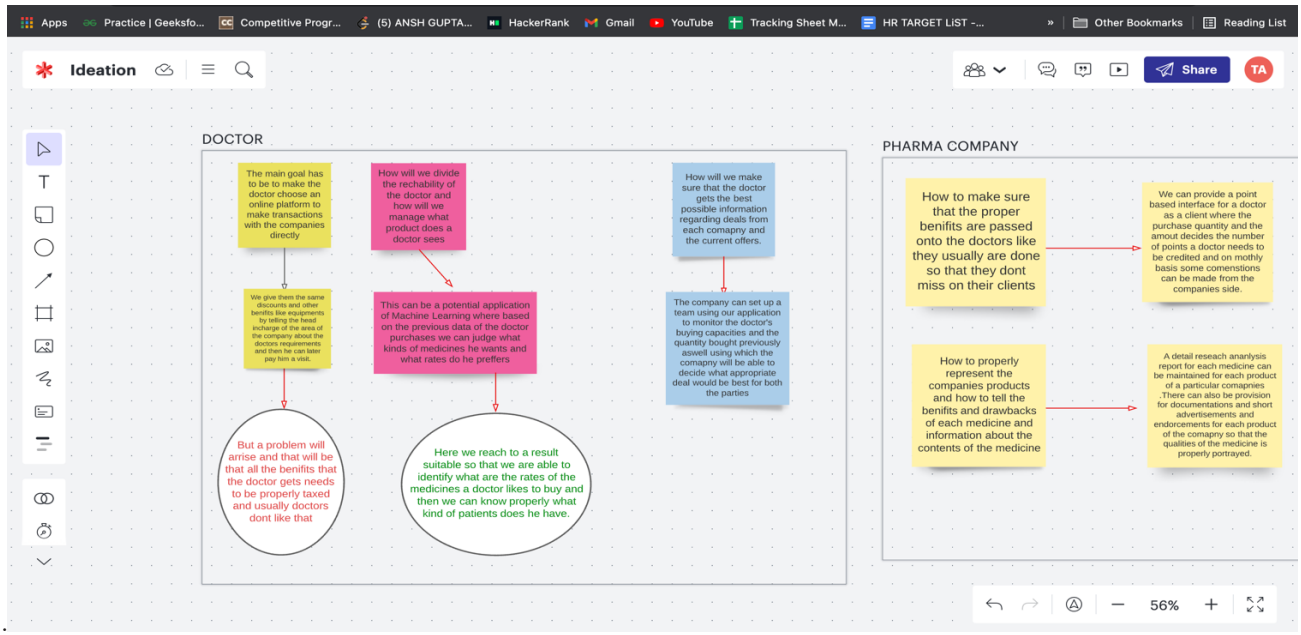

Fig. 3

3.4 *Prototype & Testing Phase*

The above model is currently under the prototypal and the testing phase. Some screen shots have been attached for reference of the application being developed. MIND MAP as a tool for prototyping in Fig. 4.

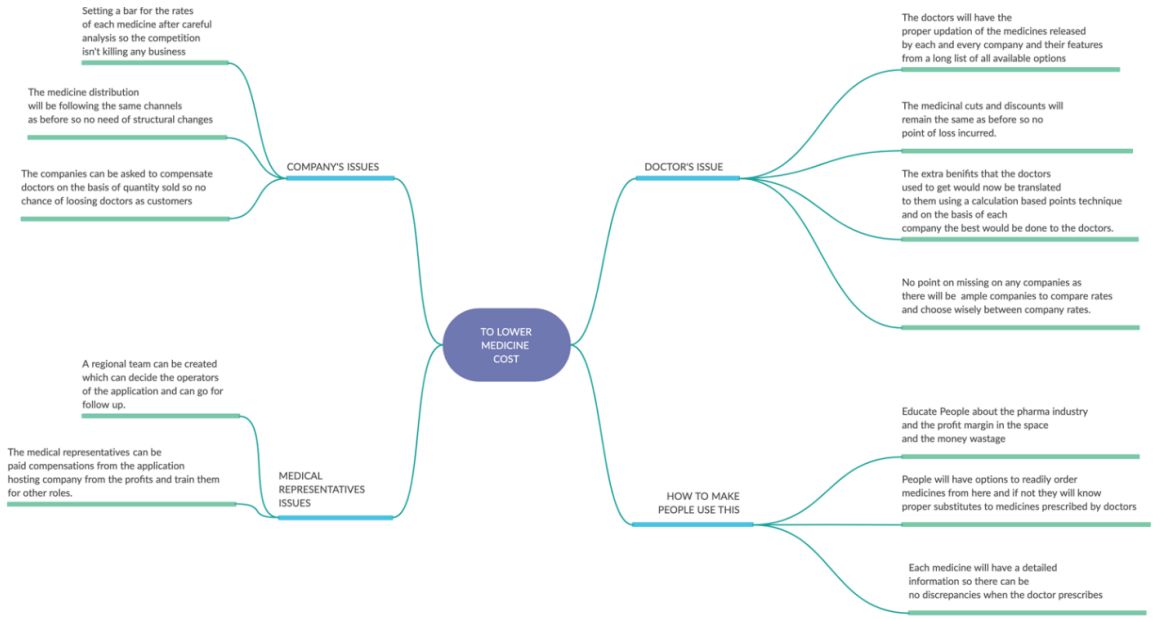

Fig. 4

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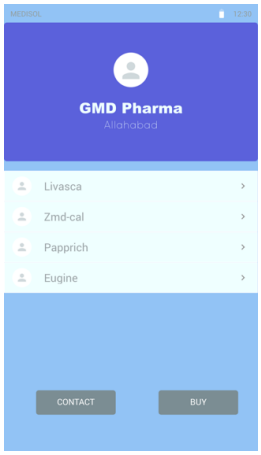

Conclusion

From the above findings and calculations, it appears that companies are spending more than twice on the marketing and promotion as they should have done on the R&D of the medicines themselves. It confirms that this is a market driven industry and proves an important point that companies should stop spending millions on marketing that can be used to either reduce the medicine prices so it reaches into the hands of the ungrateful and poor in need. This would be a step in favour of the fact that Pharma Giants should focus more on the research and less promotion.

The application can prove to be a revolutionary idea if all flaws removed, and will definitely prove to be the reason behind the price drop in medicines. And if not that at least it will educate people about the market conditions and evolution. Not forgetting the doctors that have been favouring the pharma giants, will have a sense of responsibility towards the world that medicines are a commodity required by the needful and not for mere pleasure and no extra charges or wasteful expenditures effecting the cost of those medicines should be involved.

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I have been taught, corrected, calibrated, cajoled, entertained, encouraged and informed by a very large number of people, my parents, my teachers specially Dr. Jasmine K.S, Associate Professor, RVCE who has always motivated me to take up new things and to always try.

There are tools that made this research better, those include Creately and Fluid UI and Microsoft Word.

I would thank RVCE to organize this event CTGZMA for providing us a platform to help us brainstorm and come with ideas that might revolutionize the world one day.

References

[1] https://pubmed.ncbi.nlm.nih.gov/26957869/

"A study on the interactions of doctors with medical representatives of pharmaceutical companies in a Tertiary Care Teaching Hospital of South India"

[2] https://www.pharmacychecker.com/askpc/pharma-marketing-research-development/#!

[3] https://www.raps.org/news-and-articles/news-articles/2019/7/do-biopharma-companies-really-spend-more-on-market

[4] General Accounting Office. Prescription drugs: FDA oversight of direct-to-consumer advertising has limitations. 2002. Available: http://www.gao.gov/new.items/d03177.pdf. Accessed 27 November, 2007.

[5] Hensley S, Martinez B. To sell their drugs, companies increasingly rely on doctors. Wall Street Journal. 2005 July 15. p. A1. [PubMed]

Catalytic Role of Critical Thinking in Aligning Gen Z with Atmanirbhar Bharath Abhiyan

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ABSTRACT

The advocacy for self-reliance and self-sufficiency can be traced back to pre-independent India. Its focus is on attaining autonomy in different sectors of economy with little dependence on the external economies. This necessitates designing, manufacturing, and delivering of products and services suiting the local requirements and possessing world class quality. Critical Thinking and Innovative approaches to problem solving can enable the organizations examine the context from a holistic perspective and deliver human centric solutions. This requires a relook at the prevailing practice of education where the emphasis is only on inculcating discipline specific competencies among the learners. As the generations evolve, the teaching learning methodologies must be tailored to suit their requirements. The authors suggest that Digizens of India need to be trained in transversal skills such as critical thinking along with the disciplinary competencies. This enables them to leverage their learnings in recognizing and solving the problems successfully, thereby resulting in achieving the objectives of Atmanirbhar Bharat Abhiyan. This work reviews the existing frameworks in National Education Policy 2020, aimed at promoting critical thinking among the learners and highlight the linkages among Digizens, critical thinking, and Atmanirbhar Abhiyan.

Keywords: *Self-reliance, Self-sufficiency, Critical Thinking, Digizen, Gen Z, Atmanirbhar, Transversal Skill, Competencies, Teaching Learning, National Education Policy-2020*

1. Introduction

India has witnessed several initiatives aimed at making the country self -reliant and self-sufficient since several decades. In the pre independent era the Swaraj Movement was focused on achieving self- rule, which is equivalent self - reliance in political space. During that period, this was considered to play a crucial role in moving towards a self -sufficient economy. Of course, self-reliance in this space is an outcome of being self-sufficient and self-reliant in various spheres of the economy. Swadeshi movement was one such philosophy pivotal to achieve self-rule. However, India moved away over the years from self-reliance strategy to dependence in economic development. In recent years, various factors influenced India to relook at self-reliance strategy towards economic development of the country. The Atmanirbhar Bharath can be visualized as continuation to Make in India policy of Government of India in its quest to achieve economic self -reliance and self -sufficiency.

This necessitates a significant transformation in the culture of identifying problems and delivering solutions for the betterment of the society. The legacy education system in India needs a revamp to meet the challenges. This is expected to be brought in through National Education Policy 2020 (NEP2020), with its focus on providing equal emphasis on education and skill for solving the local problems. The requisite capabilities among the learners can be inculcated by adapting appropriate pedagogical structures for teaching and assessments. The pedagogy must be designed for enabling the Gen Z learners think critically and come out with innovative solutions.

This work tries to discuss the need to instil critical thinking abilities amongst the Digizens of India. The critical role of NEP 2020 in achieving Atmanirbhar Bharat by infusing critical thinking skills among Digizens will be delineated.

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2. Essence of Atmanirbhar Bharat Abhiyan

Although there is an increased push for self-reliance globally these days, the idea of being self-reliant in India is a long one. However, in the pre independence era. The relationship between the independence movement and self-rule is an expression of political self-reliance. The latest invocation of self-reliance by India is primarily about economic self-reliance. But the nature of self-reliance is such that it is difficult to understand economic self-reliance without other forms of self-reliance, most importantly, a self-reliance of the 'self' as well as of the 'intellect' (Sundar Sarukkai, 2020).In the post-independence regime, it all started with Make in India campaign, emphasising on fostering innovation, enhance skill development ,protect intellectual property and build best in class manufacturing infrastructure in the country to deliver world class products that cater to both national and global requirements. This initiative was followed by Atmanirbhar Bharat Abhiyan. The term "Atmanirbhar" has been exercised in connection to building India "a major and a more salient fragment of the world economy", driving policies that are well organised, cut-throat, and resilient and being self-sustaining and self-generating. Atmanirbhar Bharat does not mean "Self-containment", "isolating away from the world", or being "nationalist". The first name of this came in the form of "Atmanirbhar Bharat Abhiyan" or "self-reliant India mission" during the declaration of India's Covid-19 Pandemic Connected economy package on 12th May 2020.

3. Critical Thinking Amongst Generation Z

Generation Z, commonly termed as zoomers, is the demographic cohort succeeding Millennials and preceding Generation Alpha. Researchers and popular media use the mid-to-late 1990s as starting birth years and the early 2010s as ending birth years. However, this generic definition does not fit to all cultural and social contexts. However, India needs its own definition of the Gen Z. Born after 1996, called Gen Z in America, the appropriate label for them in India is Digizens. The oldest is still under 23 years old, and none of them know the India that was before its Y2K.

The characteristics of this Generation among many others include technology and digital savviness, entertainment by passive visual platforms, read only brief pre-digested or curated texts, do not concentrate for long periods, prefer not to make cognitive efforts, use of social media stimulates only virtual relationships, write short text messages on WhatsApp or other messaging apps and expressing opinions through memes and emojis.

Based on the findings of Generational White Paper (2011), Gen Z tends to be more impatient, instant minded, lacking the ambitions of previous generations, have acquired attention deficit disorder with a high dependency on the technology and a very less attention span, individualistic, self-directed, more demanding, and materialistic (Giadhani, *et al.*, 2019).

Technology is a part of their identity, and they are tech savvy but lack problem-solving skills and have not demonstrated the ability to look at a situation, put in context, analyse it and make a decision (Singh & Dangmei, 2013).

Critical Thinking is not a spontaneous activity, but a long-drawn process aimed at enhancing the ability of an individual to conduct objective analysis and evaluation of an issue to form a judgement or arrive at an acceptable solution. The process comprises of steps such as knowledge, comprehension, analyse, application, synthesis and acting. The principles of critical thinking are clarity, fairness, accuracy, precision. relevance, depth, breadth, and logic. Techniques such as 5W and 1H are predominantly used in triggering critical thinking mindset amongst the problem solvers in organizational settings.

Several research studies in recent times indicate that Digizens are technically savvy, but they lack the right soft skills and experience to solve the problems in organizations. India with an appreciable demographic dividend, the future of work will be driven by Gen Z professionals. It is expected that the twenty first century skills can revitalise Indian economic activity. Reports indicate that the rapid advancement in technology is re-wiring the brains of Digizens, but they entirely lack critical thinking skillset. It is well documented that Gen Z have challenges in their ability to think critically and solve problems. Across industries and jobs, the emphasis is on soft skills. It is identified the top three missing soft skill sets among Digizens as problem solving/critical thinking/innovation/creativity, ability to deal with complexity and ambiguity, and communication.

4. Gen Z in Atmanirbhar Bharat

Technology is expected to play a major role in India's quest to achieve Self-Reliance. In the past couple of years, the technology has made inroads in all spheres of professional and personal environment, thereby disrupting

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the existing fabric. The Digizens are becoming conversant with digital technologies and have been extensively leveraging the same to solve issues in an independent manner. The environment is not only enabling them to be self-reliant independently but are exploring ways and means to solve the societal issues using digital technologies. This is leading to a phenomenon, where Digizens are advocating vocal for local.

The start- up culture coupled with digital initiatives which is a sine-qua-non with Digizens is fuelling the Atmanirbhar Bharat Mission.The unique characteristics of Digizens ensure they align with the mission of Atmanirbhar Bharat. However, as discussed in previous paragraphs, the Digizens need to hone their critical thinking skills.

5. Critical Thinking and Atmanirbhar Bharat Abhiyan

Critical Thinking skills play an important role in creating capabilities for self-reliance. Studies indicate that lack of critical thinking contributes to many of the challenges faced by developing societies. It is considered to support societies to question the processes for ensuring better decisions. This means that learning, particularly lifelong learning, becomes part of a development process, aimed at equipping development actors to view learning as a way of life, as a continuous process and a key focus of development. If the purpose of supporting development is to encourage self-reliance and long-term viability of projects, then development programmes need to be designed in a way that reflects that process.

The mission advocates a self-reliant India in economic sense. For achieving the objectives, it is necessary to implement bold reforms to enhance the capability of human resources along with several structural reforms. The ability of an economy and its businesses to generate and imbibe innovative changes has now become a key component of self-reliance.

The mission in its attempt to strengthen domestic industries needs to enhance the competitiveness by empowering the human resources to think critically in providing solutions to local issues along with enhanced incentivization schemes for motivating entrepreneurs. This will ensure the domestic firms to play an important role in global supply chains.

6. New Education Policy 2020 and Critical Thinking

The NEP 2020 aims at universalization of education at all levels. The document envisions to bring a paradigm shift in the prevailing education system through several structural and procedural reforms. Successful implementation of the policy necessitates to work upon challenges such as restructuring of curriculum, pedagogy, and contents. leveraging technology with the teaching and learning processes to amplify the relevant outcomes, shifting the focus of assessments from marks based to competency based and ensuring the adaptability of teachers by making them digital literates.

Gen Z attributes suggest that they are more practical than previous generations. Gen Z are good at solving problems in the structured confines of their classrooms. However, the actual work environment is a little more unpredictable, perhaps chaotic with dynamic factors influencing the outcomes. A survey conducted by SHRM State of the Workplace Report(2019) indicates about 51 per cent of Gen Z learns best through hands-on learning experiences, while only 12 per cent learn by listening. Conventional teaching learning methodologies such as classroom lecture is not suitable and will not encourage engagement with the learners. It is imperative for the organizations to create a learning-by-doing environment. This is expected to engage the Digizens with technical and soft skills. Experiential learning can provide Digizens an opportunity to reflect, perceive, analyse, prototype and test. Several alternatives to infuse experiential learning include gamification, simulations, case studies, hackathons, challenges, skill marathons and so on. Emerging technology like augmented reality (AR), enable learners roleplay real-world scenarios and provide human centred solutions.

In the above context, it is appropriate to highlight the initiatives delineated in the NEP 2020 aimed at inculcating the necessary skills among the learners. The policy emphasizes on practical and experiential learning which will lead to instilling the 21st century skills of creativity and critical thinking in the Digizens. It requires a paradigm shift in the pedagogical structure where the learning outcomes measurement should not be based on the completion of course but on the understanding of the contents and application of the concepts in solving the problems. Hence, shifting the focus of assessments from marks based to competency based is recognized to be the need of the hour. This requires evaluation of higher-order skills, such as analysis, critical thinking, and conceptual clarity. Also, the policy advocates for optimal learning environment and support for learners offering a holistic and multi-

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disciplinary education. The drive must be towards integrated improvement of capacities such as cognitive, cultural, social, physical, emotional, and moral among individuals along with rigorous specialization in chosen fields. It is expected that holistic skills will empower learners with abilities to offer innovative and sustainable solutions to the issues they encounter in both professional and personal spaces.

The attainment of such a holistic and multidisciplinary education necessitates all the higher education institutions to put in place a highly compliant and adaptive curriculum. The innovative curriculum must be an amalgamation of choice-based credit courses and project-based learning in appropriate proportions. MOOCS can be leveraged as complementary mechanism through which any skill gaps can be bridged. The areas of focus shall include but not limited to, community engagement and service, environmental education, and value-based education. The learners will be provided with ample opportunities to intern with industries, businesses, faculty, and researchers at local and community levels, thereby enabling to provide inclusive and sustainable solutions to the prevailing issues.

7. New Education Policy 2020, Critical Thinking and Atmanirbhar Bharat

The crux of NEP 2020 emphasises on imparting critical thinking with a focus on skills along with practical knowledge to the learners. The new policy is expected to bring tectonic changes in the prevailing education system along with socio-economic transformation of the nation.

The most significant changes proposed by the NEP2020 such as an increased focus on providing the education to students in their mother tongue, dismantling the role of regulatory institutions introduction of a four-year undergraduate programme with multiple exit options, among others will provide an opportunity for Digizens to hone practical insights and critical thinking skills in solving domestic issues contributing to self-reliance. The policy is expected to provide much needed relief from factory model of education that was the source of restrainment of Digizens potential. NEP2020 envisages to ease the burden of classroom teaching and examination on students but fostering critical thinking resulting in innovative and sustainable solutions for societal problems. NEP 2020 enables Multidisciplinary approach, patent culture, creating start -up opportunities, resilient systems through leveraging digital initiatives, interdisciplinary teaching, and research, etc.in higher education institutions to contribute and pave way for Atmanirbhar Bharat.

The policy emphasises on the need to impart Indian Centric education among Digizens through incorporating courses such as human values, ethics, Yoga and Indian knowledge systems resulting in reinvigorated educational ecosystem. This will transform India into an equitable and vibrant knowledge society by encouraging Indian citizens to have global outlook yet connected to local roots firmly thereby contributing to the transformation of India into a self-reliant global power.

Conclusion

Digizens though are digitally savvy, lack critical thinking skills. The self-reliant nation can be a reality only when the contributions from the youth are innovative, sustainable and customer centric. This necessitates the contributors to possess critical thinking attitude and skills. The NEP 2020 envisioned the holistic development of Digizens with an emphasis on skill development as the pivotal contributor to realise the mission of Atmanirbhar Bharat. The NEP 2020 focuses on implementing initiatives for skill upgradation, entrepreneurial development to make the learners skilled and develop them into initiators of start-ups, which is one of the prime foundational elements to Atmanirbhar Bharat. Thus, a well-articulated NEP 2020 will contribute to the unlocking of Atmanirbhar Bharat through the earlier' s focus on imparting practical, holistic education enabling critical thinking amongst the Gen Z.

References

[1] Sarukkai S., Self-reliant India: self of a nation or a national self ?, *J. Soc. Econ. Dev.*, 2020.

[2] Singh A. P. & Dangmei J., Understanding the generation Z: the future workforce. *South-Asian Journal of Multidisciplinary Studies*, *3*(3), 1–5, 2016.

[3] Gaidhani S., Arora L. & Sharma B. K. Understanding the attitude of generation Z towards workplace. *International Journal of Management Technology and Engineering*, *9*(1), 2804–2812, 2019.

[4] Baru S., Self-Reliance to dependence in Indian economic development. *Social Scientist*, 34–46, 1983.

[5] White M. M., Gearing up for Gen Z: An analysis of employers' recruitment marketing targeting the new, Generation Z, workforce, 2019.

ISBN: 978-93-91355-21-0 (e-Book)

[6] Sharma P., & Pandit R. Workplace expectations of GenZ towards factors of motivation, *Studies in Indian Place Names*, *40*(08), 76-88, 2020.

[7] Seibert S. A., Problem-based learning: A strategy to foster generation Z's critical thinking and perseverance, *Teaching and Learning in Nursing*, *16*(1), 85-88, 2021.

[8] Birgili B., Creative and critical thinking skills in problem-based learning environments, *Journal of Gifted Education and Creativity*, *2*(2), 71-80, 2015.

[9] Aithal P. S. & Aithal S., Analysis of Higher Education in Indian National Education Policy Proposal 2019 and its Implementation Challenges, *International Journal of Applied Engineering and Management Letters (IJAEML)*, *3*(2), 1-35, 2019.

[10] P. S. Aithal, Shubhrajyotsna Aithal, Implementation Strategies of Higher Education Part of National Education Policy 2020 of India towards Achieving its Objectives. *International Journal of Management, Technology, and Social Sciences*, pages 283-326, 2020.

[11] National Education Policy 2020, Ministry of HRD, GoI, New Delhi

[12] Renu Batra and Neethu S Thulaseedharan, Quality Improvement Programmes in Indian Higher Education University News, 59(06) February 08-14, 2021, 26-37, University News, vol.59, No:6, Feb 2021.

[13] Shyam Sundar P, Proceedings of 1st National Conference on Unlocking Atmanirbhar Bharat Through NEP-2020, 2020.

[14] https://www.financialexpress.com/education-2/nep-will-make-india-atma-nirbhar-by-promoting-critical-thinking-skills-and-practical-knowledge-pm-modi/2076831/

[15] https://www.deccanherald.com/national/nep-2020-will-play-key-role-in-creating-atmanirbhar-bharat-pm-modi-891280.html

[16] https://timesofindia.indiatimes.com/home/education/news/nep-2020-new-national-education-policy-focuses-on-learning-critical-thinking-says-pm-modi/articleshow/77971958.cms

[17] https://www.livemint.com/news/india/why-india-needs-its-own-definition-of-what-it-means-to-be-a-millennial-11577809636255.html

[18] https://www.delltechnologies.com/en-in/perspectives/gen-z.htm

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Enhancing Quality in Higher Education Institution: Measures and Practices

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ABSTRACT

In this article, an overview of measures and practices that can be implemented by a Higher Education Institution (HEI) to enhance quality in its functions is presented. These measures and practices are generic in nature and can be applied to varied disciplines of HEI. The objective of this article is to highlight the need for enhancing and assuring quality which contributes to the improvement in stakeholders' satisfaction, governance, leadership, reputation, and sustenance.

Keywords: *Quality, Quality Enhancement, Quality Management, HEI*

1. Introduction

Quality is a critical term that is used as a measurable terminology to determine excellence, to showcase distinctive characteristics and compliance with implied needs. Furthermore, it is also subjective as it varies with respect to an individual's opinion. Quality is an important factor to be considered by any kind of organization to survive and thrive in the environment. Quality practices ensure value to the stakeholders of an organization.

There are varied approaches for ensuring quality in HEI. However, there is no concreted evidence of best results from any of the approaches. Since quality in HEI is highly subjective in nature, there are no universally accepted methods or practices that can be applied for certain enhancement of quality [1]. The diversity in HEI makes defining quality practices even more difficult. However, quality in HEI is time-tested and through proper quality practice; the HEI will eventually evolve its model of quality management. This is the ultimate goal of ensuring quality.

In literature, we can find a good number of articles on aspects of quality in HEI. In this section, a brief review of some important articles is presented.

Magda and Henirich [2] addressed the challenges to enhance quality in teaching and learning regarding the reference to the quality assurance policy in South African Universities. Furthermore, they suggested strategies for adopting the quality assurance models in the HEI.

Pennington and O'Neil [3] compared and contrasted the learning experiences and application of strategic objectives required for quality teaching. Alice and David [4] proposed a new framework for experimental learning and suggested the benefits of experimental learning in key areas such as assessment, student and faculty development, etc.

Jo *et al.*, [5] suggested that the existence of three conceptual categories: 'Establishing Readiness', and 'Connecting with the Students' and 'Developing a Work and Learning Environment' in enhancing student learning experience based on a modified model for analysis. Fanz and Jill [6] suggested a pedagogical model which considers practice, pedagogy, and partnership for enhancing students' employability and professionalism.

The authors in [7] proposed a quality management model for HEI that is capable of addressing the service and implementation functions of HEI. Zhao [8] examines the efficacy of online education and elaborated on the various issues involved. Furthermore, he proposed a framework for assessing the quality of online teaching and learning.

Sahney *et al.*., [9] argued that HEI should adopt the quality measuring techniques used in the service industry for ascertaining the satisfaction of the stakeholders. They suggested the use of statistical tools for framing and analyzing the questionnaire. Zhuair and Al-Hemyari [10] proposed a knowledge management model for monitoring the quality in HEI. Furthermore, the implication of the use of the model in the HEI's of Oman has been found that it can be used as an effective tool for monitoring the quality and performance of HEI.

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Maria and Maria [11] reported the implication of teachers' performance assessment. They propose a 36 degree model for feedback for the evaluation of teacher's performance and argued that the new model is fit for objective assessment. Maureem [12] attempted to analyze the relevance of measurement of quality and performance in their work. Furthermore, they investigated the measurement models in literature such as value-added approach, production model, total quality experience approach, and highlighted the pros and cons of each of the models.

In another work, Teeroovengadum [13] proposed the hierarchical model for measuring quality which considered both the functional and technical aspects in HEI. The model contains 48 dimensions for measuring quality and can be applied for enhancing quality. Mizikaci [14] proposed a systems approach-based program evaluation model for quality in HEI. He argued that the new model is efficient for evaluation and helps in enhancing quality in HEI. Further, he claimed to be the first to combine the concepts of social, technical and managerial aspects for quality measurement.

Kay [15] proposed an evaluation model for ascertaining the quality of service in education. The tool gathers the student's perceptions, analyzes them and provides useful analysis for decision making. Oria [16] addressed the issue of enhancing the employability of students by incorporating additional courses and activities. These activities are specifically aimed at improving the students' skills and competencies.

Kye and Miyeon [17] in their study reported that there is a significant link between the ratio of number of students and full-time teachers which affects the students' employability rates. McCarthy [18] reported the study of feedback models in HEI to understand the attitude of students towards online and regular classes. Faculty feedback, student feedback, and peer feedback models were considered in the work. The findings of the study directed the increase in the use of collaborative learning and interest towards peer feedback.

The implications from the survey papers on quality in HEI are described in the following paragraphs:

Halina and Bjorn [19] analyzed the context of quality management in the HEI. They highlighted the opinion expressed in the current literature were similar in nature. Nina and Maureen [20] reviewed the implications of quality management practices in HEI for the period between 1996 and 2006. They highlighted that most of the models rely on quality models used in the manufacturing industry and inferred that the industrial models required fine-tuning and refinement to be used in HEI. Nonetheless, the authors argued the need for quality models specifically for the HEI.

Reema *et al.*., [21] systematically reviewed the methods to assess and enhance quality in particular to teaching functionality. Their review synthesized the efficacy of student feedback data, assessment tools, peer review, and teaching portfolios. Furthermore, they suggested a multimodal approach is more apt for the assessment of teaching.

Mohammad [22] reported the findings of the survey on the adoption of total quality management in HEI. Furthermore, he argued that the industry-related quality models cannot be directly applied to the HEI due to the persistence of high diversity. In a similar survey on total quality management, Mary [23] reported on the application of total quality management and continuous quality improvement in the HEI. Ka ho Mok [24] reviewed the quality enhancement and assurance techniques adopted by the Hong Kong special administrative region and highlighted the challenges encountered by the state.

In summary, the articles reported in this direction focus on mandatory enforcing of quality in HEI functions for excellence. It is evident with numerous case studies the importance of quality management in HEI. Furthermore, the quality management has been part of the industrial revolution for producing high-quality goods or services which meets the customer's expectation. Therefore, quality in HEI should be an integral factor for overall improvement. Additional literature on quality in HEI can be found in [25-28].

2. Role of HEI in Ensuring Quality Management

Each entity of an HEI is responsible for maintaining and enhancing the quality in their operations. The purpose of quality has to be determined whether the education is given for knowledge or education is for employment or education is given for becoming an entrepreneur. i.e., learning to understand or learning for learning or learning for earning or learning for employment creation. The purpose has to be chalked out for each of the programmes offered by the HEI and an appropriate quality policy has to be enforced.

The quality policy should address the goals of quality, schedule of review and audit activities, management guidelines, commitment to quality standards and continuous improvement, etc. Quality management is attained when the quality in each of the functions in HEI is ensured. HEI should give more prominence to exploring thoughts and

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ideas which directly reflects continuous improvement. Further, HEI should provide the right tools and platform for activities in quality management.

2.1 Importance of Quality in HEI

The importance of quality in HEI is mainly dependent on the following factors which is depicted in Fig. 1:

Stakeholder Satisfaction: When quality is maintained, the stakeholders of HEI are satisfied and thereby reflect the growth of the institution.

Building Reputation: Help to uplift the reputation of the institution worldwide.

Objective Achievement: Help to achieve stated objectives of the Institution.

Systematic Approach: When a standard practice is followed in all the functions of HEI then a systematic approach for the management of HEI is achieved.

Improved Professionalism: A quality practice incorporates a high degree of professionalism.

Quality Output: The students' output from the HEI will be highly skilled and sound when HEI involves best practices in teaching and learning.

Fig. 1: Importance of Quality in HEI

2.2 Quality Assurance in HEI

Quality assurance is always aligned to requirements and a scheduled time frame. This aims in ascertaining the intention of meeting the requirement or not. There are two major drivers for quality assurance viz., reviewing and auditing and accreditation. These drivers aim to verify, validate and qualify the aspects of quality in HEI.

2.2.1 Drivers for Quality Assurance

Review and auditing as well as accreditation through national and international agencies are the two major drivers for quality assurance.

1. **Review and Auditing:** A review followed by the periodic quality audit is the first step in the procedure of assuring the quality of the teacher, education processes, practices, programmes, and services through

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appropriate techniques, mechanisms, and activities. This can be done in three levels viz., peer level, internal expert level, and external expert level. Furthermore, incorporating stakeholders views such as feedback, suggestions, etc., are also considered in this process.

2. **Accreditation:** The most widely used method of external quality assurance is accreditation and participation in the National or International Ranking System. This helps in uplifting the image of HEI across the globe for quality practices and assurance.

2.2.2 Measuring Quality in Teaching and Learning

Teaching and learning is a functional quality that reflects how well it satisfies based on the requirements and perception. Measuring quality in education is highly complex and challenging as teaching and learning is not the product or service that can be measured. However, some yardsticks can be used for measuring quality in teaching and learning such as:

- Performance of students along with other measures such as employment rate, tracking the advancement of the students, etc., are indicators of quality teaching and learning
- Review to ensure and check whether the teaching process is satisfactory as expected. Any deviations reported should be addressed and suitable corrective measures have to be adopted. Approval of quality practices is directly proportional to the outcome of the review
- Audit is a higher-level activity of reviewing. This helps in verifying the compliance of the HEI to set quality standards
- Feedback and approval by the stakeholders
- Some kind of automated tools, for example, an algorithm to measure the degree of quality can be used for checking quality
- Benchmarking the process should be involved which helps to know the actual performance by comparing with external best practices

2.3 Measures for Improving Quality in HEI

In this section some measures for quality enhancement that can be followed by HEI are discussed.

1. **Curriculum Framing and Revision:** The curriculum is the main aspect in deciding the purpose of education. HEI should follow proper guidelines for framing the curriculum. Furthermore, the board should be composed of internal and external experts. HEI should have futuristic ideas and creativity should be given more prominence. The curriculum should relate to the actual work carried out in the real world. Furthermore, we recommend the 40:60 ratio to be followed during the framing of the curriculum, wherein 40% and 60% refer to basic and advanced topics respectively. Also, HEI should give importance to design new courses which are needed for society as well as futuristic in nature. The curriculum has to be revised periodically to address the dynamic environment.
2. **Curriculum Planning:** Teaching learning process and all the extra-curricular activities of HEI should be implemented with a strategic calendar of events.
3. **Working with Real-time:** HEI should align to real-time and foresee the demands of the future and prepare the resources for the needs of society.
4. **Collaboration:** It is a known fact that HEI will thrive in the dynamic environment only through strategic partnering in activities such as research, offering joint degree programmes, exchange programs, internships, industrial exposure, MOU's, etc., and build an ecosystem that will meet the needs of stakeholders.
5. **Teaching Methods:** Delivery of teaching is successful only through appropriate usage of teaching methods such as direct instruction, flipped classrooms, inquiry-based, personalized, etc.
6. **Best Practices:** The uniqueness and identity of HEI can be highlighted by following the best practices.
7. **Data Management:** Data of each function and entity in HEI has to be methodologically documented for effective data management.

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8. **Quality Manuals:** A quality manual for each of the processes has to be designed and followed. The standard operating procedures have to be given to all the employees of an HEI. Process that is clearly defined should be given with templates and checklists for smoother functioning and reviewing.
9. **Bridging Teaching and Industry:** This is an example of student-centric approaches, wherein an HEI plays the role of filling the gaps so as to ensure the students will align with the industrial requirements as they are incubated.
10. **Course Materials:** Most of the HEI's fail to address this issue and do not give much prominence. However, it is the course material that helps the teachers to deliver the right content. Further, it makes learning easy for the students. Depending on the nature of the course, materials can be given in four categories viz., 1. Reading material 2. Textbook 3. Case study 4. E-resources. This helps to ensure the student is given ample resources to learn and also promote blended mode of learning.
11. **Scope for Soft skills, Personality Development, and Moral Education:** Most of the students fail to adapt in the society after graduating as they are unaware of the practicalities and few strive to adhere to fundamental behavioral responsibilities. Therefore, for the students to transform in a right way, HEI should focus on imparting the required education.
12. **Quality of Teachers:** HEI should take suitable measures to recruit quality human resources for teaching, failing to which, a major part of the quality objective will not be achieved. Qualities such as IQ, EQ, empathy, ethics, attitude, etiquettes etc., have to be tested during the recruitment process. Furthermore, the spirit of learning forever has to be imbibed in the teachers.
13. **Training the Teachers:** Periodic and need-based training has to be provided for upskilling and reskilling the teaching faculty.
14. **Use of Standard Tools:** HEI should be techno-futuristic and use ICT enabled tools, automation of process through software, etc., in its functions.
15. **External Quality Management Models:** The use of quality management models such as ISO, TQM, etc., helps to improve the overall activities and streamlines the quality management.
16. **Research:** HEI should ensure that the knowledge created by the HEI is published in universally accepted quality publication houses. Furthermore, the research measures such as the i-10 index, h-index, g-index, citation count, bibliometric analysis, etc., should be used for determining the impact of research.
17. **Bound to Vision and Mission:** The vision and mission of HEI play a vital role in managing and enhancing the quality. All the initiatives must be in-line with the institutes' vision.
18. **Capacity Building Initiatives:** HEI should focus on capacity building initiatives for decreasing dependency.

Conclusion

This article has presented generic insights of quality management in HEI to ensure quality in its functions. Various measures for enhancing quality in all aspects of HEI have been discussed by providing brief guidelines that can be followed by HEI. It is evident from the current dynamic environment; the sooner HEI enforces quality policies the better results are achieved. Therefore, HEI should instil the aspects of quality in all its functions and measure the quality through periodic audits for effective quality management.

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ISBN: 978-93-91355-21-0 (e-Book)

References

[1] Jennifer Rowley, Measuring Quality in Higher Education, Quality in Higher Education, 2:3, 237–255, DOI: 10.1080/1353832960020306, 1996.

[2] Magda Fourie and Heinrich Alt, Challenges to Sustaining and Enhancing Quality of Teaching and Learning in South African Universities, *Quality in Higher Education*, 6:2, 115-124, DOI: 10.1080/713692737, 2000.

[3] Pennington, G. and O'Neil, M., Enhancing the Quality of Teaching and Learning in Higher Education, *Quality Assurance in Education*, Vol. 2 No. 3, pp. 13-18. https://doi.org/10.1108/09684889410071087, 1994.

[4] Alice Y. Kolb and David A. Kolb, Learning Styles and Learning Spaces: Enhancing Experiential Learning in Higher Education, https://doi.org/10.5465/amle.2005.17268566, 2017.

[5] Jo Cahill, Jan Turner & Helen Barefoot, Enhancing the student learning experience: the perspective of academic staff, *Educational Research*, 52:3, 283–295, DOI: 10.1080/00131881.2010.504063, 2010.

[6] Franz and Jill, A pedagogical model of higher education/industry engagement for enhancing employability and professional practice. In Kay, J (Ed.) Work Integrated Learning (WIL): Transforming Futures. Practice. Pedagogy. Partnerships. *Australian Collaborative Education Network* (ACEN), Australia, pp. 164-169, 2008.

[7] G. Srikanthan and John F. Dalrymple, Developing a Holistic Model for Quality in Higher Education, *Quality in Higher Education*, 8:3, 215–224, DOI: 10.1080/1353832022000031656, 2002.

[8] Zhao, F., Enhancing the quality of online higher education through measurement, *Quality Assurance in Education*, Vol. 11 No. 4, pp. 214–221. https://doi.org/10.1108/09684880310501395, 2003.

[9] Sahney, S., Banwet, D.K. and Karunes, S., Enhancing quality in education: application of quality function deployment – an industry perspective, *Work Study*, Vol. 52 No. 6, pp. 297–309. https://doi.org/10.1108/00438020310496569, 2003.

[10] Zuhair A. Al-Hemyari, *International Journal of Quality and Innovation*, 4:1–2, 99–119, 2019.

[11] Maria Luskova, Maria Hudakova, Approaches to Teachers' Performance Assessment for Enhancing Quality of Education at Universities, *Procedia - Social and Behavioral Sciences*, Volume 106, pp. 476–484, ISSN 1877-0428, https://doi.org/10.1016/j.sbspro.2013.12.053, 2013.

[12] Maureen Tam, Measuring Quality and Performance in Higher Education, *Quality in Higher Education*, 7:1, 47–54, DOI: 10.1080/13538320120045076, 2001.

[13] Teeroovengadum, V., Kamalanabhan, T.J. and Seebaluck, A.K., Measuring service quality in higher education: Development of a hierarchical model (HESQUAL), *Quality Assurance in Education*, Vol. 24, No. 2, pp. 244–258. https://doi.org/10.1108/QAE-06-2014–0028, 2016.

[14] Mizikaci, F., A systems approach to program evaluation model for quality in higher education, *Quality Assurance in Education*, Vol. 14, No. 1, pp. 37–53. https://doi.org/10.1108/0968488061064360, 2006.

[15] Kay C. Tan and Sei W. Kek, Service quality in Higher Education using an enhanced SERVQUAL approach, Quality in Higher Education, 10:1, 17-24, DOI: 10.1080/1353832242000195032, 2004.

[16] Oria, Beatriz, Enhancing higher education students' employability: A Spanish case study, *International Journal of Technology Management & Sustainable Development*, Volume 11, Number 3, pp. 217–230(14), DOI: https://doi.org/10.1386/tmsd.11.3.217_1, 2012.

[17] Kye Woo Lee, Miyeon Chung, Enhancing the link between higher education and employment, *International Journal of Educational Development*, Volume 40, Pages 19-27, ISSN 0738-0593, https://doi.org/10.1016/j.ijedudev.2014.11.014, 2015.

[18] McCarthy, J., Enhancing feedback in higher education: Students' attitudes towards online and in-class formative assessment feedback models. *Active Learning in Higher Education*, 18(2), 127–141. https://doi.org/10.1177/1469787417707615, 2017.

[19] Halina Pratasavitskaya and Bjorn Stensaker, Quality Management in Higher Education: Towards a Better Understanding of an Emerging Field, *Quality in Higher Education*, 16:1, 37–50, DOI: 10.1080/13538321003679465, 2010.

 ISBN: 978-93-91355-21-0 (e-Book)

[20] Nina Becket and Maureen Brookes, Quality Management Practice in Higher Education – What Quality Are We Actually Enhancing?, *Journal of Hospitality, Leisure, Sport and Tourism Education*, Vol. 7, No. 1., DOI:10.3794/johlste.71.174, 2008.

[21] Reema Harrison, Lois Meyer, Patrick Rawstorne, Husna Razee, Upma Chitkara, Steven Mears and Chinthaka Balasooriya, Evaluating and enhancing quality in higher education teaching practice: a meta-review, Studies in Higher Education, DOI: 10.1080/03075079.2020.1730315, 2020.

[22] Mohammad S. Owlia, Quality in Higher Education-a Survey, *Total Quality Management*, 7:2, 161–172, DOI: 10.1080/09544129650034918, 1996.

[23] Mary Cruickshank, Total Quality Management in the higher education sector: A literature review from an international and Australian perspective, *Total Quality Management & Business Excellence*, 14:10, 1159-167, https://doi.org/10.1080/1478336032000107717, 2003.

[24] Ka Ho Mok, Enhancing Quality of Higher Education for World-Class Status, *Chinese Education & Society*, 47:1, 44–64, DOI: 10.2753/CED1061-1932470103, 2014.

[25] Fry, H., Ketteridge, S., and Marshall, S. (Eds.)., A Handbook for Teaching and Learning in Higher Education: Enhancing academic practice (4th ed.). Routledge. https://doi.org/10.4324/9781315763088, 2014.

[26] Gordon, G., and Land, R. (Eds.), Enhancing Quality in Higher Education: International perspectives (1st ed.). Routledge. https://doi.org/10.4324/9780203590218, 2013.

[27] Bamber, V., Trowler, P., Saunders, M.,and Knight, P, Enhancing learning, teaching, assessment and curriculum in higher education. Maidenhead: Open University Press, 2009.

[28] Pokorny, H., and Warren, D. (Eds.)., Enhancing teaching practice in higher education. London: Sage, 2016.

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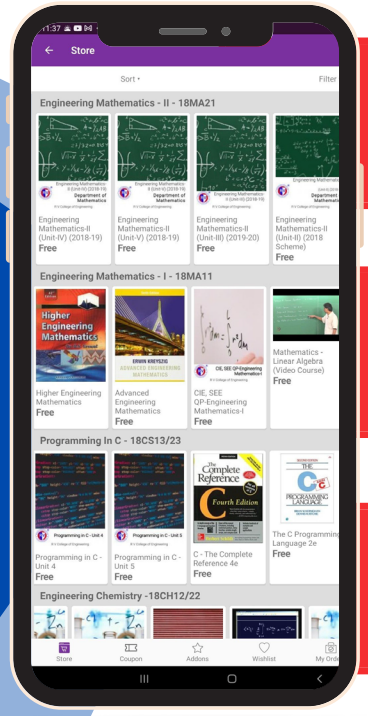

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