10.48047/jocaaa.2024.33.08.251

Using Gaming in Pedagogy to Transform Lower Order Cognitive Abilities into Higher Order: An Examination in the Context of IT Education

Ravi Prakash, [Professor, Computer Engineering Department, K C College of Engineering & Management Studies and Research Mumbai, India]
Shobha Tyagi, Associate Professor, Manav Rachna International Institute of Research and Studies, Haryana, India
Nilima Patil, Assistant Professor, Bharati Vidyapeeth (Deemed to be University), Department of Engineering & Technology, Navi Mumbai, India
Sarita Yadav, Assistant Professor, Department of IT Engineering, Bharati Vidyapeeth College of Engineering, New Delhi, India
Pratap Nair, Assistant Professor, Bharati Vidyapeeth (Deemed to be University), Department of Engineering & Technology, Navi Mumbai, India

Corresponding Author
Ravi Prakash
Professor, Computer Engineering Department, K C College of Engineering & Management Studies and Research Mumbai, India
jravi54@gmail.com

Abstract

Benjamin bloom offered three hierarchical frameworks for classifying educational learning objectives based on their specification and complexity. The three paradigms are categorized as affective (sentiments-based), psychomotor (movement-based) and cognitive (knowledge-based),. The authors intend to discuss knowledge-based cognitive model. This model evaluates learners' competence across six distinct levels. The levels are as follows: recall, comprehend, apply, analyze, evaluate, and create. The first 3 mentioned levels are known as lower-order cognitive abilities ie (LOCA), whereas the next 3 mentioned levels are known as higher-order cognitive abilities (HOCA). An individual can enhance proficiency with progress through different levels, namely from a lower order cognitive (LOC) to a higher order cognitive (HOC). Bloom's Taxonomy (BT) competences also serve as indicators of a learner's likelihood of obtaining employment. This study presents a proposed outcome-based education mechanism for observing the transition from lower-order cognitive abilities (LOCAs) to higher-order cognitive abilities (HOCAs) in IT education. The mechanism involves using unusual teaching and learning approaches. The findings indicate a substantial enhancement in teaching methodologies and offer valuable perspectives for policymakers and stakeholders in education. The motivation of this change is to encourage learners and minimize the disparity between teaching and learning, which is a short-term goal. The ultimate objective aims to provide students with the necessary readiness to engage with great career or entrepreneurship or employment.

Keywords: BT, HOCA, LOCA, CO, PO, OBE Pedagogy, Learning, OBL.

Introduction

Efficiently instructing contemporary students is a perpetual worry for educators and institutions. Oguchi Onyeizu Ajaegbuet al. conducted an analysis of different literary works and reached the

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conclusion that any civilization that aims to enhance its knowledge should not underestimate the significance of a "Strong Innovative Strategy" [1]. Bloom's taxonomy and bloom's revised taxonomy, as shown in figure 2, are utilized by educators and educational professionals as a fundamental and indispensable hierarchical framework of cognitive processes designed to organize effective instructional strategies with the objective of achieving favorable academic outcomes for their pupils [2]. Esteemed scholars regard this scientific model as an indispensable instrument for augmenting educational programs in the 21st century. Higher education students have the ability to engage in teaching, learning, training, and assessment of course materials both in person and through online platforms [3]. Technology based on blockchain have significant potential to support higher education by decreasing expenses and mitigating fraud through the elimination of hand examination of academic records, including transcripts [4–8]. K. Shyamala and S.P. Rajagopalan demonstrated the offering a data mining model created especially for colleges and universities to demonstrate the possibilities of data mining in the field of higher education. [9].In the same context Nabil M. Hewahi, had created a new set of rules which is Hierarchical Rule (HR) [10]. This rule structure efficiently expresses knowledge in Intelligent Educational Systems (IES) and Intelligent Tutoring Systems (ITS) . This is driven by the growing demand for education system in online mode , whether it is by personal preference or due to external circumstances. The use of fuzzy logic in analyzing higher education benchmarks is extensively explored as a common practice, encompassing both conventional and creative teaching approaches [11-14]. Given the dynamic nature of the business landscape and the global context, it is becoming more and more essential for students to not only acquire knowledge, but also develop a deep understanding of successful learning strategies. The The Internet of Things' (IoT) emergence and its primary areas of application have undeniably had a significant influence on business, the economy, job skills, education, and training [15].

Instruction should priorities developing students' core thinking skills, problem-solving abilities, imagination, and transdisciplinary knowledge. It should also emphasize their capacity to adapt, advance, and assimilate new information in emerging and evolving disciplines. Indeed, these current approaches have been effective in the past and continue to be so. However, the education sector has yet to establish a framework for education that can effectively adapt to and incorporate the advancements of the modern era. Fog computing technology is significantly contributing to the improvement of educational operations by offering a seamless and flexible platform, instead of impeding or disregarding them [16-18]. Consequently, global higher education policies are embracing a modern teaching and learning approach known as outcome-based education (OBE) model, in order to fulfill the demands of the new educational framework [19]. Outcome-based education is a is student-centered approach that emphasizes accomplishing specific goals and outcomes via organized instruction and evaluation as shown in figure 1. The student's success is measured by various outcomes, including knowledge, attitude, and abilities, which may vary at different levels. Academic Engineering institutions and Universities in India are swiftly embracing the OBE approach, which has garnered substantial appeal [20-21]. We anticipate that it will profoundly transform the educational environment for technical education in India.

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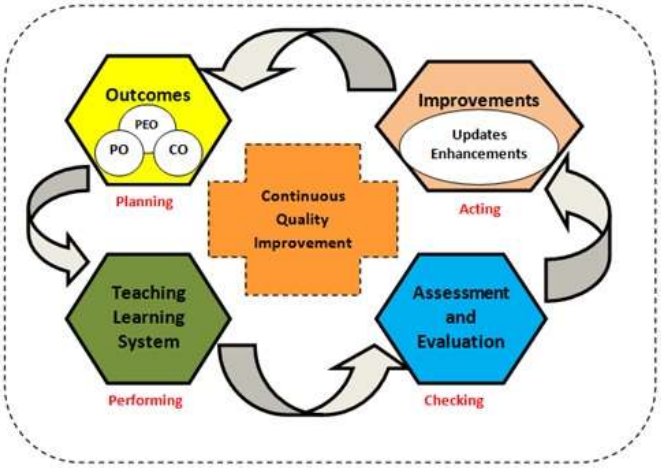
Figure 1: The framework of outcome-based education.



The OBE approach assesses students' advancement based on three criteria: programme educational objectives (PEO), programmer outcomes (PO), and course outcomes (CO) [22]. PEO is known as comprehensive declaration which outlines the program's total expert achievements and the accomplishments that graduate learners attain. We assess the performance of PEOs four to five years post-graduation. The second parameter PO's, often referred to as more concentrated statements, which specify, by the time of their graduation the learners are expected to have acquired specific information and abilities. Undergraduate engineering programmes must align with the twelve graduate criteria set by the NBA. CO's refer to the parameters that are evaluated to measure the success of each student in every course they take during each semester. Typically, each course will define three or more course outcomes based on its importance or significance.

The institution has the autonomy to employ a diverse range of assessment instruments, such as, quizzes, assignments ,project-based assessments, , tutorials presentations, final exams, midterms etc., to evaluate graduate students. This assessment framework quantifies the achievement of the program's desired results. PEO is assessed through the evaluation of placement records, alumni questionnaires, employer satisfaction surveys, and various other parameters. The paper endeavors to address two essential inquiries pertaining to pedagogy of learning. The initial inquiry is: In the educational field hat is the necessity of utilizing BT (Blended Learning Technology) , and what is the significance of OBE (Outcome-Based Education)? The second inquiry pertains to how it can enhance the learning methodology.

Figure 2: The representation of new bloom’s taxonomy[23].

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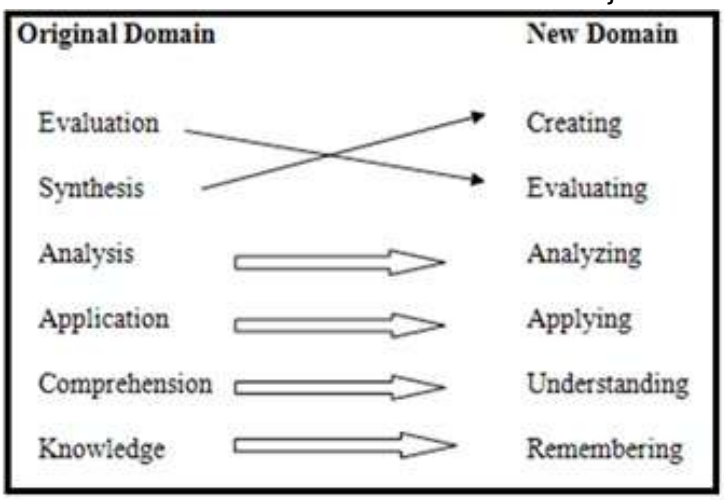

Methods and Materials

The education reforms promote the acquisition of distinctive teaching and learning approaches by teachers, with the aim of fostering innovative learning among students. Significant preparation of subject knowledge is necessary before talking to learners in the classroom and this is the minimal requirement to facilitate teaching-learning methods. Considering the cognitive model, Benjamin Bloom proposes six stages for assessing a learner's proficiency in it. [24]. The first three stages, namely recall, understand, and then apply, are categorized as lower-order thinking levels as they showcase a students' capacity to apply the acquired subject understanding. Collectively, higher-order thinking skills levels such as analysis, evaluation, and creation enable the freedom to explore the potential for creativity and generate novel outcomes with existing resources.

Undoubtedly, the transformation of lower-order cognitive abilities (LOCAs) into higher-order cognitive abilities (HOCAs) requires the inclusion of supplementary input in the instructional methods [25]. In professional education, the course content is specifically prepared to accommodate students and teachers with diverse skill sets, enabling them to obtain credit. Since the professional programme's main goal is to ensure employment after graduation, it is desired to create an environment surrounding the course that allows learners to actively contribute to their own growth. Implementing Higher Order cognitive abilities (HOCAs) during the learning phase can assist in accomplishing this objective.

The authors present a system for transforming lower-cognitive (LOC) thinking abilities into higher-order (HOC) ones for learners. The writers of the demonstration have formulated a series of inquiries for the topic "Distributed Computing (DC-4 credits)". The students have this subject in their last semester of the BE (CSE) curriculum at the Mumbai University. The Bachelor of Engineering (BE) Programme contains a total of 12 programme outcomes (Pos) that need to be achieved. On the other hand, the subject Design and Construction (DC) has six course outcomes (COs) that must be accomplished by the end. By utilizing the current 6 COs, a student can

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successfully attain PO1, PO2, PO3, PO4, and make partial progress towards PO6. In this instance, we will make arrangements to accommodate all three levels of Lower cognitive abilities (LOCAs) to ensure effective assessment. Both the educator and the learner adhere to this traditional curriculum. The proposed approach aims to enhance the DC course curriculum by broadening the scope of learning. The objective is to ensure that the enhanced course modules are in accordance with all 12 Programme Outcomes (POs), thereby maintaining the Levels of Cognitive (LOCs) and Higher Order cognitive abilities (HOCAs). Indeed, the query arises as to What system was used to update and match the course outcome (CO) to every program outcome? The data depicted in Table 1 and Table 2 illustrates the mapping methods employed. In traditional teaching methods, a teacher employs a pedagogical approach known as chalk-talk, as seen in Table 1. On an ICT-enabled platform, the teacher employs video aids or a virtual classroom. Some institutes are now embracing the flip classroom as a customary practice. The proposed mechanism integrated input from stakeholders and examined the possibilities for promoting collaborative learning. The BT level of the question indicates the learner's certain proficiency. The intriguing aspect in Table 2 examines the potential career opportunities following the educational process. The last parameter is used as feedback to choose the next learning path.

The mechanism is explained with an example. First, examine Table 1, It displays the basic correlation between COs and POs. All the COs are mapped to PO1, PO2, PO3, PO4, and partially to PO6. After the DC upgrade, we have assigned all the Central Offices (COs) to all 12 Point of Sales (POs). Table 2 illustrates this correlation. The depiction includes technological deliberation, input from stakeholders, and the cultivation of learning skills and interests. The course improvement has received feedback from an alumna who is employed in IT infrastructure and has expertise in high-performance computing. Therefore, it guarantees that HOCAs (higher-order cognitive abilities) develop the ability to "create" while also aligning with PO 3, which promotes the inclusion of design elements in technology and engineering. The question can be solved by utilizing value-added practice. In addition to the conventional Talk with Black Board & Chalk talk methodology, authors utilized field trips, expert interaction and presentation , alumni engagement, laboratory work and class tutorials. The level of excitement determines the learners' motivation to tackle the question or explore the career prospects. Annexure I comprises a collection of sample questions and their corresponding answers.

Results

Initially, the authors noted in the table that there are six questions designed to assess the proficiency of higher-order cognitive abilities (HOCAs) and four questions for lower-order cognitive abilities (LOCAs). Furthermore, the majority of the questions necessitate proficiency gained through unconventional instructional methods, such as field trips and presentations by experts. Additionally, there are 8 questions designed to assess 8 specific Programme Outcomes (POs) that were not included in the course originally. In general, it has been observed that the additional

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mapping points of interest (PO5, 6, 7, 8, 9, 10, 11, and 12) that are required to complete the course either necessitate proficiency in HOC abilities (BT 4, 5, and 6) or a distinct pedagogical approach.

Table 1: Listing of CO, PO (Existing Curricula)

Sr No	**CO**	**PO**	**Instrument used**	**BT Level**
1	CO1 - CO3	P1,P2 ,P4	Classroom teaching	2
2	CO4 - CO6	P1,P2 ,P3,P 4	Classroom teaching	4
3	-	P5	Laboratory work	NA
4	-	P6	Fieldwork	NA
5	-	P7	Fieldwork	NA
6	-	P8	Fieldwork	NA
7	-	P9	Industry visit(IV)/Pe er learning	NA
8	-	P10	Tutorial/ Peer learning	NA
9	-	P11	Fieldwork	NA
10	--	P12	Cognitive approach/E xpert talk	NA

To accelerate the experiment, we released a game-based set of 10 questions to the distributed computing class. The students were asked to select the right answer and provide an explanation. Each question was awarded a single mark. 346 learners participated in the game concurrently and

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were collectively awarded a total of 10 marks. The outcome was undeniably remarkable. Out of all the learners, 75% have achieved a score higher than 6 marks, assuming that a score of 60% is considered satisfactory for every learner. Table 2 displays the scores of the contestants for each individual question.

Table 2: Candidates' Performance Index with BT Level (Input Mode: Gamification)

Sr No	**CO**	**PO**	**Instrument used**	**BT Level**
1	CO1-CO3	P1,P2,P4	Classroom teaching	2
2	CO4-CO6	P1,P2,P3,P4	Classroom teaching	2
3	CO5	P5	Laboratory work	5
4	CO6	P6	Fieldwork	4
5	CO5	P7	Fieldwork	4
6	CO6	P8	Fieldwork	4
7	CO4	P9	Industry visit (IV)/Peer learning	5
8	CO4	P10	Tutorial/ Peer learning	5
9	CO5	P11	Fieldwork	5
10	CO6	P12	Cognitive approach/Expert Talk	6

Table 3 : Candidates' Performance Index with Correct Answers (Input Mode: Gamification)

Sr No	**CO**	**PO**	**BT Level**	**Correct Answers**

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				(Sample size 346 learners)
1	CO1-CO3	1,2,4	2	323
2	CO4-CO6	1,2,3,4	2	323
3	CO5	5	5	311
4	CO6	6	4	318
5	CO5	7	4	296
6	CO6	8	4	245
7	CO4	9	5	294
8	CO4	10	5	290
9	CO5	11	5	301
10	CO6	12	6	201

Figure 3 -Performance Analysis

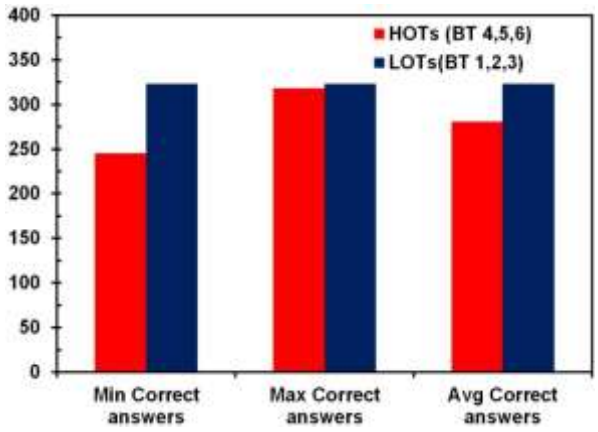

Table 4: Correct answer state

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	Min correct answers	Max correct answers	Avg. correct answers
HOTs(BT 4,5,6)	CO1-CO3	1,2,4	2
LOTs(BT 1,2,3)	CO4-CO6	1,2,3,4	2

Table III indicates that the questions or queries pertaining towards HOC abilities could obtained greatest marks of 318, while the bottom level score is 245. The mean value for high-order tasks (HOCAs) is 280.5, whereas for low-order tasks (LOCAs) it is 323.

Discussion

Following the conclusion of the game-based question session, a survey was conducted to get feedback from 346 learners regarding their reflection places. The subject The survey was administered online using the Google Forms platform. We requested learners to provide answers to a set of five inquiries. The remarks were categorized into three levels: high, medium, and low. Figure 4 depicts a quantitative effect analysis of the exercise. The Reflection Spot promotes instructors to critically evaluate the need for mapping at the higher-order cognitive abilities (HOCAs) level in order to attain desired learning outcomes (PO).

Students are aware that Learning Outcome Tests (LOTs) allow them to gain course credits in the programme. However, in order to improve their competitiveness, they should embrace Cognitive-Process Oriented (CO-PO) assessments at the Higher Order cognitive abilities (HOCAs) level. Not only will it facilitate learners in attaining the desired goal of the course, but it will also enhance their dedication to studying. An instructor develops pedagogical tactics to help learners acquire higher-order cognitive abilities (HOCAs) by addressing issues at the level of competitive examinations such as GATE, GPAT, MBA, GRE, or comparable.

Figure 4: Impact Analysis

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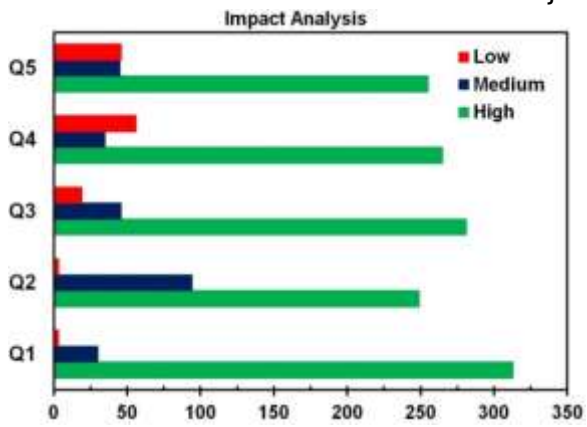

The definitions of Q1-to-Q5 can be found in Appendix II, as shown in figure 4.

Conclusion

Although HOCAs (Higher Order cognitive abilities) is considered important, the research findings indicated that some aspects presented difficulties for teachers when it came to creating HOCAs-based questions. These were the teachers' diverse interpretations of Higher Order cognitive abilities (HOCAs). We categorized the difficulties into three dimensions: those pertaining to the educators, the components of instruction and acquisition, and those affecting the learners. Therefore, the objective of the The goal was to enhance teaching methods. and provide important information for legislators and stakeholders in education. The authors hope to further augment their research on Open and Distance Education. Due to the stimulating effect of real-time data on pedagogical innovation, the authors propose implementing a Faculty Development Programme (FDP). The participation of teachers from around the nation in the Faculty Development Programme (FDP) is crucial due to the varied teaching methods, which allow learners to perceive each facet of the teaching process from distinct perspectives. The writers have created several games that will unquestionably introduce novelty to conventional teaching and learning methodologies. Integrating gaming into education is crucial for effectively preparing learners.

Significance statement: This study's significance stems from its identification of an outcome-based education mechanism that observes the shift from lower-order cognitive abilities (LOCAs) to higher-order cognitive abilities (HOCAs) through unconventional approaches to teaching and learning in the field of IT education. This discovery may be advantageous for educators, learners, and institutions of higher learning. This study aims to elucidate the important aspects of Bloom's taxonomy that have remained unexplored by previous academics. Therefore, it is possible to develop a novel theory on the transformation from lower-order thoughts to higher-order thoughts.

Annexure: I
Overall Evaluation:-

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1: Disagree
2: Somehow agree
3. Strongly Agree

Figure 5: Survey on learners' ability to analyze and solve critical problems

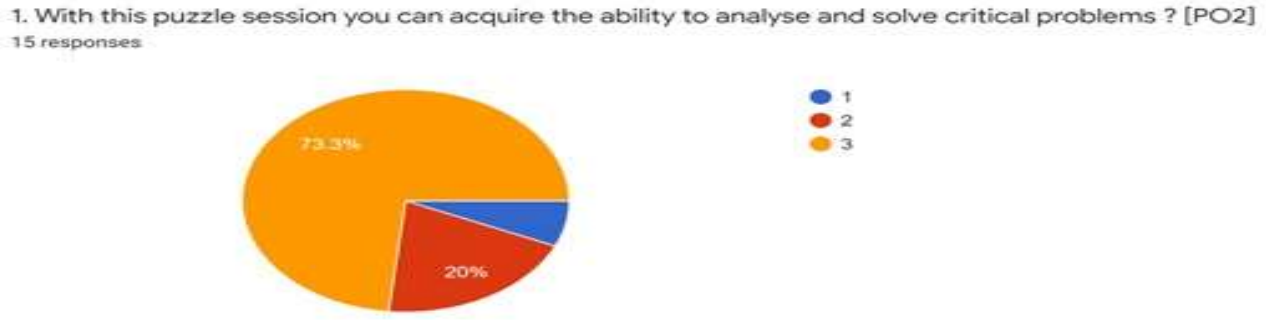


Figure 6: Survey on learners' ability to perform collectively

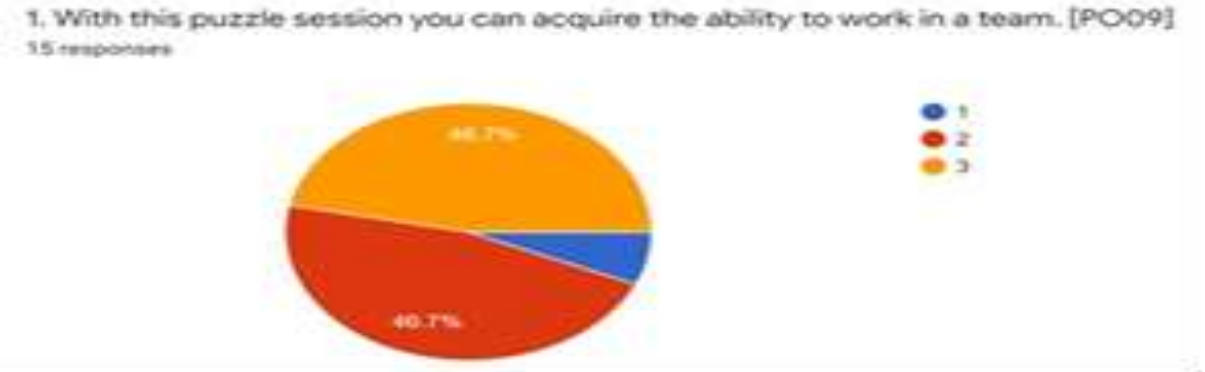
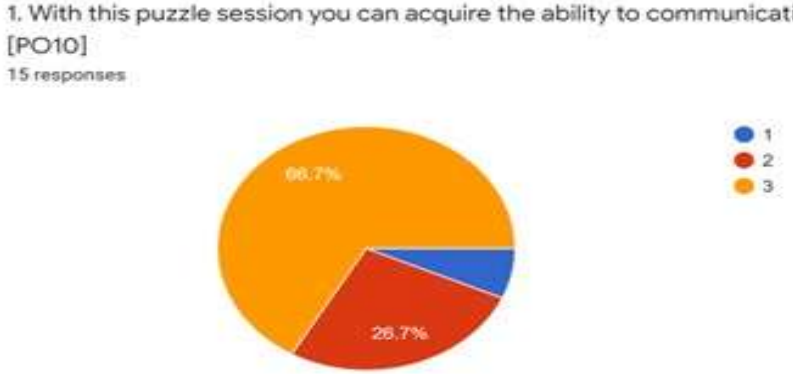


Figure 7: Survey on learners' ability to communicate



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Appendix: II (Figure 4)
Q1: Exercise is useful in terms of relevance to the respective field?
Q2: Exercise is useful to enhance analytical and cognitive skills?
Q3: Exercise lets the learner integrate the local solutions in order to solve bigger problems?
Q4: Gaming in pedagogy encourages introduction of modern tools in the T&L practices?
Q5: Gaming in pedagogy facilitates instructor help learner inculcate with peer learning?

Author Contributions Statement
RP conceptualized the idea of implementation and prepared the structure of the paper. ST and NP wrote the draft. RP and PN analyzed the data and map with the proposed out come. SY contributed in documentation. Over all contribution of every single author is significant.

Clinical trial number: not applicable

Human Ethics and Consent to Participate declarations: not applicable

Funding Not Applicable

Availability of Data and material The datasets generated and analyzed during the current study and can be made available on request.

Code availability(software application or custom mode) Not Applicable

Declarations

Conflicts of Interests The authors declare that there is no conflict of interest.

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Authors

Dr. Ravi Prakash has twenty years of varied academic experience. Information systems is his area of expertise. He is an author, mentor, evangelist, speaker and demonstrator of active learning through gamification. He is currently working as Professor in the Computer Engineering Department at K C College of Engineering and Management Studies and Research, Thane Mumbai.

Dr Shobha Tyagi Working as an Associate Professor in the department of Computer Science, since Feb. 2022 till present. Also have around 20 papers in reputed journals and international conferences indexed at IEEE, Springer and ACM libraries and 4 patents (2 international from Germany and 2 national level) in her research portfolio.

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Nilima Patil with 17 years of academic experience is pursuing PhD degree in Computer science and Engineering from Mumbai University. More than 18 papers of International Conference and Journals are in her credit. She is carrying out research work in the area of Deep learning and Medical Image processing. Her research interest includes Data mining, Deep learning, Software engineering and Database systems. She is currently working as Assistant professor in Bharati Vidyapeeth (Deemed to be University), Department of Engineering and technology, Kharghar Navi Mumbai.

Sarita Yadav has a B.tech and M.tech degree in Electronics and Communication Engineering(ECE). She also completed her Ph.d degree from NCU, Haryana in Mixed wireless communication systems. Currently she is working as an Assistant Professor in Bharati Vidyapeeth's College of Engineering, New Delhi. She has more than 18years work experience in teaching. Her area of interest includes Machine learning, Communication systems, Digital systems.

Mr. Pratap Nair pursuing PhD in Computer Science & Engineering from Pacific University, Udaipur. He has published more than 10 papers in Reputed Journals and Conferences including 1 patent. His research area is in Blockchain Technology in Mobile Networking. Other areas of proficiency are Deep Learning, Natural Language Processing and Machine Learning.

[Optional: Acknowledge any individuals or organizations that contributed to the study but are not listed as authors.]

Note: Text format: Times New Romans, Text size:12