The Role of Discussion Forums and Peer Assessment for Enhancing Team Building Skills and Cognitive Learning

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***Abstract*— In the GenAI era, discussion forums and peer assessment significantly contribute to the educational domain by enhancing collaboration, personalized learning, and critical thinking. Online teaching and learning process has become essential after this Covid-19 pandemic. A few instructors follow a hybrid mode of teaching learning processes and set an adaptive learning environment for the learners. However, handling theory courses is one of the most challenging tasks for the instructors both in traditional as well as in online mode. Students may not give their complete attention and they are easily distracted by other means. Hence, it becomes necessary to prepare a structured course plan with adequate interactive and participative sessions for the learners so that the learning objectives would be met. The plan shall be customized to any mode of learning there on. This article focuses on the DTP Framework - *Discussion forum, Team practices and Peer assessment,* which sets up a suitable learning environment for the learners for improving their team building skills, and thereby cognitive experience. This article considered Software Engineering course as the case study and demonstrated how the team building activities and peer interactions helped the learners in their academic performance.**

***Keywords*— Discussion Forum; Learning Environment; Online Learning; Peer Assessment; Teamwork.**

***ICTIEE* Track*:* Pedagogy of Teaching Learning**
ICTIEE Sub-Track: Differentiated Instruction in Meeting the Needs of Every Student

I. INTRODUCTION

STUDENT engagement inside and outside the classroom is one of the most challenging tasks now-a-days. It is more difficult in online mode than in the traditional mode. The global pandemic compels all the educational institutions to go for online mode of teaching learning practices. Students and instructors who are new to this mode feel very difficult and take more time to accustom that makes the situation worse. The academic community suffers a lot because of this huge change and struggles for sustainability in learning. However, there is always a scope to overcome this issue. Instructors shall customize their usual lecture plan so as to accommodate more interactive and participative sessions between the learners.

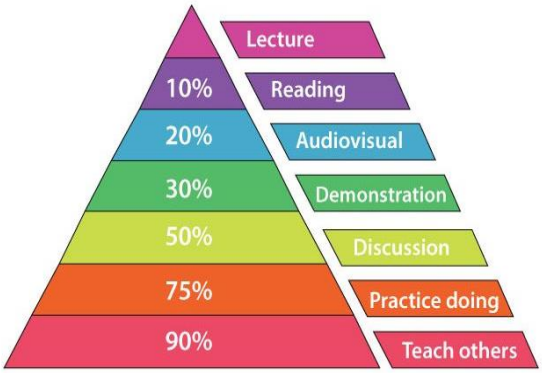

Fig. 1 The Learning Pyramid
(Source: https://www.onlinecoursefacts.com/the-learning-pyramid-what-percentage-of-learning-is-retained/)

The learning pyramid, as shown in Fig. 1, says that only 10% would remain after reading; but 90% would remain if the learner does practice and teaches others. This kind of participatory learning can be brought inside the classroom by properly setting the learning environment.

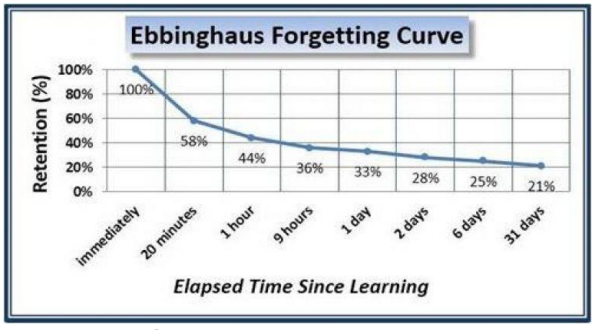

Fig. 2 Forgetting Curve
(Source: https://securityawarenessapp.com/forgetting-curve/)

Also, the instructors have to continuously motivate the

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learners for the active participation in all individual and team activities. The Ebbinghaus Forgetting Curve, as shown in Fig. 2, says that only 21% of learning remains after 31 days. Schimanke et. al. (2013) developed an alternative for this Forgetting Curve and explained what has to be done to have more retention, as shown in Fig. 3. Repeated reviews on the already taught content, and adding new content on top of it would help the learners to build the stories by relating the concepts. It makes them remember those concepts for a longer time.

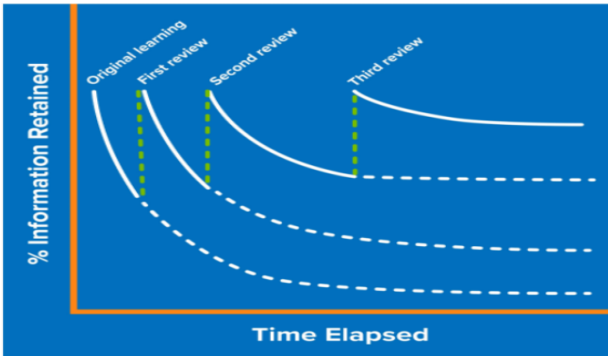

Fig. 3 Spaced Learning - Alternate for Forgetting Curve (Source:www.mindtools.com/pages/article/forgetting-curve.htm)

The instructors have to customize their course or lecture plan to resolve these issues and bring the learners in the comfortable zone through different active learning strategies and pedagogical practices like discussion forums and peer assessment. Discussion forums provide enhanced interaction and engagement, foster critical thinking and problem solving skills among the learners. They involve an asynchronous mode of learning by allowing students to participate at their own pace, enabling thoughtful reflection and responses. They also provide rich resources if the learning platform is integrated with modern AI tools.

Peer assessment develop collaborative knowledge building and shared expertise through the evaluation of each other's work, gaining insights from diverse approaches and ideas. Engaging in peer assessment helps students develop critical evaluation and analytical skills. Assessing peers' work encourages reflection on one's own learning and understanding.

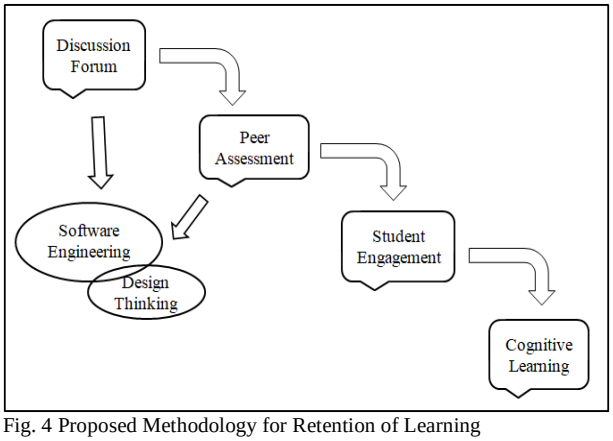

Fig. 4 Proposed Methodology for Retention of Learning

Providing and receiving feedback fosters a sense of community and accountability among learners. Software Engineering theory course was considered for this study and the proposed methodology was shown in Fig. 4. The objective of this research work is to experiment how the repeated team activities like peer interactions and assessment help the learners to remember the concepts, and in turn support their academic performance.

II. RELATED WORK

Learning Management Systems (LMS) like Canvas and Moodle are used widely to set up a suitable learning environment for the learners which supports interactions between the peers. One of the main activities of LMS is discussion forums. This helps the students to chat with their peers and course teachers at anytime from anywhere. Wikle et. al. (2018) made a detailed analysis on discussion forum participation that helps in improving the learning outcome of the students. There are many studies coming in for engaging the students in LMS. Villa et. al. (2019) did a study on finding the students' involvement in various task-based methods and in connection with LMS activities such as assignments, forums. They found that the connection of students in LMS access is shorter than the other methods. A research model proposed by Alomari et. al. (2020) that investigated the impact of technological characteristics, psychological characteristics, and student-instructor interaction characteristics of students' in LMS. Costa et al. (2020) identified new learning styles using student interaction through LMS.

Stahl et. al. (2021) carried out a project based learning (PBL) approach so as to inculcate the professional practice among the students through software engineering course. Abirami et. al. (2021) explained the effective implementation of the lecture plan and the improvement in the Course Outcomes for Software Engineering course. Yoo et. al. (2022) applied machine learning techniques to predict the students' success in an online flipped classroom through log data collected from various activities such as watching video, participation in forums. Ahmad et. al (2022) focused on predicting the performance of weaker teams in software engineering course projects using the swarm intelligence based model. Saad (2022) evaluated students' practical knowledge and soft skills through PBL in software engineering course. Watson et. al. (2022) applied deep learning approach in software engineering research for analyzing the components of learning through 128 research papers. Stol et. al. (2022) introduced gamification for engaging software engineering professionals during the development phase which in turn improved the job satisfactions of the developers. Power et al. (2023) analyzed the relationships between self, peer, and expert assessment for university students and concluded that there is a strong correlation between students' academic performance and the quality of feedback received from peers.

From the literature, it is understood that much research

focused on active learning strategies like peer assessment and discussion forums for the enhancement of students' learning. To our knowledge, very limited research work was done in setting up the customized learning environment through peer assessment and forums. This article proposes the DTP framework *(Discussion, Team Practices, Peer Assessment)* for setting up the suitable learning environment for the learners to improve their team building skills, and thereby the cognitive experience.

III. METHODOLOGY

The proposed methodology includes team project implementation by participating in the discussion forum and involving in the peer assessment activity at different stages. These kinds of active learning strategies for the learners set up the participatory learning environment, which in turn supports them to remember the concepts taught for a longer period of time and perform better in academics. The proposed DTP framework is shown in Fig. 5 and explained in subsequent sub-sections.

A. Team Formation and Problem Selection

All students were asked to form teams, each consisting of 3 to 4 members. The instructors provided an orientation on the Sustainable Development Goals (SDGs) and various problem domains. Following this, each team was asked to select a suitable problem from these SDGs to focus on.

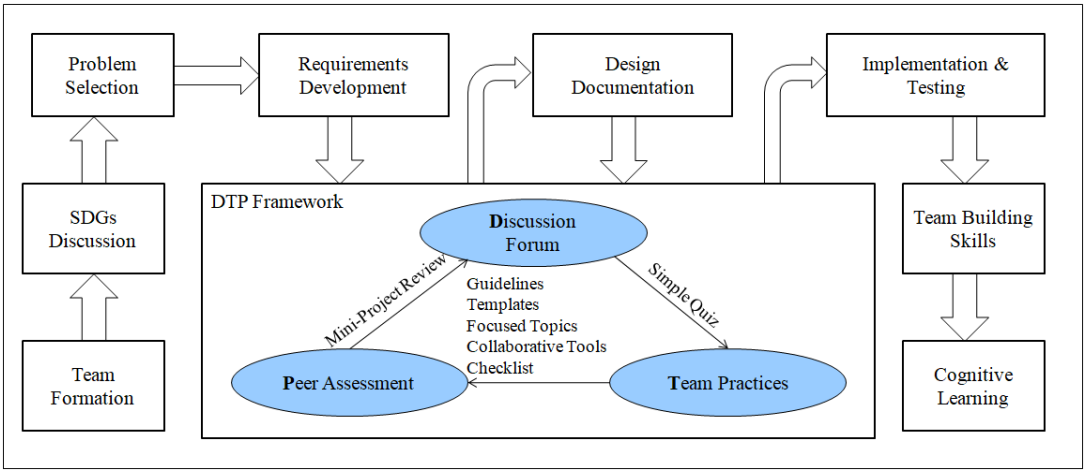

Fig. 5 DTP Framework for Team Building Skills and Cognitive Learning

B. Requirements Development (Stage 1)

The requirements development phase involved meeting with stakeholders to gather their interests in the application. The team then analyzed these requirements and categorized them into functional and non-functional requirements.

C. Design Documentation (Stage 2)

Once the Software Requirements Specification (SRS) was finalized, the team utilized various design drawing tools to create the design documentation. Unified Modeling Language (UML) diagrams, Data Flow Diagrams (DFDs), and User Interface Design (UID) sketches were developed to demonstrate the functional specifications of the application.

D. Implementation & Testing (Stage 3)

A suitable programming language was selected for implementation, and the application was tested using both white box and black box testing techniques.

E. DTP Framework

In each stage of application development, team members participated in discussion forums, team activities, and peer assessments. The instructor identified a peer team for each group, which acted as a client team to state requirements and evaluate documents. Each team received templates and guidelines for documentation, along with checklists for peer assessment. Collaborative tools such as Jam and Whiteboard were used for team discussions and activities. After discussions on focused topics, a simple quiz was given to ensure participation from all learners.

Each team prepared documents such as Requirements Specifications, Design Documents, and Test Case Specifications at each stage, which were then submitted to the peer team for assessment. The peer assessment technique helped individuals learn from other teams and correct their own mistakes. Instructors verified each learner's participation in peer assessment during the mini-project review. Fig. 6 (a), (b) and (c) shows the customized course plan for various DTP activities planned using Moodle for 3 stages.

Fig. 6 (a) Activity Planner for Stage 1

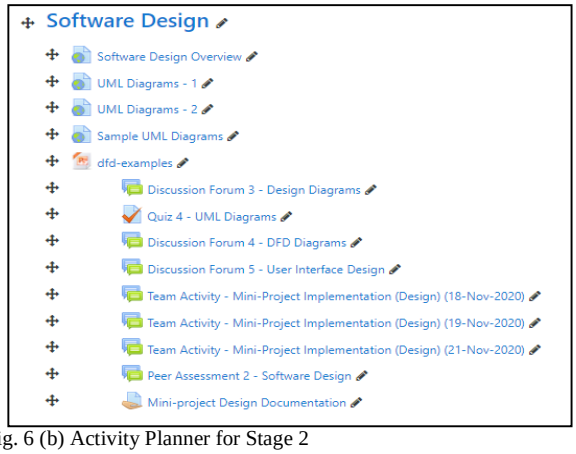

Fig. 6 (b) Activity Planner for Stage 2

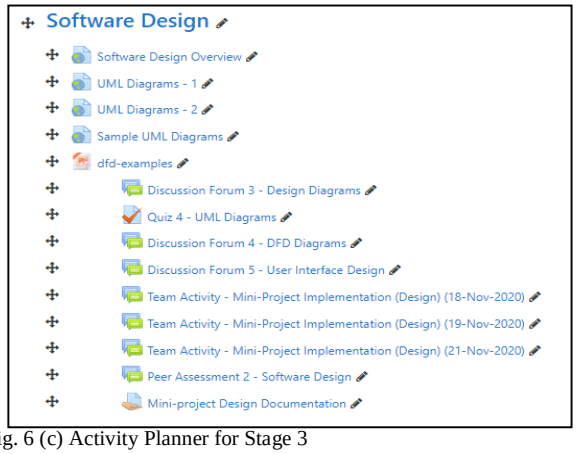

Fig. 6 (c) Activity Planner for Stage 3

Fig. 7 (a) and (b) show the peer assessment and discussion forum participation by the learners and more details are given in Appendix I.

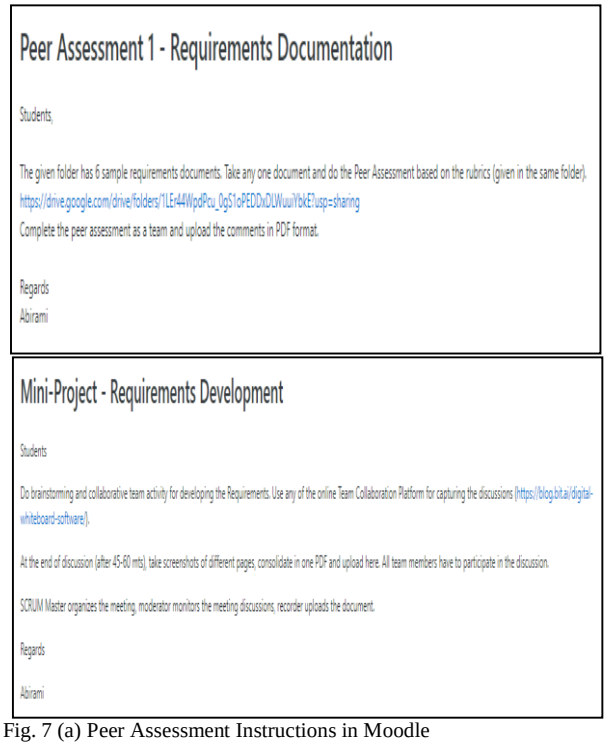

Fig. 7 (a) Peer Assessment Instructions in Moodle

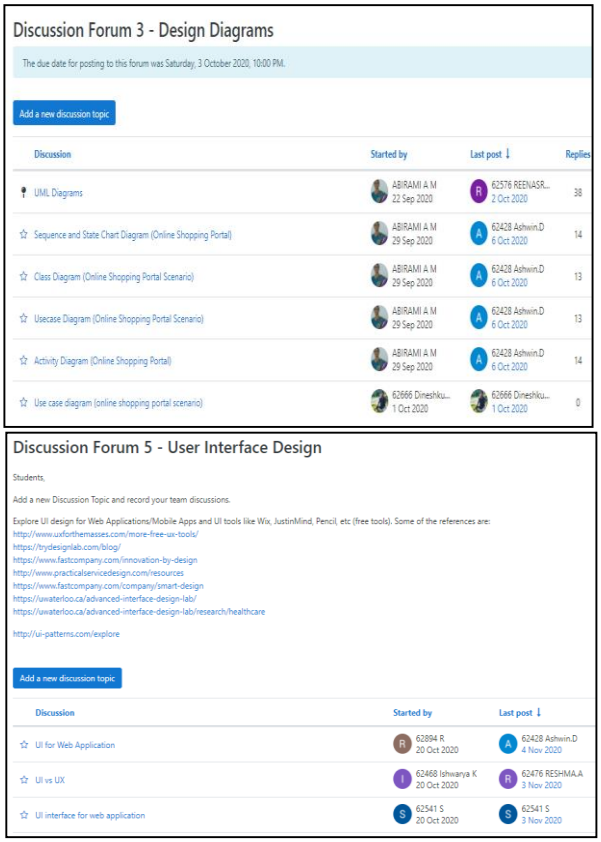

Fig. 7 (b) Discussion Forums in Moodle

F. Team Building Skills & Cognitive Learning

Listening to the class, participating in forums after lectures, engaging in team activities for project implementation, and conducting peer assessments after each stage of application development enhance team-building skills and cognitive learning. This process is illustrated in Fig 8.

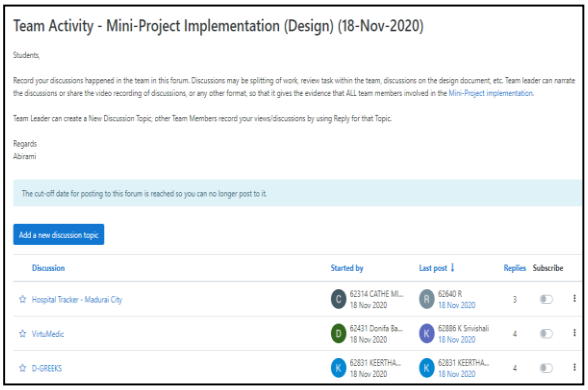

Fig. 8 Mini-Project by Project Teams in Moodle

These set of student engagement activities in DTP framework support knowledge retention among them for the period of time which in turn makes the learners to perform well in their tests.

IV. Results And Discussions

The instructor used the proposed DTP framework for the second year B.Tech. Information Technology programme

students, 59, for the course Software Engineering. All teaching learning activities like content sharing, team activities and assessment were done in Learning Management System (LMS) completely. Moodle played a significant role in implementing this DTP framework. All individuals participated in 10 discussion forums during the course where each of them discussed the salient features of software design, design tools and testing techniques. 2 quizzes were given for Individual Assessment (IA) after these discussion forum participations. 3 peer assessments were done by the peer teams on the documentations and then mini-project reviews were conducted. Fig. 9 shows the performance of students in reviews and tests. It is seen that most of the students performed well in review 2 and test 2.

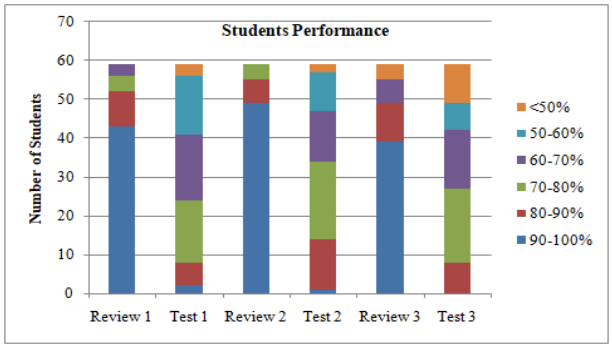

Fig. 9 Performance of Students

The results have been further analyzed and are presented in Table I. The instructor had discussions with students who scored low marks and did not participate in IA-1 and IA-2, which led to their increased participation in subsequent peer assessments and mini-project reviews. Although achieving ≥90% in tests was challenging, only a few students scored below 50%. This indicates that the activities within the DTP framework effectively supported the academic performance of students.

TABLE I
STUDENTS PERFORMANCE IN CONTINUOUS ASSESSMENT TESTS

Marks Range	Number of Students							
	IA-1	Review 1	Test 1	IA-2	Review 2	Test 2	Review 3	Test 3
Max Marks	10	10	50	10	50	50	10	50
90-100%	16	43	2	0	49	1	39	0
80-90%	11	9	6	16	6	13	10	8
70-80%	10	4	16	13	4	20	0	19
60-70%	7	3	17	9	0	13	6	15
50-60%	1	0	15	5	0	10	0	7
<50%	4	0	3	2	0	2	4	10
Not participated	10	0	0	14	0	0	0	0
Class Average	7.9	8.9	33.5	7.1	9.5	35.3	8.7	32.7

Tests like Test 1, Test 2 and Test 3 consisted of 1 mark Multiple Choice Questions (MCQs), 1 mark Multiple Answers Questions (MAQs), 2 mark MAQs and descriptive questions. Further analysis on Test 2 marks is shown in Table II. It is seen that 55 students and 51 students scored ≥70% in MCQs and 1 mark-MAQs respectively whereas only 26 students scored ≥70% in 2 marks-MAQs and in design diagrams. The repeated actions on the concepts support the learners to perform well in MCQs rather than the MAQ type of questions. The distractors might be more in these types of questions and the instructors need to look into this issue. Nearly 10 students scored low marks in review 3, which resulted in poor performance in Test 3. These learners might have taken the peer assessment and review in the lighter sense and they scored <50% in Test 3. These types of issues shall be identified earlier, discussed with the students and resolved before the test.

TABLE II
PERFORMANCE ANALYSIS OF STUDENTS IN TEST 2

Marks Range	1 Mark (10 - MCQs)	1 Mark (10 - MAQs)	2 Mark (5 - MAQs)	Design Diagrams (20)	Overall Marks (50)
90-100%	31	16	5	5	1
80-90%	14	13	12	11	13
70-80%	10	22	9	10	20
60-70%	3	6	10	12	13
50-60%	1	1	9	9	10
<50%	0	1	14	12	2
Class Average	8.6	6.5	7.5	12.7	35.3

In spite of participation in forums and peer assessments, 12 students scored low marks in design diagrams. There might be various factors such as not understanding the scenario given in the question paper for which design diagrams need to be drawn, not following design concepts, or poor time management in completing this question. The instructors shall have one-to-one discussion with these students to find out the reasons for the same. The instructors shall plan for one more checkpoint like individual assessment (IA) after peer assessment activity or strengthen the review for further improvement. This additional checkpoint mechanism would help the learners to recall the important attributes while answering the MAQs and drawing the design diagrams.

The performance of students of different batches in test 2 is shown in Table III. It is seen that only 3% students got <50% score in the Batch 2 *(online)*, whereas it is 17% in the Batch 3 *(hybrid)*. All students and teams spent more time for doing team activities in *online mode* learning.

TABLE III
STUDENTS PERFORMANCE OF DIFFERENT BATCHES IN TEST 2

Marks Range	Batch 1 - Offline (in %)	Batch 2 - Online (in %)	Batch 3 - Hybrid (in %)
90-100%	9	1	3
80-90%	9	22	14
70-80%	11	33	12
60-70%	10	22	23
50-60%	10	17	30
<50%	9	3	17

Feedback from students was obtained at the end of the course and it is shown in Fig. 10. Nearly, 98% of the students said that the participative learning environment was given by this course and tests/assignments (team activities) supported their cognitive learning.

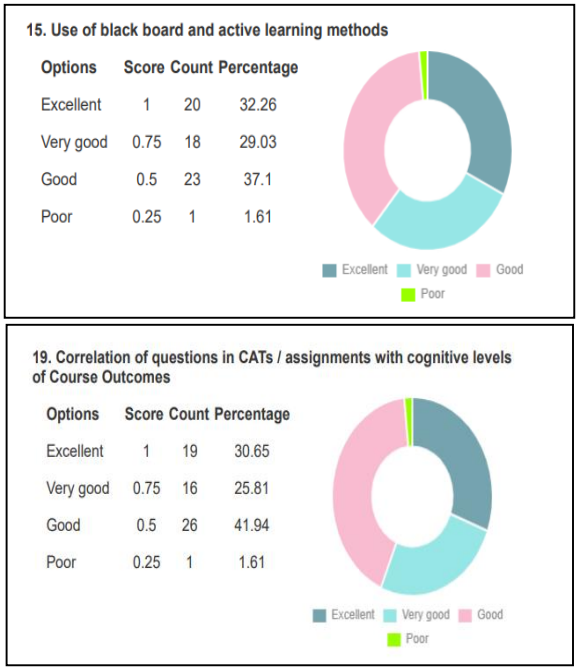

Fig. 10 Student Feedback about the Course

Peer assessment and its learning by the team were recorded in the document after each stage. Samples of these reports are shown in Appendix.

Conclusion

Discussion forums, team activities and peer assessments are the most important strategies that the teachers can adopt to increase the student participation in classes. These techniques make the learners move from passive learning to active learning; and help them to actively interact with their peers and teachers. The DTP framework, which focuses on discussion forums, team practices and peer assessments, has been proposed in this article for improving team building skills and cognitive learning. The different types of review mechanisms followed by this DTP framework in different stages of application development supported the learners to perform well in multiple choice questions. The concepts that they learnt during the classes and activities were retained for a longer time and supported them to get better scores.

However, the instructors have to plan a few more review mechanisms to make the learners get high scores in other types of questions also. The results showed that there is an increase in the performance of students in the marks range 60-80%; the number of students with <50% is also reduced. From this, it is evident that the sequence of activities carried out in the course engaged the students to a greater extent, helped them to retain the concepts for a longer period of time and enabled them to score high marks in the course. In summary, discussion forums and peer assessment, created a more interactive, personalized, and collaborative learning environment. They helped in the development of critical thinking, fostered a sense of community, supported skill development, and ensured fair and effective assessment, ultimately leading to improved educational outcomes.

Future work may include the use of item analysis, a statistical approach for determining the quality of questions to ensure whether the team activities have a vital role in test performance. Also, the student behavior in team activities shall be analyzed by using the Moodle log report and adequate preventive measures can be taken prior to tests or examinations.

Acknowledgment

We acknowledge our Institute for this work.

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APPENDIX

A. Peer Assessment Report for Requirements Document

Department of Information Technology

Date : 19/09/2020
Document Name : TechApp R1
Review Team Members :

1) M.GA.Ragul (19IT073)
2) T.R.Abijeeth Vasra (19IT001)
3) M.Arun Kalyan (19IT011)
4) G.Sidharth (19IT094)

Rubrics for Peer Assessment

Criteria	Exemplary(4)	Proficient(3)	Basic(2)	Needs Improvement(1)	Remarks
Problem selection	Selected societal relevant problem, the need of the day	Selected the problem having wider scope	Selected the problem which addresses the smaller group of community	Selected the problem for the sake of doing	**Basic(2) –** This problem addresses only the student community and the app is not indispensable as there are other apps which serve the same purpose. With the flow of time, the necessity of the app is also put into question.
Documenting FRs	Identified all requirements (Normal, Expected, Excited)	Identified only the needed requirements	Identified only very minimal requirements	No FR is identified	**Proficient(3) –** The functional requirements are identified and documented.
Documenting NFRs	Identified all NFRs	Identified few NFRs	Identified one NFR	No NFR is identified	**Needs Improvement(1) –** The non-functional requirements are identified but are not documented properly. The NFRs are shallow and not mapped to the application in question.

Use case diagram	Use case diagram is drawn using tool and matched with all identified features	Use case diagram is drawn using tool and there are missing FRs in the diagram	Use case diagram is drawn but no drawing tool is used	No use case diagram	**Basic(2)** – The use case diagram is developed using a tool but it does not cover every FR and it also does not focus on the actors.
Use case template	Use case template is used and all fields are filled with relevant information	Use case template is used but some fields have irrelevant data	Use case template is used but most of fields are empty	No use case description is given	**Basic(2)** – The Use Case template is used but some fields do not have relevant data. The flow in some use cases is unsatisfactory.

Overall comments:
Based on the above mentioned criteria, the application seems basic and the requirements are not documented properly. Applications such as these are obsolete and easily outdated due to the effluxion of time and also due to the fact that there are other applications which serve the same purpose and cover a larger community of members.

Your learning by doing Peer Assessment:
The idea of an application developed must not be outdated by the passage of time. The non-functional requirements are as important as functional requirements and must be identified and documented in an exemplary manner. Only when the requirements are identified accurately, the design process can take off without any setbacks. It also ensures that the problems encountered during design phase are less and that the efforts of the team can be precisely put upon the development and testing of the product. The requirements engineering tasks provide the solid foundation on which the application can be built upon.

B. Peer Assessment Report for Design Document

Department of Information Technology

Checklist for Peer Assessment

Description	Yes/No	If no, write Comments
I. UML Diagrams		
Are all 5 UML diagrams drawn? (Usecase, Class, Activity, Sequence, StateChart)	Yes	-
Has Class diagram shown all required relationships (dependency, generalization, association with multiplicity)?	Yes	-
Does Classes used in Sequence diagram matched with classes used in Class diagram?	Yes	-
If generalization relationship shown, is there "is-a-kind of" relationship?	Yes	-
II. Data Flow Diagrams		
Are all 3 level DFDs drawn? (Contextual, Level 1 and Level 2)	Yes	-
Is Level 0 and Level 1 or Level 1 and Level 2 same?	No	The team has shown variations between different levels and made sufficient improvements per each level.
Does the design document have atleast two Level 2 diagrams?	No	One detailed Level 2 Data-flow diagram has been drawn, which is sufficient.
III. User Interface Design Does the UI Design exhibit the following characteristics?	Rating (1-5 likert scale) 1 – poor, 5 – excellent	
Usability - whether the product meets its intended use, whether any explicit requirements are missed, etc	4	-
User Tasks - whether the product has minimum navigations, self-explainable, etc	5	-
Aesthetics - whether the user interface design has appealing colors, layouts, etc	5	-

Project Title that was reviewed : Guider App of Deaf People

Team Member Name, RegNo	Review Date	Topic of Design (that has been reviewed)
M.GA.Ragul (19IT073)	24/11/2020	Use Case Diagram, Level 2 DFD Diagram, UI Design
T.R.Abijeeth Vasra (19IT001)	24/11/2020	State Diagram, Sequence Diagram, UI Design
G.Sidharth (19IT094)	24/11/2020	Activity Diagram, Class Diagram, UI Design
M.Arun Kalyan (19IT011)	24/11/2020	Level 0 DFD Diagram, Level 1 DFD Diagram, UI Design

Team's learning by doing this Peer Assessment:
When we drew our UML and Data-flow Diagrams, we were on the same page and so we saw our diagrams from the same perspective. When the peer review was done, we also got to see the other team's perspective of our diagrams, which helped us improve it. Moreover, during the peer review, we also learnt more about the UML Diagrams and Data-flow Diagrams.

C. Peer Assessment Report for Testing Document

Department of Information Technology

Checklist for Peer Assessment

Description	Yes/No	If no, write Comments
I. White Box Testing	**No**	-
Is code written for the identified FR?	**No**	-
Is CFG drawn?	**No**	-
Is Cyclomatic Complexity determined?	**No**	-
Are minimum Test Cases generated as per Format	**No**	-
Is Test Coverage determined (statement, branch, condition, path) ?	**No**	-
Is there any chance to enhance test cases?	**No**	-
II. Black Box Testing		
Are test cases designed for the identified FRs?	**Yes**	-
Has EP or BVA or Cause Effect Graph Technique used appropriately?	**Yes**	-
Is there any chance to enhance test cases?	**No**	The test cases are well developed.
III. Behavioural Skills		
Do you find any copyright violations, misuse of software, etc in the design documents?	**No**	There is no copyright violation or misuse of software.
Has the team submitted the document for review on time?	**Yes**	The team co-operated well.
Are all your team members involved in this review process?	**Yes**	-

Project Title that was reviewed : Guider App for Deaf People

Review Date : 6/12/2020