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IMPROVEMENT OF ENGAGEMENT IN ONLINE LEARNING FOR TECHNICAL EDUCATION

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Abstract: In online education, student engagement in their online studies is the biggest challenge, leading to higher dropouts. Student engagement means student involvement in learning and participation in the course. An outcome-based curriculum is designed based on the framework designed by IIT Kharagpur. The outcome-based course structure was prepared and given to students before they attended the online class. The students were said to prepare for the class before attending the online class. The teaching-learning process is followed for the entire semester, and student engagement is measured from the questionnaire given to the student at the end of course completion. 109 participants filled out the feedback form during the year 2020 and 128 participated in 2021. The result shows that this teaching-learning process could increase student engagement throughout the course work. The dropout rate for the even semester of 2020 was reduced by 3.66% and similarly, the dropout rate was reduced by 25.4% in the 2021 odd semester. The performance also increased using this methodology.

Index Terms - Active-learning, Online Education, Outcome-based education, Self-learning, Student Engagement

I. INTRODUCTION

The “real-world skills” essential for a person to interact with another person to transcend barriers like different countries and cultures and be a part of a globalised world are communication, critical or higher-order thinking skills and collaboration. The 21st-century education system needs proper infrastructure and an appropriate teaching-learning methodology to cope with this demand. The education system should help the learners acquire both domain-dependent and domain-independent skills and contribute to sustainable development. Since December 2019, we all have been through a challenging situation. The novel coronavirus has shaken every person, in every spare. The education systems worldwide have been closed down and/or shifted to online education. To run the education in this challenging situation the face-to-face (F2F) classroom has shifted to the online platform. Online education should be adequately planned and executed so all learners can access it [1]. We have surveyed openideo where participants could share their views on online education. Around one thousand participants and 442 ideas were collected. There were many advantages like i) flexibility- the students can learn from anywhere, anytime ii) Less distraction- everything depends on students how and how much they want to learn iii) more focused- students can be more focused and cover the syllabus more quickly, The drawback of online teaching are i) no peer support- it is very difficult to interact with peers as could be done in F2F class ii) network issues- disruption due to network-related problems iii) Student engagement- it is very difficult to engage the student in the online classroom. For an excellent online class, these challenges must be taken care of. Online learning can be either synchronous (live class) or asynchronous (prerecorded class), which learners can access from their mobile, tablet, laptop or desktop using the internet.

In synchronous classes, instant interaction is possible, but the internet connectivity should be good. The time and internet speed can be chosen per learner in an asynchronous class. In regular classes, the synchronous classroom is very close to the face-to-face real-time classroom[2]. Online learning (OL) was done through various platforms such as Zoom, Google Meet, webinars, etc. When everything is back to normal, the universities are planning for blended learning, i.e., both face-to-face learning and OL. The requirements for blended learning to be efficient are i) a proper learning management system, ii) suitable learning materials iii) an Upgraded curriculum and process, which ensure learners' engagement in the learning process (Adeoye et al. 2020). Online learning is new for both learners and instructors. A proper e-learning infrastructure for curricula and syllabuses to design is necessary. The e-learning infrastructure would help prepare us for global education and environmental challenges like COVID-19[3][4]. The major problem in online learning(OL) is student engagement and dropout rate [5] [6]. One of the essential skills a learner should possess is self-learning, which is vital for both online and offline courses[7].

Student Engagement states how much the learner is involved positively in educational goals and learning[8]. An increase in engagement reduces the ill behaviour of learners, less attendance, low academic performance and dropout[9].

The OL started in the early 21st century with the evolution of internet and web technology and a shift in the education system from teacher-centric to learner-centric. With the help of the internet globalisation of the education system could be possible through OL [10]. To carry OL effectively, e-mentoring was done to support learner engagement. E-mentoring was done by the teachers using mail and an online chat. Instructors, through e-mentoring, can make students engaged in the course. Here, collaboration is done between instructors and learners, and vital peer interaction is missed. The success of the OL solely depends on the instructor[11]. To make online teaching as good as a face-to-face class, the teachers were encouraged to record their classes and introduce gamification or some addition to teacher-centric teaching. OL through games can make learning easy but may only be suitable for some learners. Different types of learners require different gamified content to make game-based learning effective. The instructor and the content developer are separate entities that must be coordinated properly. Designing game-based learning materials and suitable games and giving them to learners through instructors is a complex process. The instructors and learners need proper training, and the designer needs to understand correctly the learning outcomes that the learners need to acquire at the end[12][13]. Synchronous OL interaction is done using a learning management system (LMS). The measure drawback of LMS is that it should address all the ways of learning styles of students, and the architecture for each course should be designed differently [14]. For the success of OL and to decrease the dropout rate, student engagement needs to be increased throughout the course. Dropout is not an independent event. When a learner remains disengaged for a long duration, he drops the class [15].

There is no structured curriculum which can be applied and address diverse learner groups or different courses. There should be a simple and robust curriculum framework which can be quickly followed by diverse stakeholders like the developer who develops the course, the instructor who presents the course to the learner and the learner who is the centre of the education system[1].

The proposed paper describes an ICT-based framework to design a learner-centric curriculum based on Outcome-based education (OBE) principles [16]. The proposed methodology was applied in the synchronous online class. To engage the learner and decrease the dropout rate in ever-fluctuating connectivity, which serves as a medium, the flipped classroom is adapted. For a flipped classroom, the learners prepared the lecture that would be covered for that class. The learner learns through the reference materials, videos or animations which suit their learning preference. They can learn through self-study or by collaborating and studying with their peers. This learner-centric is beneficial for student retention and engagement [17]. The flipped classroom prepares the learner with the knowledge that would be delivered in the class prior. The procedure will develop lifelong learning habits [18].

II. METHODOLOGY

The proposed methodology stresses developing a web-based framework where an outcome-based curriculum promotes student engagement and equips the student with the needed skills and attitudes. The curriculum designed is learner-centric, a pattern suitable for every course with an exception. The Designed outcome-

based curriculum (OBC) is carried out in synchronous OL classes where the class was in a flipped model. Flipped teaching is chosen to make the learner-centric OBC more effective.

Curriculum Framework

The outcome-based curriculum framework is open-source, web-based, and designed using Java. The curriculum framework can be used at the institutional level where the institute can enter its mission, vision, program educational objectives and program-specific outcomes. The institute can then register different courses for that program. The instructor can then start designing the course. The course begins with the course name which is divided into course overview, course level learning outcome, course level practice problems and course Modules. A course overview is a paragraph write-up stating the course coverage and justifying the course for the program. The course-level learning objectives defines what the learner will acquire on completion of the course. The outcome must be specific, measurable and doable. The course objectives test items are designed according to the course-level learning outcomes so that the learner can assess whether they have achieved the intended learning outcomes. The test items are at the same cognitive level of Bloom's taxonomy as the outcomes defined. The course module is further divided into module overview, module-level learning objectives, module level test items, and module learning strategy including additional learning material and module units. The module learning strategy and additional learning material are the set of self-study guides, including the textbook chapters along with the page number, relevant papers, website address, simulation tools, videos and animation as applicable. The module unit is again divided into unit summary, unit-level learning objectives and unit-level test items. The module lecture is at the bottom of the hierarchy. Each outcome stated has at least two practice problems associated so that the learner can self-assess their learning. The designed curriculum is shared with experts, instructors and the students so that they can be aware of what is expected from the learner after completion of the course. Figure 1 shows the block diagram of the OBC framework.

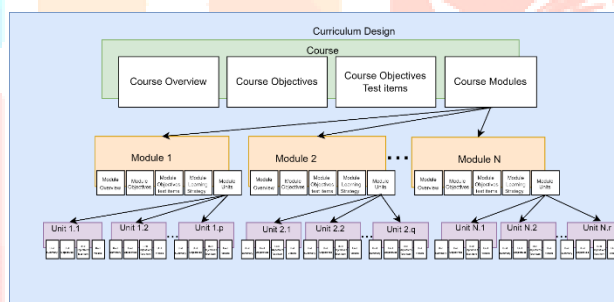


Fig.1. The block diagram of the OBC framework

Teaching and Learning Process used

The OBC was designed for Basic Electronics Engineering (RBL1B002/RBL2B002) and Basic Civil Engineering (RBC1B002/RBC2B002) courses at Biju Patnaik University of Technology, Odisha, India. The developed OBC structure was given to learners of a BPUT-affiliated engineering college named "**Seemanta Engineering College**." It took time and patience to motivate the instructor. They initially were very reluctant, but as they started understanding the concepts, they enjoyed designing the curriculum. The learners were exposed to OL for the first due to the pandemic COVID19. The methodology was applied during the first wave of the novel coronavirus when the whole world was in despair. The learners were happily engaged with this new learner-centric approach. The OBC helped the learner understand what to learn, how to learn, and how much to learn and helped the instructor carry the TLP efficiently. The OBC design in this study is to improve both domain-dependent and domain-independent skills. With OBE, we have inverted learning. This teaching-learning process helps learners acquire domain-independent skills and attitudes and provides space for them to follow their way of learning. The learner got the OBC one week before the scheduled class. The learners were instructed to prepare themselves from the provided curricula before coming to the class. They were encouraged to study in small groups and collaborate with their peers. The role of the instructor was to mentor the process instead of long lecture hours. Here in this methodology learners are the centre. The learner by following this methodology learns in their preferred learning style, at their convenient time. The practice problem provided in OBC helps the learner to assess their depth of learning. The class lectures are delivered on the google/zoom platform which first 10-15 minutes were used in explaining the important concept or the

zest of the lecture. The instructor of the course does this. The rest time is utilized for discussion on the lecture topic of the day. The students ask about their doubts about their peers and if they fail to clear the doubts then the instructor clears the doubt. Teachers only provide the necessary resources and study materials to facilitate the process.

Questionnaire Design: Quantitative self-report questionnaire consisting of twenty-one test items measured the domain-independent parameters. This questionnaire has been categorized into five categories. The number of the questionnaire is precise so that learners fill it out without hesitation as compared to other papers present (70 in [19] and 47 in [20]). The questionnaires used were self-developed to measure five parameters. Here in this paper, we are focusing only on student engagement.

The questionnaires state the contributions of learners to designing a good curriculum and TLP[21]. It also makes the learners understand their responsibilities for their learning[22][23].

Table 2.1: The questionnaires used to measure student's engagement

Self-Learning	
SL01	After reading the lecture materials, how many classes have you attended?
SL02	After reading the lecture materials, how many of the problems in the proposed curriculum were you able to solve by yourself?
SL03	Does the proposed course emphasize spending significant time studying and doing academic work?
SL04	Does this method of learning make you more engaged or understand the subject better?
Active and Collaborative Learning	
ACL01	How often have you asked questions in class or participated in class discussions?
ACL02	How often did you discuss with your friends for solving the problem given in the course/subject?
ACL03	How often you have worked with other students for completing the given assignment?
ACL04	How many times you have worked with your classmates outside of the class to complete the given assignment?
ACL05	How often you have tutored or taught other students during this course/subject learning?
ACL06	How often you have referred to electronic mediums (Google, chats, blogs, open courses, etc.) to complete your given assignment?
ACL07	How many course-level problems you have solved by yourself?

The questionnaire was designed from the standardized questionnaire available. There were eleven questions in this category. Student engagement means how much students are involved with course materials and participate in class. Self-Learning(SL) means learning on their own from materials available without the help of anyone[24]. The first four questions of the questionnaire measure the self-learning of the learner and the next seven questions measure active and collaborative learning (ACL). Table 2.1 shows the questionnaire used to measure student's engagement.

The questionnaire was designed for the TLP on 5 points MOS scale. The feedback was collected online mode through a google form after completion of the course work. The study was done for a semester and learners were asked to rate their responses on a scale of one to five, one represents a lower value and five represents the highest value and three is neutral. In even semester 2020, 53 students were in the course RBC2B002. For the RBL2B002 course, 56 students were there. The reliability of the survey was analyzed using IBM SPSS20.0 to correlate the survey response. For SL Cronbach alpha was 0.91 and for ACL it was 0.94.

The end semester performance was compared with the previous year's semester performance result and the grade was compared. In the previous year (2019) 56 learners were there which is considered the control group for the course RBC2C002 and 53 were there in the experimental group. For the course, RBL2B002 61 learners who gave their end semester in the year 2019 are considered as the control group and 56 in the experimental

group. Both the learners had similar performances in their previous exams and were first-year students. The dropout rate for the even semester 2019 was 11.36% and the dropout rate for the year 2020 was 7.7%. The dropout for the 2020 even semester during the time of the first wave of covid19 was better than expected. The performance result was in the grading system, to compare the results, the grades were converted to their respective assigned numbers. According to the marking system used by the university grade “O” is equivalent to “10”, grade “E” is equivalent to “9”, grade “A” is equivalent to “8”, grade “B” is equivalent to “7”, grade “C” is equivalent to “6”, grade “D” is equivalent to “5” and grade “F” is equivalent to “2”. The end-semester performance was compared between the experimental group that followed TLP and the control group with traditional TPL.

During the academic year 2020-2021, there was no connection with the college, due the second wave of COVID 19, we continue our research again in the year 2021-2022. During 2021 odd semester classes were online but semester exam was conducted offline. There were 189 students who had participated in research out of which 61 students were there in Basic Electronics Engineering (RBL1B002/RBL2B002) and for Basic Civil Engineering (RBC1B002/RBC2B002) courses 128 students have participated. These students also filled up the questionnaire as was done previously. We have considered the previous year as control group. The control group had online classes and the end semester examination was also in online mode. The control group followed traditional teaching learning process. The dropout rate was 26.4% in the control group whereas for the experimental group it was about 1%. The reliability of the questionnaire was calculated through IBM SPSS20.0 and was found 0.86 for the SL parameter and for ACL parameter it was 0.89.

III. RESULT AND DISCUSSION

The eleven questionnaires' responses were recorded and are shown in figure 2 for the self-learning parameter and for the active learning parameter for year 2020. From figure 2 it is seen that for questionnaire1 64% of learners strongly agreed or agreed that they have done pre-classroom reading. 51% of learners have solved the problem set provided to them, 42% of learners agreed that they spend significant time studying and 52% of learners agreed that this TLP has increased their engagement.

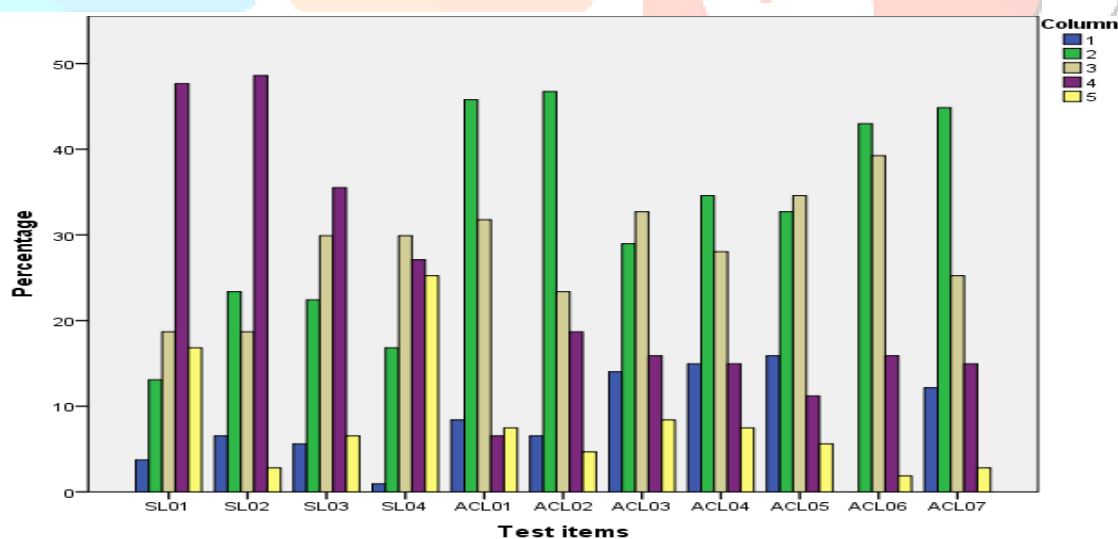


Figure 2 The feedback collected in the year 2020

Table 3.1: The result of the questionnaires collected for even semester (2020)

S. L.	Test items	Primary analysis			
		Mean	Standard Deviation	Skewness	Kurtosis
1.	SL01	3.60	1.03	-0.71	0.040
2.	SL02	3.17	1.03	-0.57	-0.80
3.	SL03	3.14	1.02	-0.25	-0.63

4.	SL04	3.58	1.07	-0.14	-1.03
5.	ACL 01	2.58	0.99	0.84	.53
6.	ACL 02	2.68	1.00	0.56	-0.43
7.	ACL 03	2.75	1.13	0.25	-0.59
8.	ACL 04	2.64	1.13	0.40	-0.53
9.	ACL 05	2.57	1.06	0.38	-0.24
10	ACL 06	2.76	0.98	0.67	-0.30
11	ACL 07	2.51	0.99	0.50	-0.26

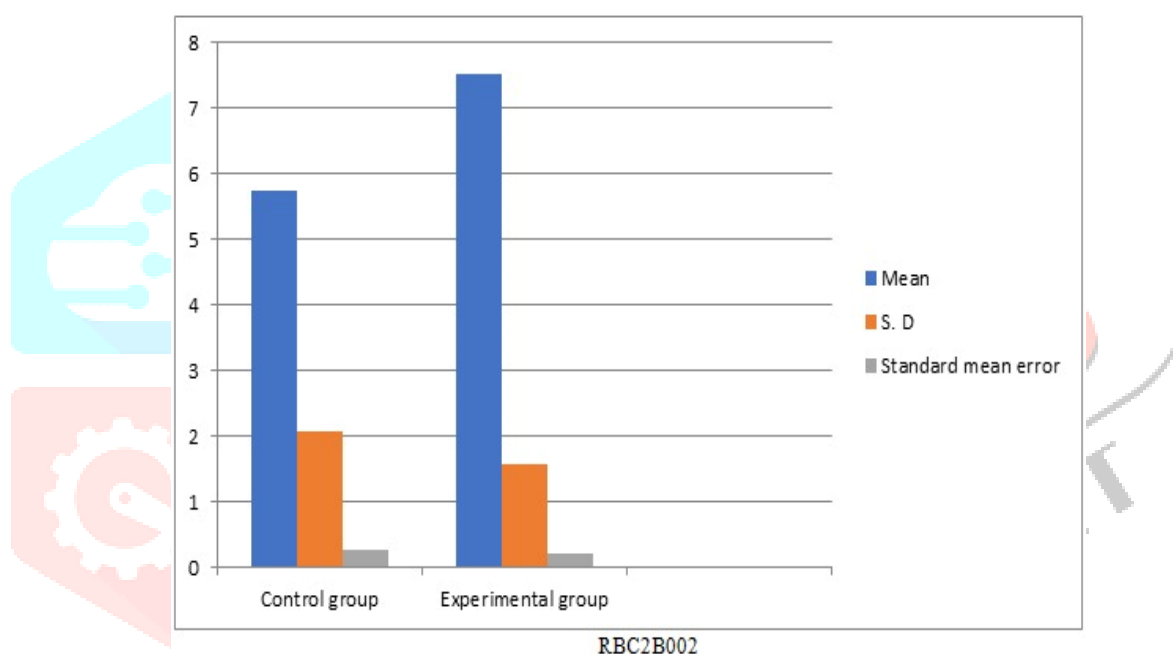


Figure 3 The result of the experimental group (2020) and control group (2019) of courses RBC2B002

Table 3.2: The performance of the control group(2019) and experimental group(2020) for the courses RBC2B002 and RBL2B002

COURSE	RBC2B002(F=1.59)		RBL2B002(F=1.39)	
	Control group	Experimental group	Control group	Experimental group
Mean	5.73	7.51	6.08	9.5
N	56	53	61	54
S. D	2.07	1.58	1.75	1.11
Standard mean error	.277	.218	.224	.151

** S.D Standard Deviation

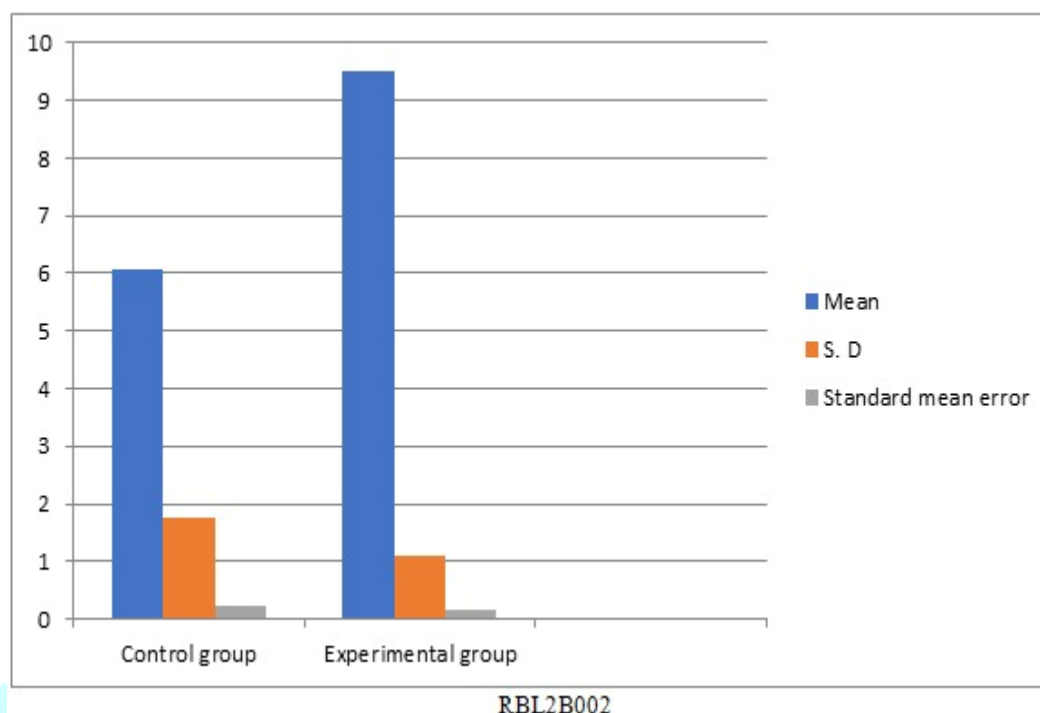


Figure 4 The result of the experimental group(2020) and control group(2019) of courses RBL2B002

Table 3.1 show the primary result obtained from the filled up questionnaire and the that the mean was between 2.51 to 3.60, the standard deviation was between 0.98 to 1.13, the skewness value of test items was less than equal to 0.25 and kurtosis was less than equal to -0.24 (acceptable range of <2.0 (skewness) to <7.0 (kurtosis)) so the test items were valid[25]. The overall mean was 2.71, the standard deviation was 1.07 and Cronbach's alpha is 0.873. The mean of ACL says we need to work more on encouraging active and collaborative learning. The learners need to understand that collaborative learning will help them to understand the knowledge more easily.

This was the first time implemented on an online platform when the world was facing the first wave of pandemic situations. The classes were in synchronous mode and the learners resided mostly in places where the connectivity was ever fluctuating. The learners were motivated to join the classes and even due to network issues they were connected with the class through the study materials and resources provided to them. The comparison of the experimental group and control group of both the courses RBC2B002 and RBL2B002 is shown in Table 3.2 It is seen that the performance in both the experimental courses is better as compared to their control groups.

Similarly, the result obtained for the odd semester in year 2021 is studied. Figure 5 shows the result of the feedback collected. Table 3.3 Shows that the result obtained is within the acceptable range. While the end semester performance with the previous year it was seen that for both the courses the experimental group has perform better. Figure 6 and figure 7 shows the comparison between experimental group and control group for the course RBC1B002(Basic civil engineering) and RBL1B002(Basic electronics) respectively.

The result indicate that the student accepted this type of methodology well and in future with more courses designed in this type of methodology they can acquire both the subject knowledge and skills and domain-independent skills and attitude desired from them. It is seen that the learners when engaged in the learning process their performance also increased which tallies with other papers[18]. This TLP encourages the learners to follow their learning style at their convenient time.

Another important observation was that the dropout rate amid the challenging situation were found to decrease using this methodology.

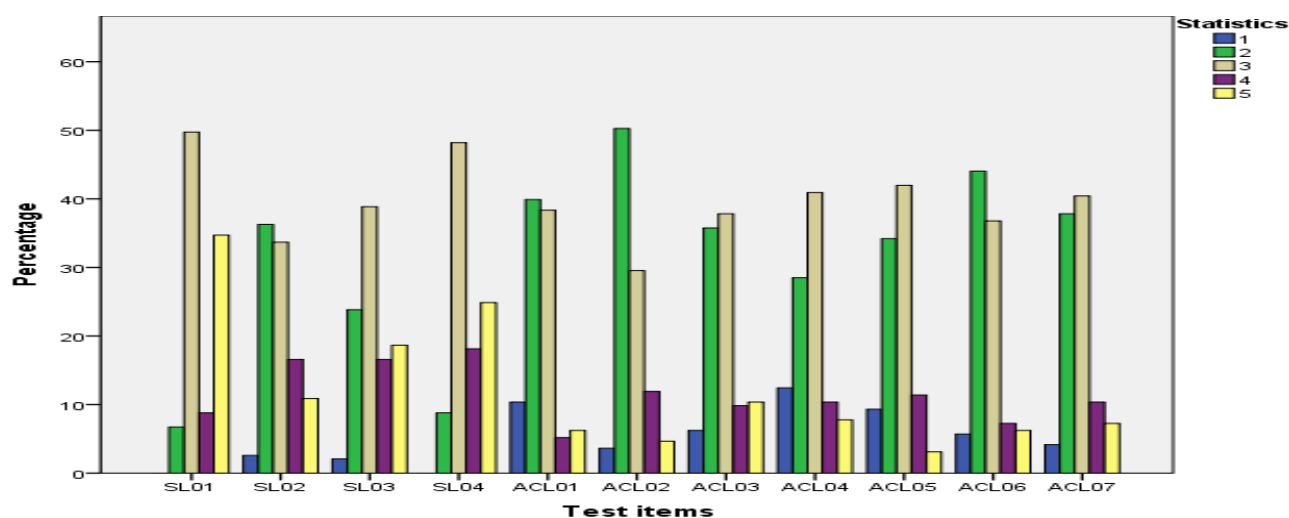


Figure 5 The feedback collected in the year 2021

Table 3.3: The result of the questionnaires collected for odd semester (2021)

S.L.	Test items	Primary analysis			
		Mean	Standard Deviation	Skewness	Kurtosis
1.	SL01	3.71	1.01	0.20	-1.45
2.	SL02	2.96	1.03	0.51	-0.56
3.	SL03	3.25	1.08	0.26	-0.85
4.	SL04	3.59	1.00	0.29	-1.07
5.	ACL01	2.56	0.96	0.67	0.60
6.	ACL02	2.63	0.95	0.86	0.31
7.	ACL03	2.82	1.04	0.58	-0.13
8.	ACL04	2.72	1.06	0.33	-0.16
9.	ACL05	2.64	1.00	0.26	0.06
10.	ACL06	2.64	0.95	0.81	0.63
11.	ACL07	2.78	0.98	0.66	0.21

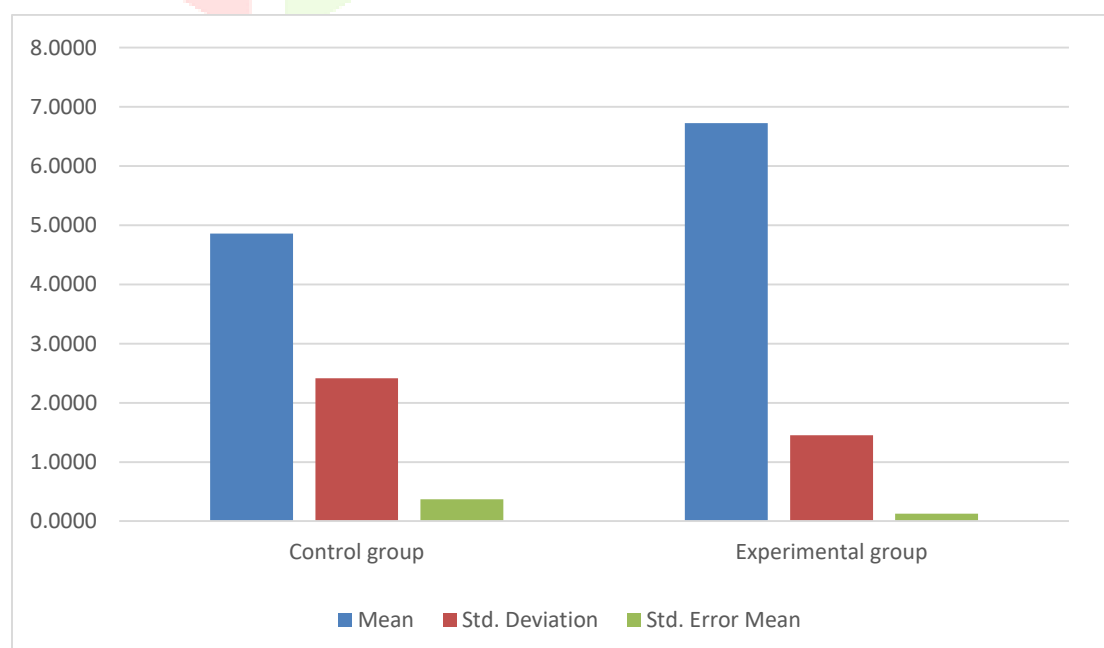


Figure 5 The result of the experimental group(2021) and control group(2020) of courses RBC1B002

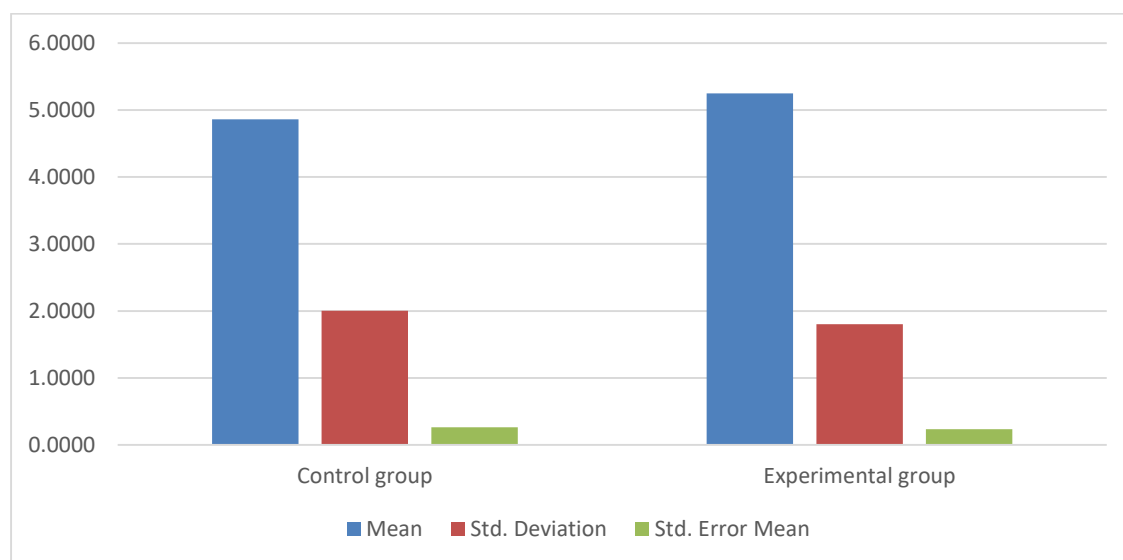


Figure 6 The result of the experimental group(2021) and control group(2020) of courses RBL1B002

IV. CONCLUSION

The 21st century demands both domain-independent and domain-dependent skills equally. This TLP emphasises both types of skills and also makes the learner understand the importance of both types of skills. The methodology highlights the skills the students learn based on the questionnaire given to the student at the end of course completion. A total of 109 participants filled out the feedback form during the first COVID-19 wave. These learners have been on online synchronous learning for the very first time. Some of the learners stayed in the very remote countryside where the connectivity is very poor but due to the availability of the OBC prior, they always stayed connected to the course. The problem set provided in the OBC helped them to assess their depth of learning. In case the learner got stuck in any place, they took the help of a peer or instructor through phone call or using a web-based platform. Many learners who have yet to participate in face-to-face classes have become involved in online mode. The result shows that this type of teaching-learning process could able to increase student engagement throughout the course work. The students also added some learning materials for further implementation. During the third wave of COVID-19, 2021(odd semester) the result further prove the effectiveness of this TLP. Though online mode is time-saving, still students prefer face-to-face more lively than online classes. Connectivity is a significant issue in online learning, but due to teaching-learning process and the availability of OBC beforehand, the learners could follow the course well. Many times, due to poor connectivity or health issues or some other reasons the learner fails to attend the virtual class, still as the OBC and reference materials are available, they easily catch the next class. The learner is encouraged to self-learn which will help them to become lifelong learners.

V. ACKNOWLEDGMENT

Prof. Shyamal Kumar Das Mandal's idea was behind all the work described in the paper. It was under his guidance the cloud-based framework was designed. He has been working in the field of learner-centric pedagogy for more than a decade.

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