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Learning Dialogues orchestrated with BookRoll: A Case Study of Undergraduate Physics Class During COVID-19 Lockdown

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Abstract: With COVID-19 pandemic forcing academic institutions to shift to Emergency Remote Teaching strategies, teachers worldwide are attempting several strategies to engage their learners. Even though existing research in online learning has proven that effectiveness of the online session is more dependent on pedagogical design rather than technology features, most teachers still focus on the intricacies of the technology. In this paper we present the adaptation of an active learning pedagogy - Learning Dialogue (LeD), for an undergraduate physics classroom. We used the eBook reader BookRoll to orchestrate an LeD along with the support of a video conferencing tool and a dashboard that provides immediate input on the engagement. The adaptation of the strategy utilized the appropriate affordance of each tool available in generating an engaging session for the students. Comparison of the student artefacts (memos in BookRoll) between regular face-to-face classroom session and online session indicated that there is a sustained engagement in the online class. Preliminary qualitative analysis also shows that the students were posing good conceptual clarifications/questions aligned with the session agenda.

Keywords: Emergency Remote Teaching, Covid19 Lockdown, Learning Dialogue, BookRoll eBook Reader, LAView Analysis Dashboard, Physics Education Research

1. Introduction

The sudden transition to Emergency Remote Teaching (ERT) (Hodges et.al., 2020) has left teachers and students with very little time to prepare for the changes that are ahead of them. Existing research in online and distance learning has already pointed out the need for promoting self-reflection, self-regulation and self-monitoring as an important factor in determining positive learning outcomes among students (Means et. al., 2009). This means that the key idea during this transition is for faculty to focus more on the pedagogical skills rather than technology skills for ensuring success of the online course experience (Shieh, Gummer, & Niess, 2008; Garrison, Cleveland-Innes, & Fung, 2010). However, with known barriers of attitude and skill deficit among teachers for online learning practices (Keengwe & Kid, 2010), it is really difficult to expect a large number of teachers to smoothly transition into an effective online facilitation mode during these times.

Due to COVID-19 pandemic, shifting from the face-to-face (f2f) to an online teaching has now become mandatory. With several concerns reported, it still remains challenging to constructively engage students in the f2f teachings (Felder & Brent, 2009). In an online teaching, it is even difficult to bring-in the classroom culture and maximize learning (Millikan, 1996). There are several challenges reported pertaining to online teaching. Few of them are social integration, low student engagement behavior, high drop-out rates, etc. (Levy, 2007). The problems are compounded for novice teachers, as they could lack recommendations for the best online pedagogical practices, adequate time to adapt to the new tool and institutional support towards providing the infrastructural facility. Scouring the existing research to make sense and then adopt those learning seems to be difficult in the current situation. Major hindrances experienced from the perspectives of online learners may be, the apprehension towards adapting new technology tools due to various levels of learner competency, feel of isolation and being out of comfort f2f learning zone (Felder & Brent, 2009). Despite the best intentions to provide an effective learning experience, most of the teachers feel apprehended to quickly switch over to the online learning. In order

to attain a better online student engagement, it is desirable for teachers to implement an active-learning (AL) online pedagogy along with the available technological affordances that would appropriately fit to their teaching context (Amy, Janet, Evelyn, & Sarah, 2012). An effective implementation of online teaching and learning practices need much detailed investigation that addresses the issues as perceived by both the teachers and learners.

We propose the use of active learning strategies that are closer to the existing face-to-face practices of the teacher along with the use of technology that supports reflection-in-practice as a possible solution to help faculty in smoothly transitioning into online educational practices. We provide an example of orchestrating pedagogy of Learning Dialogues (LeD) with technology affordances offered by the tool BookRoll. The case being described in the current paper is that of an undergraduate physics class for engineering students in India. The instructor has utilized the MOODLE and BookRoll features available as part of the Technology-enhanced Evidence-based Education and Learning (TEEL) project for more than a year. In the earlier report (Vijayanandhini & Sai Preeti, 2019), we show that the adaption of AL strategies in flipped learning method using the TEEL tools had been effective to better engage the students and enhance learning. In the current paper, we examine the pedagogic strategy called the LeD orchestrated with BookRoll in two different teaching contexts: (i) regular f2f class during the pre-lockdown (abbreviated as f2-LeD) and (ii) purely online conducted during lockdown with the help of synchronous meeting tool - GoTo Meeting™ (abbreviated as on-LeD). Both the f2-LeD and on-LeD orchestrations included the flipped learning provided within the TEEL platform as the learning management system (LMS). The study investigates the following research questions:

RQ1: What is the difference in engagement of students while participating in f2-LeD and the on-LeD methods ?
RQ2: What is the variation in the performance of students in assessments conducted after the f2-LeD and on-LeD, when following the LeD orchestrated with BookRoll pedagogy for similar topics ?

2. Literature Review

Physics educational researchers have shown that the simple conceptual acquisition from a limited context may not be sufficient to solve real world problems (Van Heuvelen, 1991). To diversify and deepen the conceptual acquisition, implementation of AL pedagogy is often emphasized. With several known benefits of AL strategies, many higher educational institutions have shifted away from the traditional lecturing. On the other hand, there is an increasing demand to develop technology tools and online platforms to cater the needs of creating different range of interactive teaching activities. In this section, first we highlight different AL strategies reported in the literature for the f2f class and online teaching. Next, we describe the AL pedagogical model adapted in our present study to create the flipped online contents. Finally, we introduce an LMS based learning analytics platform that has been designed with many optimal dashboard features which assisted the seamless orchestration of our active learning pedagogy.

2.1 Active Learning Pedagogies for f2f and online teaching

Several AL strategies are reported for f2f teaching to promote physics education at a tertiary level degree programs (Mintzes, Walter, 2020). Some of cooperative learning techniques includes peer instruction (Crouch, Mazur, 2001), think-pair-share (McTighe, & Lyman, 1988), jigsaw method (Aronson, & Patnoe, 1997), etc. In all of these strategies, the students are allowed to discuss with the peers to learn concepts while the teacher facilitates the process. In online teaching, there are technology affordances that helps to leverage the effectiveness of AL. However, adapting AL along with the technology adaptions to navigate and engage students within the online setting are still being explored (Nurul, Martin, & Frances, 2015). The researchers have shown how to appropriately shape the instructional design of online lecture videos to effectively engage learners using the click-stream data tool (Lin, Aiken, Seaton, 2017). Few reports highlight that the conceptual videos should be short and avoid abrupt transitions (Kim, Guo, Seaton, 2014). Whipp & Lorentz (2009) suggests to maintain an effective student interaction by asking a challenging question and then, provide a timely and concise feedback to those seeking help.

2.2 Pedagogical foundations of current work: LCM Model

The Learner-centric MOOCs (LCM), 'a prescriptive model consisting of a set of guidelines, activity formats and actions for MOOC creators' has been proposed (Murthy et.al., 2018). The model emphasizes interactive activities rather than traditional information transfer. Thus, it maintains a learner-centric pedagogy as its main orchestration. As shown in the Figure 1, the pedagogical basis of the LCM model consists of four active-learning structural components as follows:

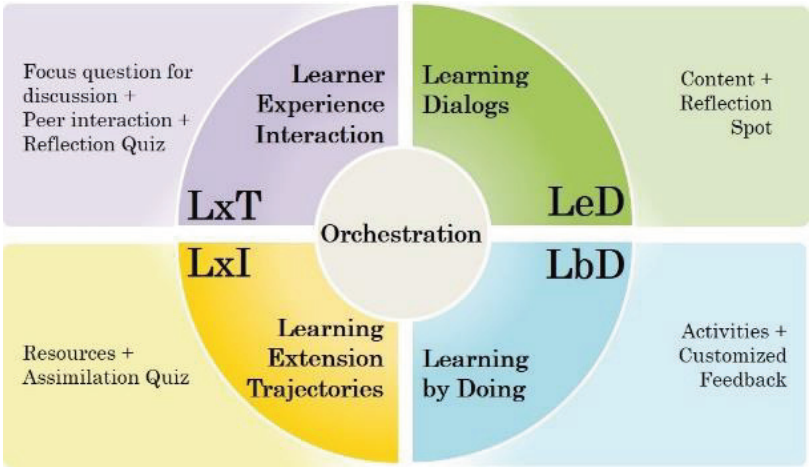

Figure 1. Overview of Learner-Centric MOOC (LCM) model (Murthy et.al., 2018)

(i) Learning dialogue (LeD), is the first element of LCM that promotes concept acquisition through learner interaction. The key design feature of an LeD is the reflection spot, a place for a learner to express prior conceptions, perform micro-practice or reflect. LeD videos (less than 15 minutes) can be created using interactive (H5P) video tool having multiple choice questions embedded within it to engage students.

(ii) Learning by Doing (LbD), an online quiz with customized and constructive feedback. LbD activities are formative assessment activities that provide learners with frequent opportunities to practice and apply their learning. It helps learner towards the goals of concept attainment, immediate application or integration of knowledge.

(iii) Learning Extension Trajectories (LxT), advanced resource materials to diversify student's learning.

(iv) Learner Experience Interaction (LxI), a discussion forum activity to cultivate a structured discussion forum interaction through focus questions. The focus questions drive and keep the discussion centred on a specific topic.

2.3 TEEL Infrastructure : BookRoll and LAViEW dashboard

We orchestrated our course on the Technology-enhanced and Evidence-based Education and Learning (TEEL) platform (Ogata, Majumdar, Akçapınar, Hasnine, & Flanagan, 2018). Figure 2 shows the four major components of TEEL. The learning behavior sensor captures the learner's and teacher's interaction data during the session. It offers a LMS, e.g. MOODLE, that integrate other e-learning tools. For instance, we used BookRoll, an e-book reader and LAViEW, the associated learning analytics dashboard (Ogata, et al., 2015, Majumdar, Akçapınar, Akçapınar, Flanagan, & Ogata, 2019). BookRoll allow students to read digital contents such as lecture slides or materials that are shared by instructor. It has a feature like red or yellow markers to highlight some parts of the text that are important or difficult to understand. Additionally, students can add memos to remember important points, annotate doubts or comments. They can bookmark pages to access them easily while reviewing the content. These actions are recorded and then can be viewed by the instructor to understand the reading habits of students in the learning analytics dashboard LAViEW (Majumdar, Akçapınar, Akçapınar, Flanagan, & Ogata, 2019). Literature reports suggest that the reading behavior of students can be used to visualize class preparation

and review patterns (Fu, Shimada, Ogata, Taniguchi, et al. 2017). LAViEW contains various panels of visualized indicators for monitoring and plays a central role to assist and identify problems in the teaching-learning scenario based on analysis of the visualized indicators. Both teachers and students can access these learning tools. Thus the TEEL infrastructure integrates the features of the eReader, LMS and Dashboard within a single service so that teachers can seamlessly move across the technology.

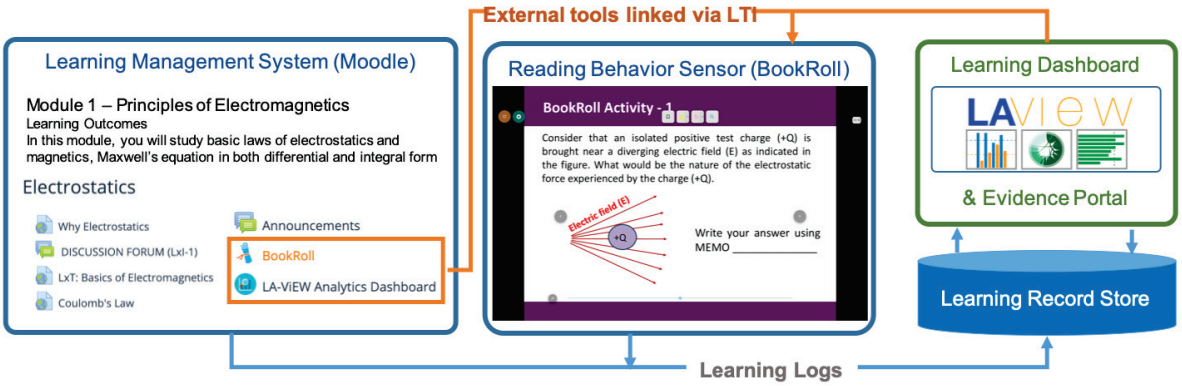

Figure 2. Components of TEEL framework in this study

3. Description of online orchestration strategy

In the present study, we utilized the TEEL platform to flip the learning content during both the f2-LeD and on-LeD strategies. Contents of every module were chunked into multiple sub-topics. The flipped contents for each sub-topic was created following the structure of LCM model: LeDs as short videos followed by LbD quiz, extended resources as LxT and the LxI forum activity. The f2f pedagogy allows a teacher to intersperse his/her lecture with regular activity to engage the learner with the concept. During online teachings, the instructor has to carefully choose the format of the content and activities based on the available technology resources. To adapt the pedagogy of LeD orchestrated with BookRoll into a technology mediated setting in the current context, the teacher designed the orchestration as shown in Figure 3 below.

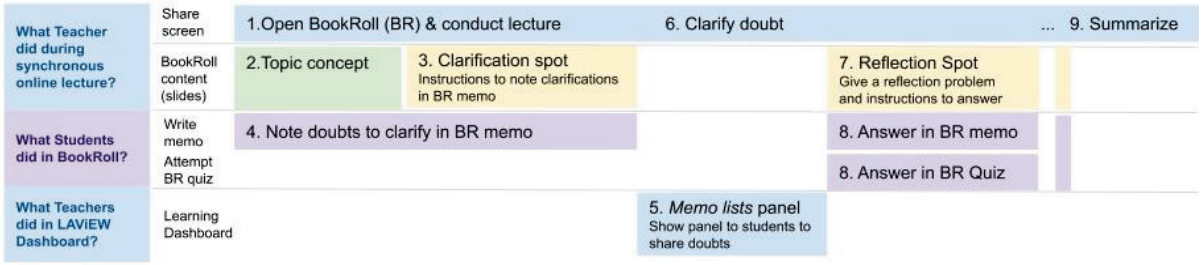

Figure 3. The pedagogical flow of LeD orchestrated with BookRoll strategy

(i) Session with GoTo Meeting and LeD video

Deliver the content through lecture mode in the GoToMeeting (a web conferencing tool) online sessions using the LeDs videos and BookRoll pdf materials of the MOODLE as shown by steps 1 & 2 in the pedagogical flow diagram (Figure 3). Design an explicit spots at pause points called "clarification spot" (as shown in Figure 4 a) in the BookRoll, where the students are required to reflect on the session till that time and post a query or ask for clarification in the form of a memo. Encourage students to note down their doubts/clarifications through the memo function of BookRoll tool during the online lecture as shown in Item number 4 in the Figure 3. The memos so created are seen by the instructor through the LAView dashboard of TEEL platform (item 5 in the pedagogical flow) and is followed by verbal explanation/clarification given by the teacher instantly during the same sessions (as shown as item 6 in the pedagogical flow).

(ii) Reflection spot activity with BookRoll

To elicit misconceptions and ensure that students have achieved conceptual understanding, these clarifications are followed by the next set of reflection spots, 1 to 3 (given as practice questions) that required students to conceptually reflect or do micro-practice on the content learnt till this time (Item 7) [screenshot image shown in Figure 4 b]. The answers that a student comes up with after this reflection/micro-practice are gathered through memos or as answers to BookRoll or LbD quizzes (Item 8 in the pedagogical flow).

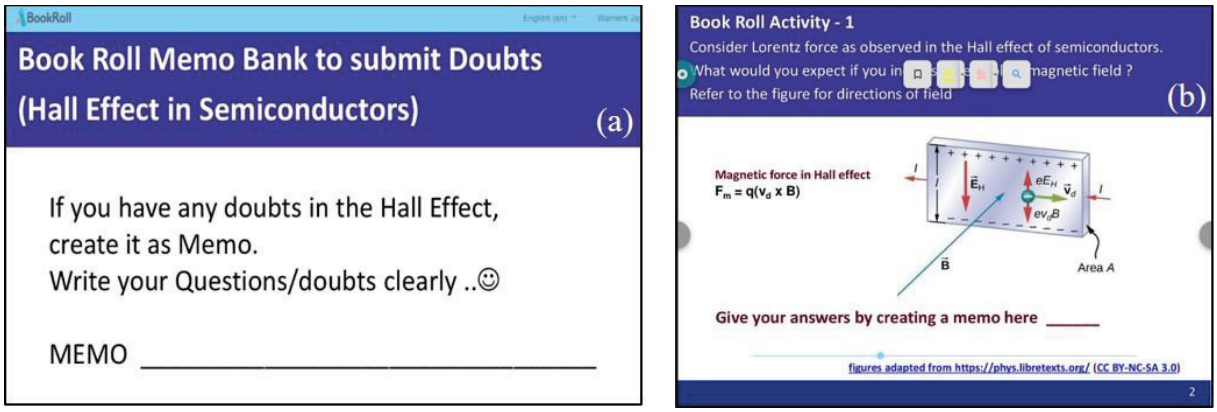

Figure 4. Screenshot of (a) Clarification Spot and (b) Reflection Spot activity created in BookRoll tool during the on-LeD method.

(iii) Feedback sharing

Share the LAView dashboard screen during the online session to summarize the concepts (Item 9 in pedagogical flow) or augment the understanding of solutions to the reflection spot problems.

4. Research Methods

4.1. Research Design

The instructional design, namely, the LeD orchestrated with BookRoll is adapted within two different teaching contexts: (i) regular f2f class during pre-lockdown (f2-LeD) and (ii) fully online during the COVID-19 lockdown (on-LeD). Both the f2-LeD and on-LeD included the flipped teaching in TEEL system – the LCM based activities primarily addressing the out-of-class component, while the BookRoll based LeD activity addressing the in-class component. The pedagogical flow as discussed in the Figure - 3 only differed in the timeline of implementation for both the f2-LeD and on-LeD methods. In case of on-LeD, all the steps from 1 to 9 were integrated within the same online sessions as an immediate post-teaching activity. Whereas, in case of the f2-LeD, the students were required to note their doubts/clarification (step - 4) in BookRoll tool provided in the LMS during the out-of-class learning, while summarizing (step - 9) were followed in the next f2f teaching session (as shown in the Table-1).

Table 1. Pedagogical flow in steps during the f2-LeD and on-LeD methods

Pedagogical flow in steps	*f2-LeD*	*On-LeD*
Step-1. Content delivery	Lecture during regular f2f	Lecture in GoToMeeting
Step-3. Clarification Spots	flip phase (out-of-class)	online immediate after Step-1
Step-7. Reflection Spots	f2f session arranged in the computer lab once in a week	online immediate after Step-3
Step-9. Summarizing	Next f2f class sessions	online immediate after Step-7

4.2. Course and Participants

The study was implemented in freshman undergraduate engineering (B.Tech) students with the specialization (major) in electronics and communication at GITAM (Deemed to be University), India. A total of 58 students were offered the Engineering Physics (19EPH131) course during the semester-II. The students were provided with an individual log-in to TEEL platform to access the learning activities of the flip phase. Same instructor taught the course during both the f2-LeD and on-LeD teaching. 19EPH131 consisted of five modules, out of which first three and a half modules were taught during the pre-lockdown and the last one and a half module was taught during the lockdown. To address the RQs, we had selected few target topics from the modules taught during the f2-LeD and on-LeD teaching methods. The topic equivalence was checked with the similarities in pre-requisite knowledge required to learn.

4.3 Data collection and Analysis overview

We attempt to answer the RQ-1 with three different data sets as collected from the LAView analysis dashboard of TEEL platform: (i) count of specific student logs (only 'viewed') for LeD activities and total LbD quiz attempts from the TEEL platform during the course period, (ii) total count of student memo responses collected during the 'clarification spots', answers to the reflection spot problems for the target topics, (iii) analysis of quality of memos annotated in BookRoll tool for the target topics. Students activity report recorded by the TEEL platform such as log data can be extracted by the MOODLE administrator. These data offer insights on the learning progress of students in the flipped learning contents. Therefore, we used them as a metric for student engagement [Rosalina & Rodolfo, 2017]. As we had three materials for LeDs of the target topics, we averaged the total student logs per single material.

Then, we compare the log data for f2f and fully online teaching. Secondly, the quality of memos was analyzed keeping the checkpoints as: (a) 'Whether the memos are relevant to the key concepts dealt', (b) 'Whether memos have been created after carefully reflecting on the session contents ?. The RQ-2 was addressed by comparing the mean scores of online quizzes conducted after the BookRoll activities of f2-LeD and on-LeD methodologies. It is important to note that we compare the post-test quiz scores of two different cohorts of participants implemented with different target topics. To justify the comparison, we select the post-test scores of only those questions that measured similar level of thinking skills (say 'Understand' or 'Apply'). Paired T-test analysis was then carried out on these scores to compare the effectiveness of learning. We used iSAT, a visual analytics tool to understand the transition pattern of student learning (Majumdar & Iyer, 2016).

5. Results

5.1 Student Engagement

Creating memos was integral part of both the f2-LeD and on-LeD sessions. Table 2 shows the number of student memos during the f2-LeD and on-LeD sessions for two different target topics. We observed that the total count of memos collected as the clarification spots in BookRoll tool were higher during on-LeD as compared to f2-LeD. It was observed that during synchronous on-LeD teaching sessions, the students proactively engaged in the BookRoll activities to create memos. Further, the instructor could instantly clarify those doubts raised before initiating the reflection spot activity. In contrast, during the f2-LeD, regular engagement of student in the flipped contents, to read and annotate memos was not observed. In case of f2-LeD, there was a lag between the topics covered during the f2f session and those flipped topics for which the student submitted their memos in BookRoll. This led to difficulty for the instructor to clarify the doubts during the f2f sessions on concepts for which the students had misconceptions. Analysis of the correct answer counts for the reflection spot questions in BookRoll indicated that the students could answer most of questions correctly. In fact, number of students who could correctly answer the questions were much higher for those different topics dealt-in on-LeD as compared to the f2-LeD (Table 2). The number of student responses for consecutive reflection spot questions from 1 to 3 decreased in both the teaching phases.

Table 2. *Comparison of learning log data (from N=58 students) in TEEL platform during f2-LeD and on-LeD sessions.*

LCM activities using BookRoll tool	Number of logs extracted from TEEL platform	
	f2-LeD session	on-LeD session
Clarification Spots	48	75
Reflection Spot - 1	64	86
Reflection Spot - 2	35	69
Reflection Spot - 3	20	64
LCM activity during flip phase		
LeD videos (average per material)	77	75
LbD attempts	30	45

The preliminary qualitative analysis of the memos posted during the online setting indicates that the learners were able to focus on the key concepts of the online lecture. The memos collected during online sessions showed that clarifications raised by students were more relevant to the session agenda. There were also memos pointing to concepts that were going to be covered in the next sessions. For example, the memo: "If the electric force would balance the magnetic force, then in this case Lorentz force would be zero" shows that the student had a misconception in understanding the balances between basic forces acting on charged particles in the Hall effect experiment. This clarification spot was addressed instantly during the session,which also helped students to better understand the subsequent topics of the same session. Further, in one another memo, students raised memos like "Please explain in detail of why the photo diode works only in large depletion condition and how such wide breakdown voltage is created in large depletion zones" showed that the students had paid attention to the topics being taught online and had put sufficient thinking on contents before raising the doubt.

5.2 Student performance

To analyse the performance of the students, we first compare the transition of the scores obtained by learners in the post-tests as shown in the Figure 5. We see that there is an effective upward transition for learners. The transition pattern is created by considering three strata of scores (high - , medium - , low-) that are obtained by students in the post-tests (Majumdar & Iyer, 2016). This transition pattern shows that 36 learners scored high score in the post-test conducted after the on-LeD session, compared to the 25 who obtained high score after f2-LeD. Out of this 36 high scorers, 15 students had initially scored a medium/low score in the post-test after the f2-LeD. Now to further verify statistically whether this is a promising trend, we compare the mean score of the group of students in both the post-tests. Post-activity test analysis of selected questions showed a higher mean score (M = 9.48 out of 10) for on-LeD teaching as compared to the f2-LeD (M = 8.37 out of 10). As shown in the Table 3, the paired T-test analysis of post-test scores indicated a statistically significant p-value ($p < 0.05$). This shows that the on-LeD method led to a better student academic performance as compared to f2-LeD method.

6. Discussion

Due to the sudden lockdown condition caused by the Covid-19 pandemic, many institutes and Universities had to switch over to the digital mode of teaching and learning within short notice. Therefore, it may be difficult to achieve the desired learning outcomes in the end-semester examinations, as switching to online teaching is not easy and demands unique skill sets from the teachers. To adapt to this sudden transition, we had implemented a teaching strategy called LeD orchestrated with BookRoll to conduct the synchronous online teaching using the GoToMeeting web conferencing tool. Analysis of MOODLE log data showed that we could effectively engage students during the online teaching. The students engagement in the BookRoll activities showed substantial improvement as compared to f2f class. Qualitative analysis of the memos submitted during online teaching inferred that the students paid more attention to the contents and asked doubts reflecting on the sessions. Presently, the f2-LeD and on-LeD strategies are implemented in two different teaching

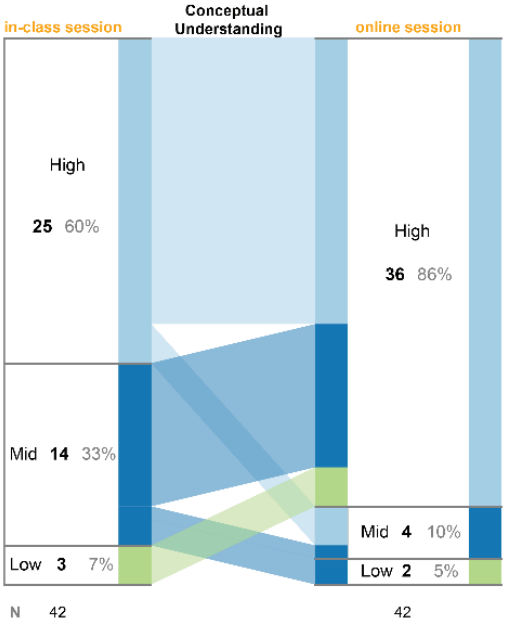

Figure 5. iSAT analysis of test scores for post BookRoll activity during f2-LeD and on-LeD.

Table 3. *T-Test analysis of post-test scores after the LeD with BookRoll strategy implemented during the f2f and online teaching.*

Post BookRoll activity test during	N	Mean (out of 10)	Std. Dev.	Variance	df	t stat	p-value*	t - critical
f2-LeD	42	8.37	2.08	4.51				
on-LeD	42	9.48	1.83	3.27	40	2.75	0.004	1.683

* Statistically significant, p value < 0.05

contexts. Therefore, we emphasis that there is a limitation to compare both the strategies taking evidences only from the quantitative data analysis. The pedagogical design of the learner-centric MOOCs has proven to be effective for conducting an online faculty development programs and MOOC courses for the diverse and a massive scale of learners (Warriem, Murthy, Iyer, 2016; Veenita, Gargi, Murthy, et., 2018]. The authors have earlier reported on contextual improvisation and data-driven validation of blended LCM model adapted for a small and less diversified group of learners in regular engineering physics course (Vijayanandhini & Sai Preeti, 2019; Kuromiya, Majumdar, Warriem, & Ogata, 2019]. In the current study, we adapted the pedagogical design of LeD, which is the first learning component of the LCM model. The pause points of the LeD design was provided as 'clarification spots', which helped the students to reflect or collate their doubts using the Bookroll tool. The feedback or doubts as collected by the LAView dashboard features of TEEL platform helped the Instructor to instantly address the portions where the students needed further clarifications. It also assisted to add new content to augment better understanding of the topics. Importantly, the clarification spots helped to break the monologue in the content delivery in online. Following the clarification spots, students were prompted with the BookRoll based reflection spot activity that required to solve and answer atleast two to three reflection spots (as practice questions) using the memo functions. This allowed students to do micro-practice immediately of those concepts being taught within the same online sessions. The instructor could then review all the solutions of the problems and reasonings using the LAView dashboard, to further help students to engage better even during the post teaching activity. The reflection spots were then followed by the summarisation of diverse view-points and a final closure of the pedagogical learning design of the LeD. Thus, the teacher could create a better engaging and interactive online sessions utilizing the technological features (BookRoll, LAView dashboard) available in the TEEL platform.

The overall student attendance behavior during on-LeD sessions was only about 50 to 60 %. Thus, the students were instructed to learn asynchronously from the flipped LCM materials such as the

LeD videos, BookRoll based activities and the LxT resources. We found that more students submitted the solved problems provided as the asynchronous assignments through the BookRoll tool. This, in turn, facilitated those learners who could not attend the synchronous GoToMeeting sessions due to unavoidable reasons like non-availability of gadgets or network connectivity issues. The analysis of post-test after the BookRoll activity for both the f2f and fully online sessions indicated a statistically significant difference in the mean scores. Thus, we show that the academic performance of students did not hamper or dip due to the sudden transition to online teaching. We adopted a similar pedagogical flow during the f2-LeD where the instructor had used the f2f class (instead of web conferencing) for delivering content and clarifying the initial doubts. However, the response of the students to get engaged and learn from the flipped activities was not completely positive. It was observed that they spent more time on exploring the technology tool rather than focusing on the content. Additionally, since there are restrictions on bringing own devices inside the classroom, all the BookRoll activities were conducted in a computer lab by carefully adjusting the time slots with other instructors. It can be noticed that there is an advantage of adjusting session, especially, in context to the teacher-mediated f2f classrooms settings. However, with most of the learning being transferred to online mode after the lockdown, the logistical limitations (of lab availability) were now removed and the instructor could focus more on the pedagogical design of the online activity. Presently, we could utilize the new dashboard tools (LAView & BookRoll) of TEEL platforms, to collect the real-time feedback and conduct an interactive online learning session, which is otherwise not possible with any other MOODLE platforms, particularly during the COVID-19 pandemic lockdown.

7. Conclusions

In the case study as discussed here, we see that transition to online settings have provided the instructor more flexibility to incorporate careful pedagogic strategies in the teaching-learning process. The available technology infrastructure also supports the instructor in the process by providing real-time data of student engagement so that further time could be invested in addressing student queries and clarifications. The teacher has carefully selected a strategy that is closer to a regular f2f strategy that both teacher and students are more exposed to. As Shieh et.al (2008) and Garrison et.al (2010) recommends, this has allowed the instructor to carefully design pedagogical actions to be done using the various technology features (GoTo Meeting, MOODLE, BookRoll and LAView) both by the teacher as well as the student during the online settings. The familiarity of the tool to both the teacher and student (through prior use in regular f2f setting) has helped to minimize the time required to adjust to the usage of tool in an online setting. This is an important factor to consider while selecting tools for online teaching-learning usage.

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