Increasing the interaction time in a lecture by integrating flipped classroom and just-in-time teaching concepts

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Abstract

Limited contact time in the traditional lecture structure poses a challenge for the lecturer to select the depth of material covered in the lecture while ensuring complete coverage of the syllabus. In the case of large groups, this also restricts the time that can be dedicated for enquiry based learning and active engagement with the students. This lack of enquiry based learning is cited as one of the main disadvantages of traditional lectures as a teaching strategy (Cashin 1985). Furthermore, due to the diverse learning abilities of the students some concepts are very basic for a subset of the class and they lose their focus if they feel that trivial points are being discussed in a session.

Technology provides a potential solution to this dilemma. One-way delivery of material can be provided in the form of a video or online presentation prior to actual contact session intended to cover a topic. The students can go through the material in advance and come prepared in the session to clarify their understanding using the enquiry-based-learning methods. An additional benefit is that the material remains available for the students for later reinforcement of their learning/understanding and also for the revision before a formative or summative assessment. This material can also be improved over time, based on student feedback and requests. In this article, we investigated how effective this mode of teaching/learning can be in traditional series of lectures by running experiments with postgraduate (PG) students at the University of Surrey.

Introduction

Enquiry-based or Problem-Based learning is known to be an effective method for deep learning experience (Healey & Jenkins 2009). Limited lecture time and large class size makes it impractical to engage with students for enquiry-based learning. Online resources (podcasts etc.) can be used to augment the classroom time, freeing up some more time for stimulating enquiry based learning and more frequent one-to-one interactions with students. This will also provide an opportunity to augment the inquiry-based teaching with guided instruction, which is shown to be more effective in certain cases, (Kirschner, Sweller, & Clark 2006).

Based on the practical constraints encountered, we incorporated online videos to augment lectures, commonly referred as flipped-classroom-based teaching. Flipped classroom promotes the use of technology (e.g. video lectures) for active learning in a classroom as well as at home, so a lecturer is able to move basic contents of lecture outside the classroom via technology (Bergmann, 2012). By using the flipped classroom, we spent more time interacting with students in class rather than traditional lecturing. The flipped classroom activities work on resolving well-known misconceptions by carefully designed tutorials that are guided by well-trained instructors and well-documented step-by-step instructions.

We had to broaden the horizon of our investigations and generalised further. Instead of just focusing on the use of flip classroom, we generalised it to a more interesting concept of "just-in-time teaching" (Novak et al. 1999; Simkins & Maier 2010) where, more generally, web resources are used to enhance the classroom teaching experience. Just-in-time teaching (JiTT) aims to enhance the active learning approach to teaching (Sutherland & Bonwell n.d.). It is a form of an interactive engagement approach to instruction as proposed by Hake (1998). In this teaching method, the students take the driving and active role in their learning experience and they steer the strategy as well as the content of the lectures. Many other recent initiatives in physics and engineering teaching employ the interactive-engagement approach at their core. Some examples are Tutorial-Based Instruction (McDermott 1991), Peer Instruction (Mazur 1996) and Workshop Physics (Laws 1991).

We integrated JIIT with the concepts of flip classroom to enhance students' learning experience and make the most of their time in the classroom. This article incorporates a flipped classroom approach with JiTT method by providing tutorial videos prior to the actual lecture and then obtaining student feedback using a carefully designed assignment for the students. The lecture can be planned based on the weaknesses and gaps in the student answers.

Peer Instruction uses some well-designed multiple choice questions to identify the trend of answers in a classroom and then sharing this trend with the group and allowing further deliberation in small peer groups when the answers to these questions are gathered again. This two-step process guides the lecturer about which concepts and areas need more time and effort to enable better learning of the group. This experiment used JiTT to help enhance the quality of the Peer Instruction questions. Based on the performance of the students in the pre-lecture assignment, the peer instruction questions were designed and Electronic Voting System was used to poll the student responses and then use the group responses to focus the lecture agenda.

The main idea of our project is to put the students in charge of their own learning, guided by a human instructor who asks them probing questions and provides constructive feedback on their learning. This idea is shared by many other active-learning innovations, such as context-rich Problem-based Learning (Heller & Hollabaugh 1992), Socrates dialogue method (Hake 1998; Hake 1987) and Active Learning Problem Sets (Van Heuvelen 1991). The main aim of all these schemes is shared by the framework adopted in this project – students are put in charge of their learning by providing them a chance to go through the material in advance and attempt to solve a problem or answer some questions. Their responses provide a guideline to the instructor to arrange the lecture content accordingly. This also enables the lecturer to prepare well designed peer instruction or electronic voting questions to guide the student learning in an optimal manner.

Project Background

As part of the initial plan, videos were designed to augment the lectures. In order to ensure that the students participate and benefit from these videos it was necessary to ensure that they engage and use these videos before coming to lectures. To this end, pre-lecture assignments were designed to test their level of effort in understanding the content before the lecture. These assignments were based on the questions that require a descriptive answer so that the thought process of the students can be assessed rather than the correctness of the answer. These were uploaded every fortnight on the online portal of ULearn and the student attempts were collected there. In order to ensure that the students take this exercise seriously, these assignments were given a 10% weightage in the final assessment of the module. This is inline with the suggestion of Hake (Hake, 1998). To circumvent the problem of student perception that they were tested on topics that they were not actually taught, all these assignments were marked on the basis of effort and not on the basis of the correctness of the answers. To provide timely feedback to the lecturer as well as the students, an online learning system called ULearn was used to collect assignments, asses and return the feedback on the assignments. ULearn was the University of Surrey's web-based learning environment until 2012 that could be used for uploading material, student discussions, collecting online submission of assignments and providing student feedback. Questions in the assignment were also used to gather some student suggestions and feedback on how to improve the delivery of the video content and the organization of JiTT framework to actively tune the process for optimal outcome using reflection on the past. Although assignments were marked based on the effort only, selected best answers were shared and commented in the classroom to provide incentives for accuracy and correctness.

The main aim of the project was to access the feasibility and suitability of a system that can achieve following goals:

- Encourage the learners to better prepare for the classroom encounter
- Off-load less conceptual and more methodological material for offline access to save valuable class time for interaction
- Enable the catering of a group of learners with diverse abilities and backgrounds, by providing extra help/information on a demand basis.
- Help lecturers identify the difficulties faced by learners in order to introduce timely changes to overcome these difficulties
- Encourage students to develop a stronger urge to gain knowledge
- Transform the lecture classroom into a more interactive learning environment

An additional aim was to identify the practical constraints and problems that may arise when implementing this system in the University of Surrey environment and within the available resources.

The final goal was to prepare a list of recommendations and action points to ensure that this technique is gradually tailored to suit the University of Surrey environment and constraints and can be gradually improved over its future implementation using the tools of reflective practice.

Implementation Plan

The method was piloted at the University of Surrey. An undergraduate module with 20 hours of contact time over two semesters (from September to April) was taught using this method. The class size was around 70 students. As a pilot experiment 10 sessions (out of total 20 sessions) were conducted based on the proposed model – online video material was uploaded a week in advance and the lecture session was used for enquiry-based learning or interactive Q & A learning session. To ensure that the students go through these videos before coming to the lecture, short assignments based on questions that require a descriptive answer were uploaded every fortnight on the online portal of ULearn and the student attempts were collected there. These submissions were marked and feedback was provided on the same online system.

Several feedback mechanisms were used to collect data on effectiveness of this method, some are listed here:

- ULearn reports to see what fraction of students actually went through the online material before the session.
- ULearn-based student feedback for each online resource, collecting information on how useful the student found this for their learning and what they prefer to be changed/improved.
- Student feedback on effectiveness of enquiry-based face-to-face sessions was also collected. Information was gathered on what was the participation ratio and did it change over multiple sessions.
- Information was gathered on how many students actually used these resources for their revision.
- After the final summative assessment a comparison was made on student performance on areas that were taught under the proposed model and the areas that were taught in conventional manner.

Selection of different research and data gathering methods was broadly guided by Cousin (2008). Student questionnaires were utilised to justify the feasibility and effectiveness of the use of online resources as well as the JITT approach of lecturing.

Strategy and Execution of the plan

In order to ensure the student engagement and participation in this experiment, we had to introduce serious motivators for them. In this regard some summative assignments (counting 10% to the final grades) were designed to gauge the involvement of the students. This is in-line with the recommendations of Hake (1998) for the success of interactive-engagement. Hake recommends that a necessary condition for the success of this approach is to provide motivational factors in the form of grade incentives to encourage students to take the interactive activities more seriously.

- Use of online videos

Online videos (12 videos mainly focusing on explanation of key ideas and mathematical derivations) were designed to explain specific concepts. In total 12 videos were prepared with an average running time of 15 minutes. They were intentionally kept different from the actual lecture since they were not to act a substitute of the face-to-face lecture rather as an augmentation and preparation for the face to face session. Online videos were also used to demonstrate mathematical derivations and working of electronic circuits. The focus of the video was the screen of the lecturer's PC who was explaining the idea using "digital ink". All screen activities were captured using screen capture software (CamStudio: freeware) on a "tablet device" (Lenovo X61). On average each of these videos takes approximately 45 minutes to prepare for every 15 minutes running time. However, these videos can be re-used every year so demanding time constraints can be justified for adopting this method.

- Delivery of online videos

Initially online videos were uploaded as files to the Ulearn. The student feedback indicated that this method of delivery was not convenient since the students had to download the complete file before they could play the video. The file size was considerably large as well. In response to this problem, Box of Broadcast (an online portal for sharing the video content and controlling the access of each uploaded video) was identified as an alternative method of delivery. This enabled online streaming of the videos directly from a link on the module webpage on the Ulearn system. A large number of students reported that this worked well for them.

- Peer groups and management

Random peer groups were made and the size was kept to a minimum: a pair of students in each group. The students expressed their inclination to be able to select their own group partner but this was discouraged to ensure a reasonable mix of abilities in each group. This random mix was also expected to provide them the valuable experience of working in a team with other team partners that are not selected by choice.

- Marking and feedback

The extra workload due to the tight time line to mark the student responses and provide them feedback was the only drawback observed for this proposed teaching framework. In order to keep this workload manageable, assignments were designed to be given fortnightly rather than weekly. An attempt was made to provide constructive feedback with some suggestions how the response could be improved. For common misconceptions and mistakes, lecture sessions were used. Model answers were provided to help the learners perform self evaluation.

- Gathering the access statistics

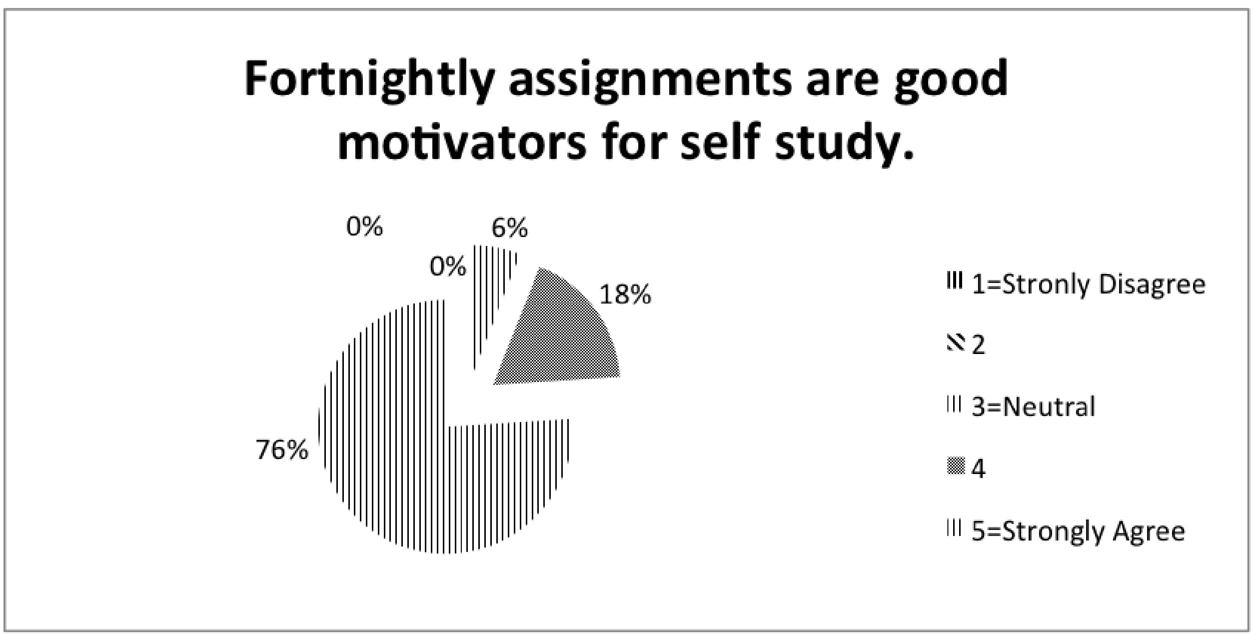
Since there were technical limitations on both online systems (Ulearn and Box of Broadcast), the access statistics were not readily available. In order to ascertain how frequently different videos were viewed and at what times, we decided to obtain explicit data through a student questionnaire. The results and the corresponding insights are discussed below.

- Managing the classroom

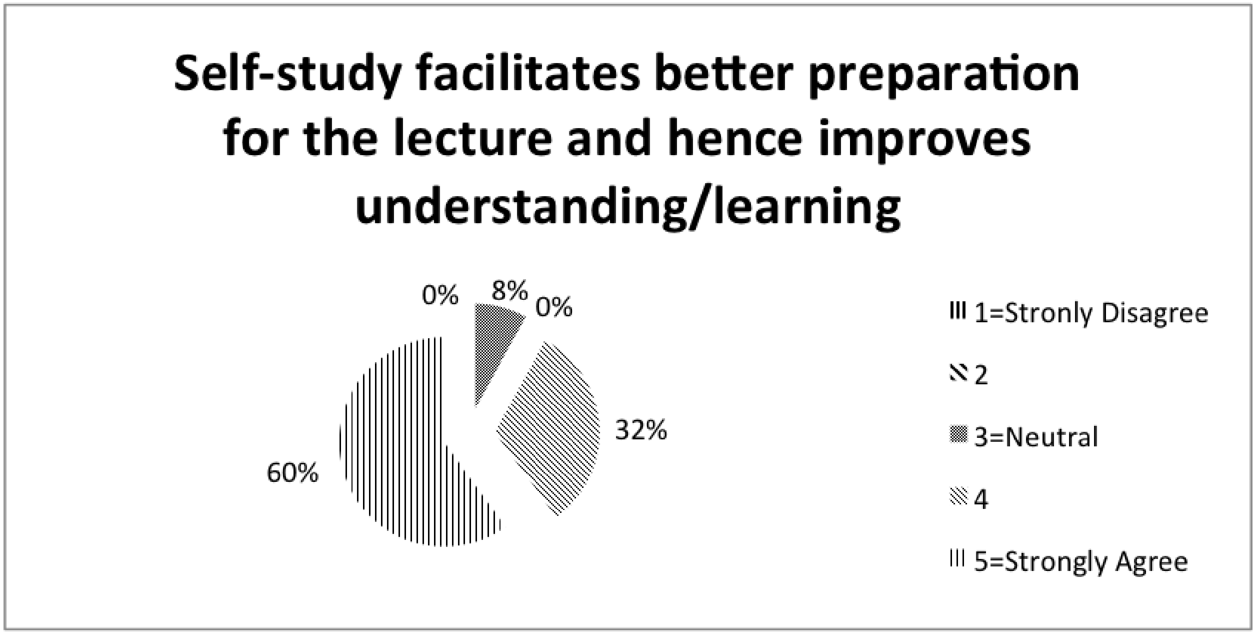
In the proposed setup, the lecture started with the presentation of some selected excerpts from the student answers to highlight best practice as well as highlighting the potential pitfalls and misconceptions. Based on the peer-review exercise, a suitably selected vocabulary is key to providing constructive feedback without causing a loss of motivation for the students who failed to provide a model answer but made a reasonable effort to understand the content and video prior to the lecture. This is followed by a pre-selected focused agenda to highlight the main concepts and key learning points. Enough time is allocated for a carefully designed polling question to be answered by the students using an Electronic Voting System (a system where handheld devices and internet enabled phones/tablets can be used to participate in a live poll to answer a question with multiple choices for the answer. The class choices are displayed instantly once the poll is closed). This question acts as an immediate feedback to the lecturer if the main point has been successfully conveyed. The session is left open to questions from the students and the lecturer takes the opportunity to guide the students to pointers for further learning as well clarifying the misconceptions.

Results and Discussion

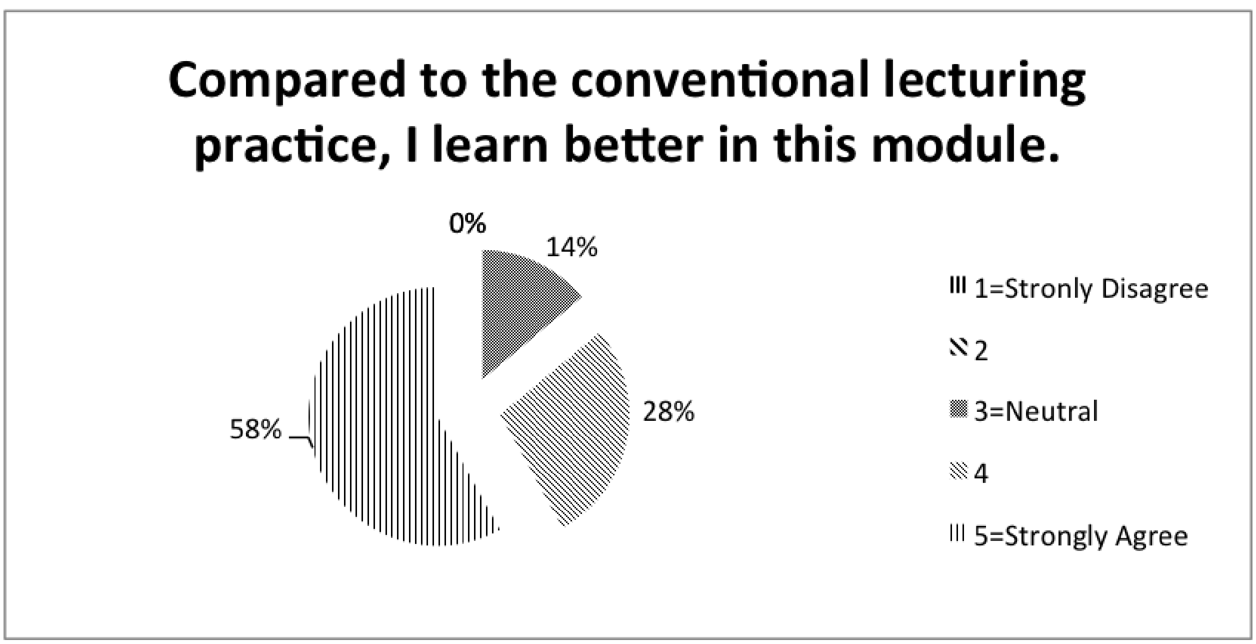
Data were collected in two phases in order to assess what was working well and what could be improved. In the first phase eight questions were asked by all volunteering participants in the lectures to gather their qualitative assessment on what was working well for them. This first phase feedback was obtained towards the end of first semester (nearly the middle of the planned duration of the whole module). In total 50 responses were obtained and the data were analysed to reflect how things could be improved for the next half of the module. The results of these questions are presented below with the brief discussion on the insights gathered from this data.



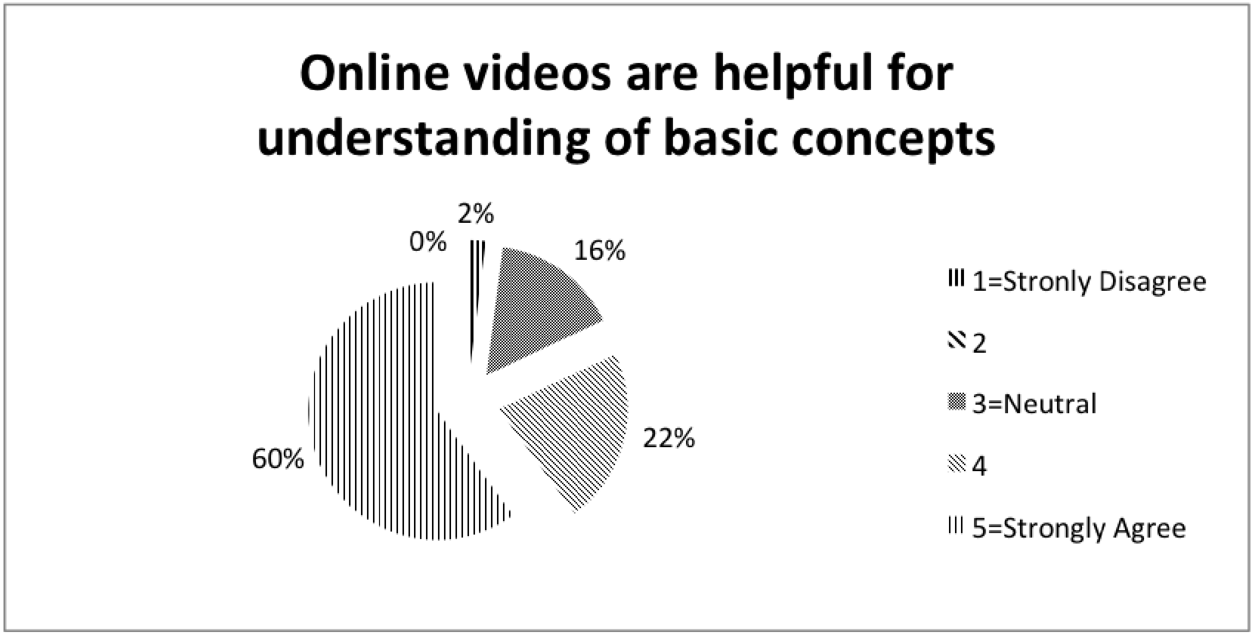
As depicted, it was verified through the student response that the idea of introducing the assignments to ensure student participation was valid since an overwhelming majority agreed that these assignments were a major motivation for participating in the self learning activities.



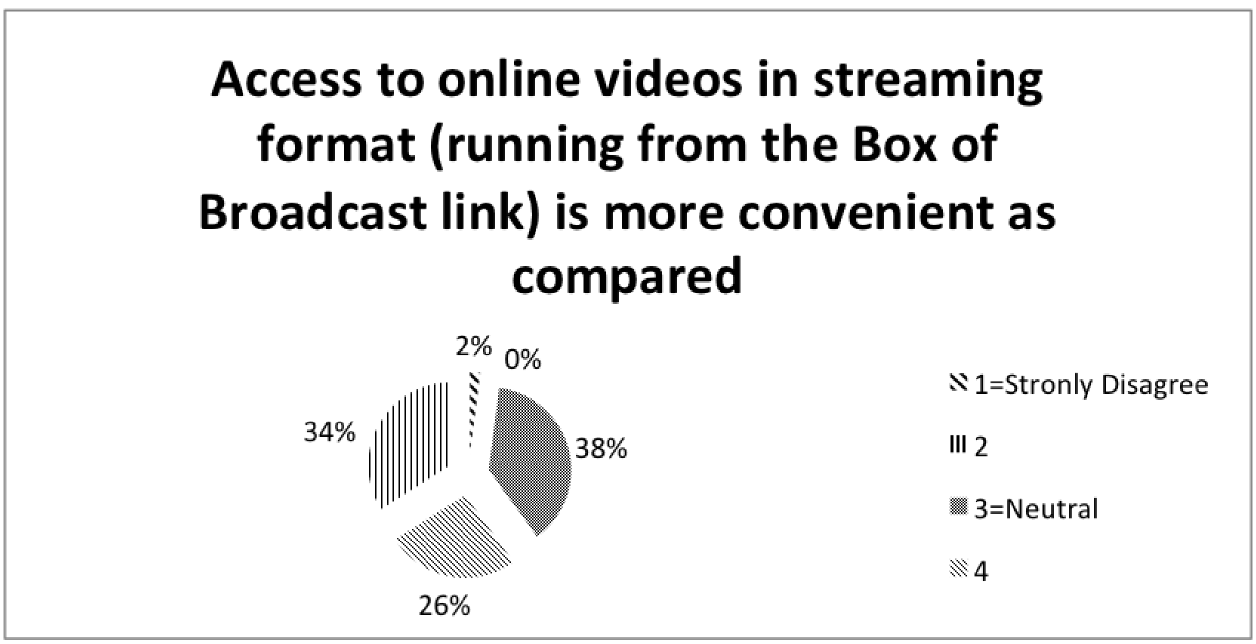
It was also verified that self study enables the students to be better prepared for the lecture and this preparation pays well in terms of better understanding and learning in the class room session. The above mentioned fortnightly assignments play a double role here by not only motivating the students for this prepartion, but also closing the loop with the lecturer and providing him or her with useful insight on where to focus the lecture content.



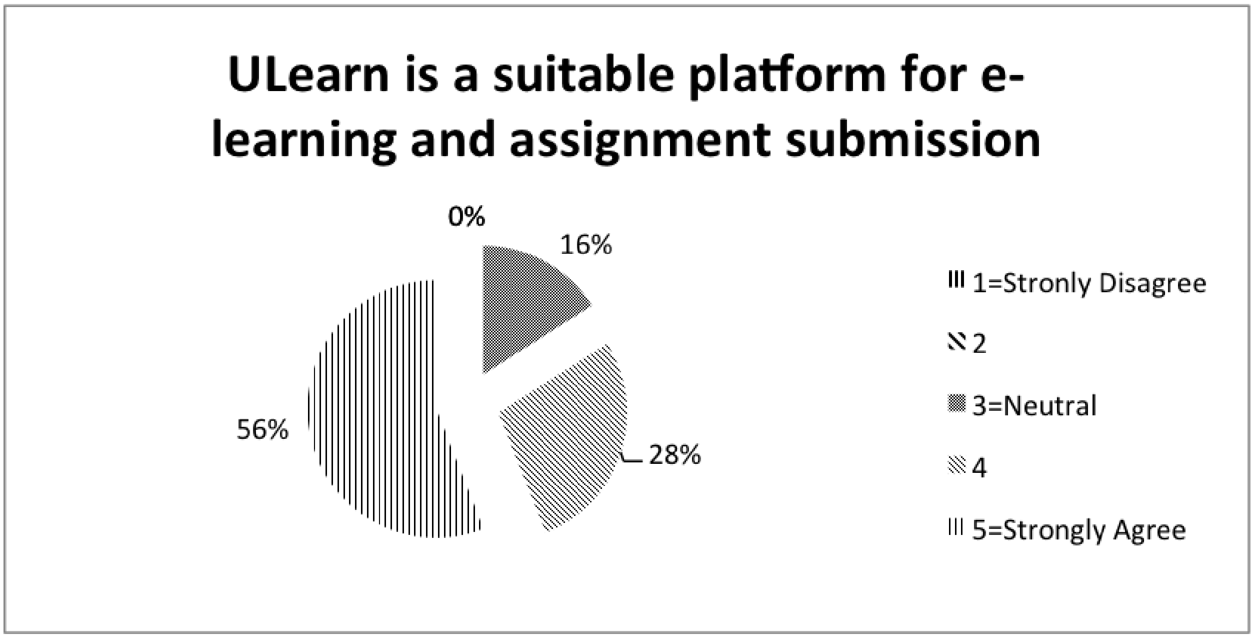
General student opinion was obtained on the feasibility and suitability of JiTT approach adopted to our context. The surprising result was that inspite of extra work load and increased pressure on the learners an overwhelming majority “strongly agreed” or “agreed” to the statement that this method was more effective compared to conventional lecturing.



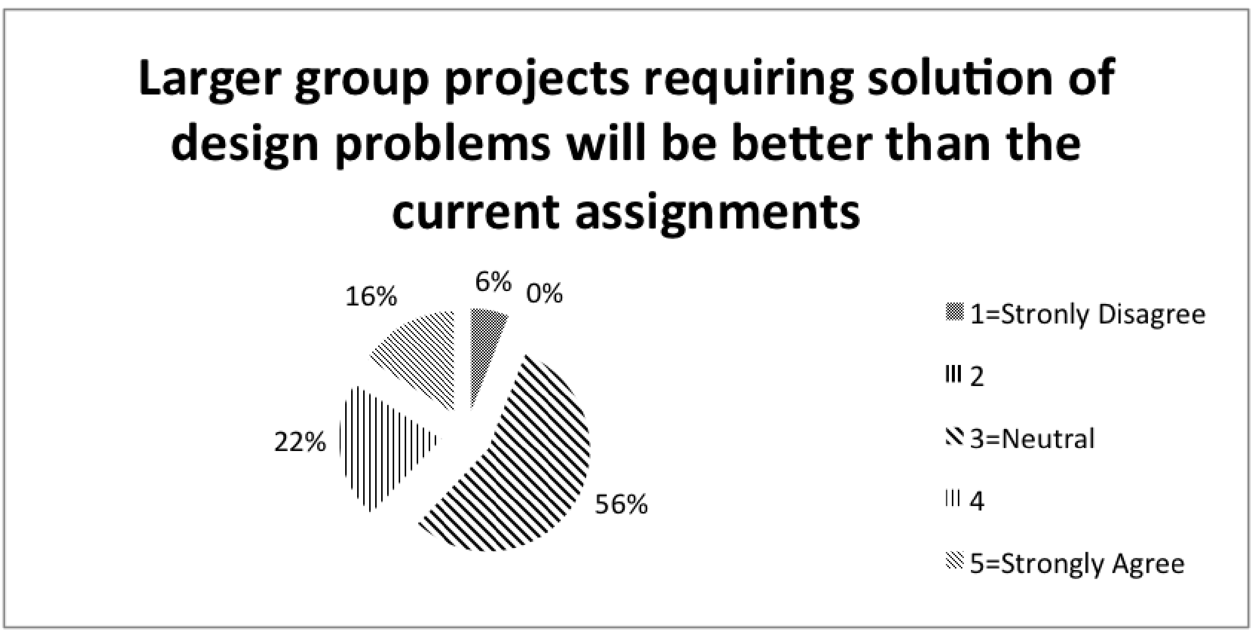
Direct input was also obtained on the suitability of the online video content in helping the students for preparing for the lecture before attendance. A reassuring majority expressed their confidence in the online video content as a helpful tool for the understanding of the basic concepts.



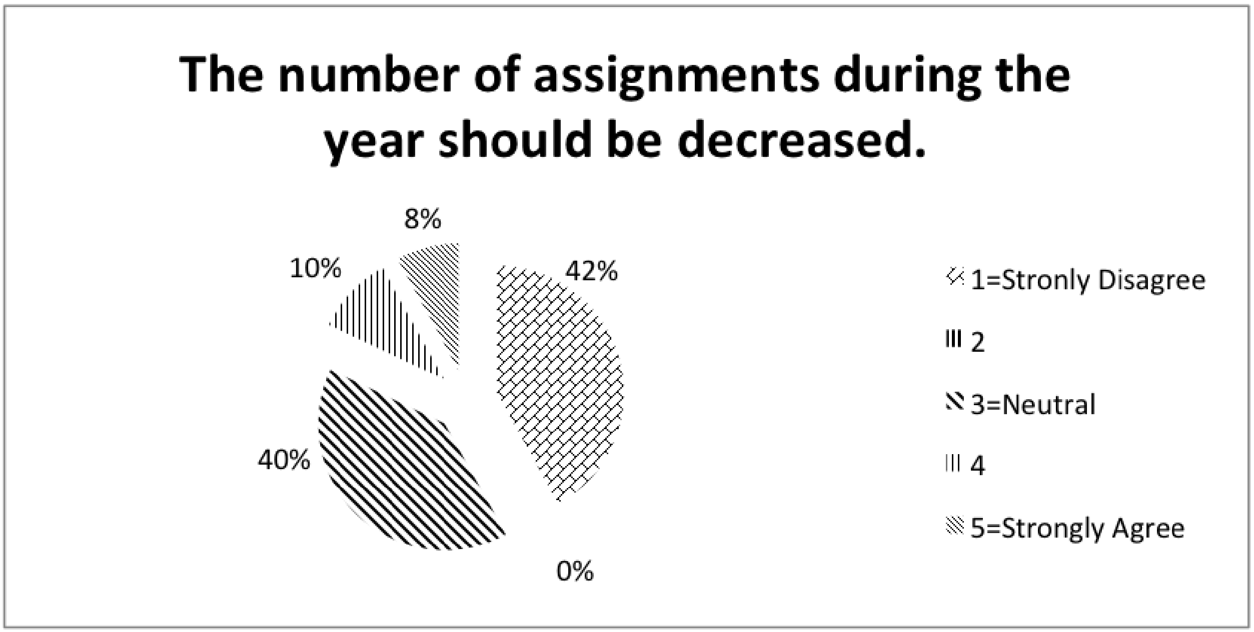
Further feedback was obtained on the suitabiltiy of an alternative method for the delivery of online content. As mentioned earlier, some students had faced problems in diretly accessing the videos from Ulearn and, except for a small minority of 2%, the majority preferred the streaming option. However, both formats were kept available to the students until a more suitable alternative is found which is acceptable and suitable to the whole group.



Ulearn was confirmed to be a widely acceptable and convenient platform for e-learning and the submission of the assignments. Some students had earlier reported inconvenience with the submission process but it was evident from the end-of-semester feedback that those initial problems were sorted and the whole group has adopted to this submission platform.



Some suggested modifications were also discussed with the students and their suggestion/feedback was sought. A suggestion was made to increase the group size in order to reduce the workload of the lecturer for constructive feedback and marking. A reasonable number (6%) strongly disagreed that group size needed to be changed and only a minority wanted to change the group size. Based on this feedback, it was decided to keep the same group size (two students) for the next phase.



To check that the students were not feeling overloaded with these assignments, an opinion was sought on the suggestion to decrease the number of assignments. The response was both surprising and reassuring since only a minority (18%) wanted to decrease the assignment. A good size of the group (42%) strongly disagreed with the idea of decreasing the number of assignments. Based on this feedback the total number of assignments was kept the same for the second phase of the project.

Conclusions and Outlook

Finally the effectiveness of the overall project framework was assessed using five selected conceptual areas and similar (but essentially not the same) questions were set from each area in the form of two sets – one administered before the teaching started on the module and the other just after the formal teaching concluded. The student performance in the two tests was compared and shown in Figure 1, it was observed that the performance was significantly improved. Hence, it can be concluded that this method was indeed successful in achieving good learning, however, it was not possible to compare this with conventional methods of teaching.

General student feedback was very positive both for the use of the online videos to help prepare for the lesson and the use of the fortnightly assignments to motivate and inspire them to regularly come prepared for the sessions. We intend to continue this successful teaching approach over subsequent years. However, reflecting on the experience we intend to incorporate two main changes. The marking strategy shall be modified to mark at least a fraction of assignments on the base of accuracy of the answers (not just the effort). Furthermore, to reduce some of the marking/assessment load, marking of a randomly selected sample of students may be used. Alternatively, we can also use the peer evaluation techniques to mark all assignments and a smaller subset can be used to guide the JiTT response of the lectures.

In summary the combination of JiTT with online video content and fortnightly preparatory assignments was seen to be an effective tool for improving the student inspiration and participation. For the evaluated cohort over the period of two semesters, it was established that it significantly improved their ability to answer conceptual numerical questions in selected areas. Based on the overall student feedback, it was concluded that the method was effective in motivating students to adopt enquiry based and active learning. It shall however be noted that these conclusions need to be strengthened based on observations of several cohorts over a longer period of time. Over this period the reflective practice framework will guide us to improve the method as well as its implementation specific details relevant to University of Surrey context (ULearn, module structures and facilities in lecture rooms and web-tools).

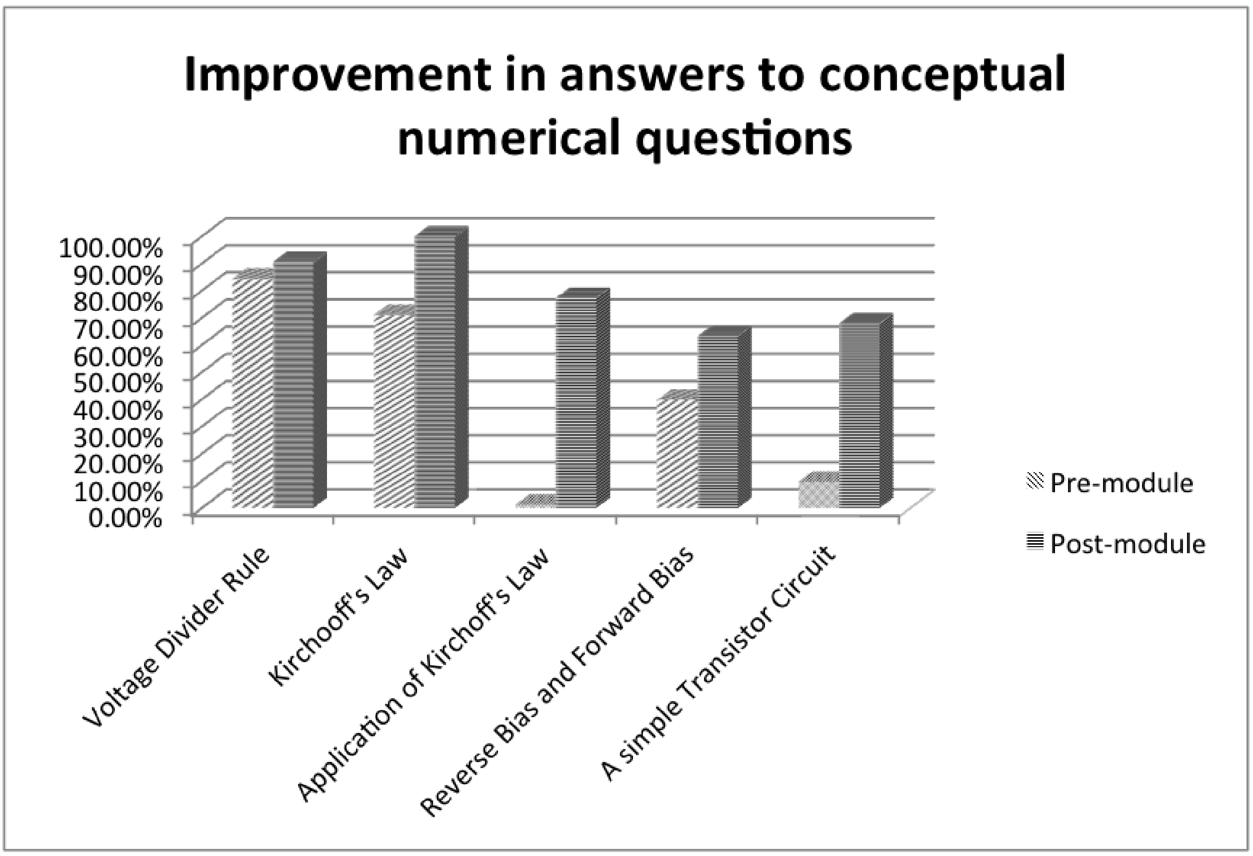


Figure 1: Effectiveness of the framework in improving the student performance in answering conceptual numerical questions.

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