In this issue, we feature the first in a series of teaching and learning projects spearheaded by some of our Teaching Enhancement Grant (TEG) recipients for 2013 and 2014. While the projects vary in their approach and implementation, our authors have been unstinting in their efforts to enhance not just their students’ knowledge and understanding of the subject matter, but also in nurturing skills that will make them motivated and effective learners.

For instance, Dr Walter Patrick Wade (Centre for English Language Communication) discusses the benefits of adopting an integrated approach to developing students’ critical thinking (CT) skills, where acquiring such skills is as integral to achieving the module’s learning outcomes as attaining discipline-specific knowledge. He also examines how an integrated approach facilitates student development of literacies in modern communication environments (p. 2). In his paper, Dr Charles Gullo (Duke-NUS Graduate Medical School) examines the effectiveness of using concept-driven sorting tasks to test whether deep learning had occurred among medical students who have completed their immunology course. He discusses the results and some of the challenges encountered (p. 6). Meanwhile, to help physics majors overcome the difficulty of “visualising the picture behind the mathematics” (p. 11) and gain a better understanding of core concepts in their quantum mechanics course, Mr Andreas Dewanto, Dr Yeo Ye and Mr Kenneth Hong (Dept of Physics) incorporated a visualisation tool called Mathematica into the syllabus. They discuss whether integrating Mathematica into their course was beneficial to their students’ learning and its effectiveness in helping them achieve the module’s learning outcomes for subsequent cohorts. In Dr Mrinal Musib’s (Dept of Biomedical Engineering) case, he wanted to find out whether incorporating the flipped classroom approach in his module “Introduction to Biomedical Engineering” would culminate in active and deeper learning for his students. He reflects on some key lessons learnt from its implementation and offers suggestions on how it can be refined for future cycles of the module (p. 18).

We are also pleased to have Mr Chang Sheh Lit and Dr Nidhi Sharma (Dept of Physics) share their experiences in using strategies from Physics Education Research (PER), namely peer instruction and problem solving through cooperative grouping, in three of their tutorial groups. They tested the effectiveness of these strategies against tutorial groups that were conducted using conventional tutorial instruction. In their paper, they discuss the benefits and limits of their study as well as improvements that can be made to this alternative form of tutorial instruction (p. 27).
Bridging Critical Thinking & Media Literacy Through Integrated Courses

Walter Patrick WADE
Centre for English Language Communication
University Town Writing Programme

The development of student critical thinking (CT) skills has become an increasingly important goal across university curricula. As a result, there has been significant academic discussion aimed at identifying its components as well as the best pedagogical strategies for imparting it. For example, in 1990, an interdisciplinary panel of 46 scholars deliberated on the major skills that make up CT and issued The Delphi Report, defining CT as “purposeful, self-regulatory judgment” arrived at via “a core set of cognitive skills—analysis, interpretation, inference, explanation, and evaluation” (Facione et al., 1995). Other relevant cognitive skills have been identified, including problem solving, hypothesis formation, and calculating likelihoods (Halpern, 2003). Robert Ennis (1993) has identified ten characteristics that go with effective critical thinking, many of which are unmentioned in the previous accounts, such as asking appropriate questions, planning experiments, defining terms, and being open-minded.

Although there is no complete consensus on which cognitive skills, character traits, or behaviours should be included in our understanding of CT, we all work with our own implicit understandings of what it is and can recognise it when demonstrated by students in the classroom. Put simply, students with strong CT skills have a better understanding of the information that they receive and are more likely to consider its quality and assumptions (Facione, 2013, p. 5). They are capable of making judgments and grounding them in good reasons (Halpern, 2003, p. 138). They are flexible in their thinking and capable of revising their own judgments when confronted with new ideas and information (Facione, 2013, p. 7). As a result, they are better able to succeed when faced with problems that have complex causes or debatable solutions (Halpern, 2003, p. 350).

Curricular strategies for providing students with CT skills have generally taken one of two tacks: either a stand-alone approach, in which principles of logic, reasoning, and argumentation are taught as the sole course learning objective, or an integrated approach, in which CT is taught as part of a subject course in which the acquisition of discipline-specific knowledge is also a major learning objective (Renaud & Murray, 2008; Hatcher, 2010). Integrated courses first instruct students in CT skills and then ask students to deploy them to deepen intellectual engagement with course materials.

In this article, I propose that there are important benefits of taking an integrated approach to CT instruction. Specifically, I hope to show that an integrated approach to CT instruction facilitates student development of new literacies appropriate to modern communication environments.
Much academic work has investigated the “new” literacies required of today’s citizens: information literacy, computer literacy, (new) media literacy, and visual literacy (The New London Group, 1996; Kellner, 1998). These have been added to the more traditional print literacy concerns of reading and writing. These new literacies are often referred to as multimodal literacies because they require that students understand how to interpret, evaluate, and produce documents that are visual, aural, textual, or a hybrid of these distinct communicative modes (Kress & van Leeuwen, 2001; Jewitt, 2008). In what follows, I will discuss one of these new multimodal literacies—media literacy—and show how it can be encouraged in the integrated CT classroom.

Media literacy entails “approaches that make us aware of how the media construct meanings, influence and educate audiences, and impose their messages and values” (Kellner & Share, 2007). It thus requires class readings or lectures that provide knowledge of media genres, production contexts, and case studies so that students have a set of facts, concepts, and theories that they can draw on as they practice critical interpretation, analysis, evaluation, and explanation. These CT skills then allow students to make their own inferences, develop their own arguments, and participate in the academic conversations to which they are exposed.

Teaching critical media literacy is especially important in college classrooms because students, as media consumers, are influenced in subtle but far-reaching ways by the media they encounter. Douglas Kellner and Jeff Share suggest that the media provide a kind of “public pedagogy” that teaches “proper and improper behavior, gender roles, and knowledge of the world” (2007, p. 4). Art Silverblatt concurs, claiming that “media presentations convey cumulative messages that shape, reflect, and reinforce attitudes, values, behaviors, preoccupations, and myths that define a culture” (2001, p. 5). This occurs in part because media consumers, who have limited time and attention, automatically process the bulk of the messages that they encounter rather than expending the effort that would be required to evaluate them (Potter, 2004). However, because the possible danger of such public pedagogies rests in a simple lack of reflection on the part of media consumers, critical thinking education aimed at developing media literacy offers a solution. The value of an integrated approach to CT instruction in this context is that it enables consideration of the varied contexts, genres, and communicative modes relevant to the deconstruction and reevaluation of media texts.

The integrated CT classroom is a good space to teach such critical analyses of media texts. Take, as an example, teaching Steve McCurry’s iconic “Afghan Girl” photograph, published in National Geographic magazine’s June 1985 issue, in an integrated CT classroom aimed at introducing students to (1) CT skills and (2) knowledge of photojournalism history and theories. I have taught (and will continue to teach) this image and its history in my Ideas and Exposition module, IEM1201K “Photography and Society”, for the University Town College Programme (UTCP). The goal of the lesson is for students to understand how the context of circulation impacts the meaning and social value of a photograph. This requires students to consider the image and its placement in relation to text, in relation to other images, and in relation to larger cultural or political contexts that may influence its meaning. Put simply, the image has a different function framed on a gallery wall of the Singapore ArtScience Museum, on display in the National Geographic retail store, on the cover of a coffee table book, on a souvenir postcard, or on a political blog arguing for the continued U.S. military presence in Afghanistan.

In class I divide students into groups, give each group a different example of the photograph’s use, and ask them to work together to figure out how the context shapes the meaning of the image. To accomplish this task, students have to practice critical thinking skills associated with critical media literacy. They start with a commonsense or naïve view of the image—it is “striking,” “beautiful,” “haunting,” etc.—and then they have to reflect on their previous view
and question their own assumptions based on their analysis of the surrounding context (Facione et al., 1995). This leads to the development of an interpretation that can be argued for with appropriate evidence drawn from that context. The result is the identification of a deeper level of meaning to the text, which is a key recognition according to advocates of critical media literacy because it allows students to explain who might benefit from and who might be harmed by the publication and circulation of the image (Kellner & Share, 2007).

Students have demonstrated their development of these skills in a variety of ways. Quantitative data from my teaching evaluations shows that students believe that the course as a whole has enhanced their own thinking ability, and these results were above the mean for department and faculty teaching (4.609/5). Qualitative student feedback supports this as well, with students commenting on the value of critical thinking skills imparted during instruction (e.g., “does not spoonfeed answers but promotes individual critical thinking,” “readings are difficult but also prompt further thoughts about the issue at hand, which compels us to explore more about the topic outside of class”). More concretely, final papers produced by my students consistently show their ability to critically examine media images that we have not discussed in class. They have demonstrated this ability on topics as varied as gendered representational conventions in fashion advertising, representations of war and disaster in the news, and controversies over photo-manipulation.

Teaching critical thinking together with media literacy may further aid students because it shows them that they can practice their critical thinking skills in their daily lives and even use them to help others. One group of students did just this, employing their media literacy skills outside of the classroom to inform public advocacy work. They started the University Town Project to Humanize Foreign Workers and held a photo exhibition, displayed at the University Town Plaza, raising awareness of the hopes, aspirations, and struggles of foreign domestic workers in Singapore. They used classroom knowledge to create a sensitive, thought-provoking exhibit that avoided common problems of stereotyping and speaking for others that so often plague (and secretly undermine) such advocacy campaigns.

The approach to integrated CT instruction and media literacy suggested here could be employed in courses across a wide range of disciplines. Although disciplines traditionally associated with media studies such as journalism or communication studies might be the most obvious examples, CT and media literacy have been successfully integrated into curricula in the sciences (Sperry, 2012), cultural studies (Radeloff & Bergman, 2009), psychology (King, 1995), and sociology (Malcolm, 2006; Daniels, 2012). An advantage of this approach is that it does not assume that a single, stand-alone course is sufficient to teach students to be appropriately critical, and rather that CT instruction and the development of new literacies can and should be actively pursued across the curriculum and throughout students’ education.

**About the Author**

**Dr. Walter Patrick Wade** currently teaches Ideas and Exposition modules at the University Town residential colleges for the Centre for English Language Communication. He believes that adopting critical thinking and media literacy pedagogies goes a long way in enriching his students’ in-class learning as well as transfer of skills outside of the classroom.
**Endnote**

This project was funded in part by a Teaching Enhancement Grant (TEG) from CDTL.

**References**


Acquisition of Medical Immunology Knowledge: A Preliminary Study of the Knowledge Structures of Medical Students

Charles Albert GULLO
Duke-NUS Graduate Medical School

Introduction

Medical students from both Duke-NUS and NUS participated in a study that attempted to assess their knowledge structure in the medical immunology domain. Students had to perform a sorting task with a list of concepts derived from immunology experts. We collected demographic information as well as sorting data and the diversity of the sorts are presented in this article.

Structuring Knowledge

The multi-store model developed in the 1970s suggests that information gained by a learner flows in through a defined set of states (Atkinson & Shiffrin, 1968). First, sensory stores capture visual and auditory information. A small amount of that information is then transferred to the short-term memory compartment. Here, a great deal of work has been performed to suggest we can retain anywhere between five to seven discrete chunks of information at any given time (Simon, 1979). The information that is transferred from the sensory stores to short-term memory stores is often dependent on repetition. However, a fraction of that information can then be transferred to long-term memory stores and is dependent on encoding, visualising and experiencing that occur during the learning process. Finally, working memory is the result of accessing information from the short-term and long-term memory stores and is thought to rely heavily on visual-spatial patterning, etc. This is controlled by the central executive that integrates written and spoken material as well as visual and spatial information, and is at the core of problem solving. This multi-store model as originally defined by Atkinson and Shiffrin has now been replaced by an alternative model which has the same components but organises them in different ways and suggests that each component has limited capacity for storage and is independent of one another (Baddeley & Hitch, 1974).

Using Concept Mapping to Assess Higher-order Learning

Yet, amid this understanding of how learners capture and process information, the difficulty then when it comes to effective teaching in cognitive education is devising methods to assess working memory and higher mental processing that we hope most of our students will achieve. Courses like immunology are particularly difficult to teach and assess for a few reasons: the terminology is complex, there are many core concepts that are important, and the mechanisms and interactions of the concepts are highly complex. Thus, we usually rely on assessment that emphasises what a student has memorised.

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and is able to derive primarily from their short-term memory or long-term memory. However, such assessment methods are rarely associative and may not test ‘real’ working memory. In order for us to start asking how well our students are achieving higher mental processes and lifelong learning in any one field, we first need to know how knowledge is structured and the tools that are needed to investigate these structures. Field-specific concept lists and their interrelatedness provide an informative platform for this kind of measurement. A concept or ‘unit of thought’ can be thought of as an element of thought that helps the learner organise and categorise his or her experience. A course is likely to have many conceptual terms but should be relatively restricted to core concepts that occupy a centre of density of meaning (Deese, 1965). Concept maps and concept mapping assessment (CMA) are not widely used in medical school classrooms formally as their validity and reliability are often called into question. However, a recent study has suggested that CMA may be useful in medical domain-specific areas and in evaluating a conceptual knowledge framework before and after instruction (West et al., 2000). However, a limitation of this and other studies using concept mapping is that students need proper training in the use of concept mapping and faculty also need to be trained on how to score these concept maps.

However, defining a set of core concepts for each course that students take during medical school would likely still yield useful information. Linking or organising these concepts into relationship trees would provide educators with useful information in designing the teaching strategy, such as recognising important areas in the syllabus to place more emphasis, and even to assess how difficult a course is likely to be (e.g. courses with fewer core concepts may require less time to teach than those with more). Finally, an additional utility of having a set of defined core concepts in a particular course is that it allows the educator to assess the students’ own knowledge structures without asking additional multiple choice and short answer questions. This can be done by asking students to come up with their own list of core concepts and compare those to a list derived from experts or asking them to sort core concepts based on similarity profiles.

In this brief report, we present a defined approach for measuring the knowledge structures of students via the use of immunology core concepts. We asked medical immunology students who had completed their immunology instruction at Duke-NUS and the Yong Loo Lin School of Medicine at NUS to look at a predetermined list of 25 terms that correspond to important core immunology concepts and to sort them into user-defined clusters. A brief explanation of how these concepts were derived will be presented in the “Results” section below. These terms represent concepts that faculty feel all medical students should thoroughly understand after taking any comprehensive medical immunology course and are not designed to map directly to the curriculum.

Upon completing the learning activity, the sorting tasks were collated and analysed. The complexity of the sorts was surprising and informative. The nature of the data and its usefulness as a tool to study knowledge structures of medical immunology and guide curriculum will be discussed. However, this study was not without its limitations. For one thing, due to the preliminary nature of this study, only a small amount of data will be provided in this brief report. We did not ask students to comment on their experience and have collected no qualitative data. However, based on the results collected, we do feel strongly that students who participated in this study actually benefited from the activity that required them to think about and organise these 25 immunologic terms. In addition to the sorting of concepts into user-defined categories, we collected a limited set of demographic information such as gender, prior exposure to immunology and how students rated their understanding of the subject after the course. The complete methods are not described here and the following results focus exclusively on the sorting task.

continued on the next page ...
Table 1. Core concepts in medical immunology.

|-----------|-----------|-------------|------------------|---------------------|

Methodology

In order to create a core concept list to assist in the assessing of the knowledge structures of medical students, we first asked faculty within the immunology discipline to come up with a list of core concepts that they expected medical students who were taking a medical immunology course to know. We derived a final list of concepts by removing those that did not conform to the criteria laid out in the instructions given to faculty (e.g. concepts that included nouns such as “T-cells” or those that were generic and not specific for the field of immunology).

This finalised list is shown in Table 1. Medical students are expected to recognise all of these terms after they have completed a course in medical immunology.

In order to gain a better understanding of how students acquire a deeper knowledge of medical immunology, we asked them to sort the various immunology-based concept lists into ‘user-defined’ categories or groupings. The students were asked to avoid putting all 25 terms into one group and to make sure that each group they defined had at least two of the 25 terms. When it came to evaluating the user-defined groups students produced, we first looked at the diversity of these groups in their totality and found an overall range of two to eleven terms for all 58 students participating in this study.

There were a total of 23 unique groups defined by the students; this means that although they sorted the 25 terms into 2 to 11 groups, the user-defined nature of the sorting gave us 23 unique groups.

Results

As students who managed to sort the terms into more defined groups suggested evidence of displaying higher-order thinking and those who sorted the terms into less groups could assumed to be displaying lower-order thinking, we first broke up the data into “low”, “medium” and “high” groups of students by the number of groups that were identified. The “low” group was designated as students who sorted the terms into 0 to 3 terms per user-defined group, “middle” group as 4 to 7, and the “high” group had between 8 to 11 (Figure 1). It is important to note that this type of study has not been performed before so there is no data to validate this conclusion at the moment, but we reasoned that the more categories that are used by students to sort the 25 terms, the greater the amount of cognitive effort used to manage these terms. We certainly do expect that organisation of these 25 terms into too many distinct categories (e.g. greater than 12) may be counter-productive and would suggest weak knowledge structures. The cut-offs point are therefore arbitrary and will need to be validated in other studies before they become reliable.
The star over the seven represents the number of categories or groups the faculty used when sorting these 25 terms. To further analyse the diversity of the responses by students following the sorting task, we ranked the descriptors students used to name their groups in order of frequency, as shown in Figure 2.

As is shown in Figure 2, the most commonly defined group was “innate” immunity. The chart in Figure 2 shows the descriptors for the sorts that were indicated by three or more student participants. The group defined as ‘other’ or ‘unknown’ by students was common as well but was the most uninformative as it cannot be well defined. Some of the most common terms included “innate” and “adaptive” immunity which corresponded to what was emphasised frequently during the instructional portion of the immunology course. Overall the user-defined terms and their frequency are only partially informative. The more interesting information is how the students sorted the various 25 terms into their respective groups as it addresses the more complex nature of integration of their knowledge. This data is still being analysed and will be published in the near future.
Concluding Remarks

The data suggest that by using concept-driven sorting tasks to assess whether effective learning has occurred, one may start to understand the knowledge structures of medical students in any given course. Ideally, this type of exercise would be more useful if performed with students before they start a course and after they have completed a given course. We hope that we can expand this work and encourage faculty to come up with a robust set of core concepts for all medical courses.

Acknowledgements

This project is a result of a fruitful collaboration between several universities and the following individuals: Justin Soon Boon WONG in the Department of Microbiology and Pathology, NUS, Dr. Preman Rajalingam at the Lee Kong Chian School of Medicine, NTU and Dr. Ruth Day in the Laboratory Medical Cognition, Duke NC, USA. This work was funded by a grant from CDTL and from financial assistance from the Department of Medical Education Research and Evaluation, Duke-NUS Singapore.

References


About the Author

Dr Charles Gullo was the Deputy Director of the Body and Disease course and Assistant Professor at both Duke-NUS (MERE) and the Yong Loo Lin School of Medicine (Dept of Microbiology). He was also the Deputy Director for Phase I at the Lee Kong Chian School of Medicine. Charles was a member of the facilitation team at both organisations and was also actively involved in pursuing academic research in medical cognition and education as well as a trainer in various areas of team-based learning.
Seeking a Visualisation Tool to Enhance Learning in PC2130

The introductory course PC2130 “Quantum Mechanics I” is a compulsory core module intended for second year physics majors. For those who are unfamiliar with the subject, quantum mechanics studies the mechanical evolution of atomic and subatomic particles. At such a scale, Nature behaves in a rather weird and counter-intuitive way. Take, for instance, the fact that electrons are behaving as particles and waves at the same time (a phenomenon known as wave-particle duality). To describe the state of such a “wave-particle” object mathematically, physicists came up with the notion of wave function, which essentially describes the probability of the electron being found at a particular position and/or momentum. These wave functions are solutions to a second-order partial differential equation (i.e. the Schrodinger equation), which itself is parameterised by various initial conditions and potential energy. If this sounds dry, tough and mathematically involved, it indeed does to the majority of the students taking PC2130. We identified that the learning-related issue may possibly lie with students having difficulty visualising the physical picture behind the mathematics. This prompted us to use the mathematical software Mathematica 9.0 (Wolfram, 2012) in the course as a visualisation and computation tool to help students gain a better grasp of the subject. In short, with the aid of Mathematica, we hope students are able to simulate the dynamics of this complex wave function.

Choosing Mathematica

When it came to selecting a visualisation tool to help us achieve the learning outcomes for PC2130, Mathematica was our software of choice. It was chosen over other mathematical software such as Matlab or Maple for three reasons:

1. It supports algebraic computation (which means that it can be used to solve equations in term of its variables);

2. It has a gentle learning curve as it comes with built-in Mathematica commands to perform sophisticated functions. For example, the “Manipulate[argument]” command in Mathematica enables the student to plot and interact with the “argument” (i.e. wave function, in our case) on a real-time basis; and

3. The software is freely available to NUS students through the academic site license. This is crucial as that means students are able to install the software on their laptops or home desktops, allowing them to use Mathematica to work on their project anytime and anywhere. We also hope that in the long run students would apply the skills they acquired beyond the course.

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Incorporating Mathematica in the Syllabus as a Term Project

At the moment we have implemented this initiative over two semesters. In Semester 2 of AY 2011/12, Mathematica was introduced as a term project, which eventually contributed up to 20% of students’ final grades.

In this project, students had the opportunity to participate in peer learning, working in pairs and using Mathematica to visualise the evolution of wave function in a potential well. The instructions, together with the expected deliverables, were given early in the beginning of the semester. To further incentivise students to explore using the software beyond the minimum requirements in their projects, higher marks would be awarded to students who chose to work on more complicated initial conditions and potentials. In most cases, students picked up the computation skill required for the software by themselves. We did not hold a specific course on how to use Mathematica per se, but we integrated Mathematica into the lectures and tutorials. For instance, apart from providing a model solution to a particular problem in writing, we also provided the solution in Mathematica codes during tutorials. Students were then expected to pick up and modify the necessary Mathematica commands.

This self-exploratory way of teaching and learning Mathematica was sufficient for students to complete the basic requirements of the project. However, if the students decided to work on more challenging problems, they would face issues with regards to using the more advanced commands and optimising the programme (in order to shorten the computation time), which they would then have to resolve through self-exploration (e.g. browsing online discussion forums to find out how others solved similar problems). We also made ourselves readily available to students for consultation throughout the semester.

Students’ Response to Using Mathematica

At the end of the semester, a short survey was conducted to determine the impact the use of Mathematica has had on students’ learning for this project. Twenty-six students (out of 41 students in the class) responded. According to the survey results, 76% of the respondents agreed that they had a positive experience using Mathematica and had learnt a useful skill by going through the project despite the initial challenges and frustration in dealing with the software. When asked if they would consider resorting to Mathematica again to help them in their study or research work in future, 84% replied in the affirmative.

In the qualitative feedback collected from the survey, students reiterated that using Mathematica helped them gain a better understanding of quantum mechanics:

- “I think the project was pretty interesting, before the project, I had absolutely no idea what the potential well did, it was simply some mathematics to me, so I’m glad I managed to visualise something.”
- “I have learned quite a lot and we actually did more than we submit. We can plot all the wave function by Mathematica which is really awesome!”
- “Thanks for all the advice along the way. Overall I think even though the project was difficult and time-consuming, it was useful to help me understand [the concepts] better.”

They also appreciated the benefits of learning from their peers while doing the group project:

- “Although highly frustrating, the project did give me much valuable insight into quantum mechanics (eg: energy eigen values etc) I like the freedom given to us to choose our wave functions. Of course, at the course of the project let my partner and I bond together, through the ups and
many downs and numerous meetings and rantings, and I appreciate the group work and camaraderie built up.”

However, students also expressed frustration at the difficulties they experienced using the software. For example, some had spent countless hours figuring out what they thought were fully functional programmes, and yet the system kept crashing or running into indefinite loops. In most cases, it turned out that the problem lay with the syntax and students being unfamiliar with programming semantics, which caused compilation or logical errors (Dewanto & Yeo, 2012).

In addition, although it was a semester-long project, most students only started work on the project near to the submission deadline, which caused much frustration towards the end of the semester when they were also preparing for their tests and facing other deadlines. In the survey, students also suggested improvements to the learning activities, including the provision of some training in Mathematica prior to the project to help them to better manage some of these difficulties:

- “This project is okay per se. Allows us to understand the concept more. But really need more training on how to use [M]athematica before we can afford to do more complex potential well or interesting initial wave functions. Independent studying is okay, I’m not asking to be spoon fed. But it’ll be good if we’re trained on [M]athematica before starting on the project. Think the focus should be on enabling us to visualise interesting physics situation rather than to figure out how to use a computer programme and how to resist the urge to throw my laptop out of the window (leave that to the computing students!).”

- “This project is supposed to make me understand more about the content of PC2130. I agree that this project helps a little bit. However, lecture quiz is much better than this project. if there is lecture quiz, I will study more the whole content of this module. This project only requires a small part of the concept taught in PC2130, not all. And also, the use of [M]athematica is quite difficult because I don’t have [the] skill in using [M]athematica and it tends to drive student only to look at the sample file the lecturer gave. So the students only learn about small part of [M]athematica. This project also tends to make student only look at the sample file and just copy it if they don’t understand it, not learn about the content. The lecture quiz tends to make student study hard because in the quiz they can’t cheat.”

Reflections on Using Mathematica for Future Cohorts

We had much to think about after our first attempt at incorporating Mathematica into PC2130. There is no doubt that learning Mathematica, as it would be the case when it comes to learning any other new software or programming language, would require a certain level of self-exploration and self-learning on the students’ part through trial and error. Conquering such a learning curve obviously takes time, which only the more motivated students would be willing to invest. As such, while students were generally positive about Mathematica’s usefulness in helping them understand key concepts in PC2130, the feedback indicated that we still had a way to go in terms of ensuring that this tool can comprehensively achieve the module’s learning outcomes. Nevertheless, we will continue to use Mathematica in PC2130, and will keep experimenting with various pedagogical strategies, such as incorporating Mathematica as part of continual assessment, to determine the best and most effective way to integrate the software into our teaching.

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About the Authors

Mr Andreas Dewanto, Dr Yeo Ye and Mr Kenneth Hong are teaching staff from the Dept of Physics. They do not subscribe to any particular pedagogy. However, throughout their years of teaching core as well as general education modules, they have been exploring various tools and medium to engage students, from interactive demonstrations that aid in the visualization of physical concepts to the utilization of mathematical software, such as the one presented here.

Endnote

This project was funded in part by a Teaching Enhancement Grant (TEG) from CDTL.

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Student Perceptions of the Impact of Using the Flipped Classroom Approach for an Introductory-level Multidisciplinary Module

Mrinal Kanti MUSIB
Dept of Biomedical Engineering

Introduction

During the last decade or so, there has been a gradual but continuous shift in how learning is accomplished in a classroom. With the advent of new pedagogical techniques, more and more faculty members are adopting the blended approach to attain and improve students’ learning experience (Ragupathi, 2013; Hughes, 2012; Bonk & Graham, 2006; Friesen, 2012). The “blended learning” approach synergistically brings together the compelling aspects of online, classroom and mobile learning to enhance student’s engagement and participation in a classroom and also helps attain the predetermined learning outcome measures. The “flipped classroom” is a type of blended learning approach where the onus of learning and mastering content falls back to students. For these approaches, the teacher’s role has gone through a metamorphosis—from being the “sage on the stage” to the “guide by the side”, and classrooms are changing as well, from the traditional and passive teacher-centred learning environment to an active student-centred one with the teachers assuming the role of facilitators (Lage et al., 2000).

The underlying idea and approach of delivering flipped content includes developing a pre-recorded video encompassing the fundamental theoretical concepts of a particular lesson, which the students can watch outside of classroom time at their leisure to gain some idea about the topic covered in next lecture (Bishop et al., 2013). This helps the instructor by freeing up classroom time, which may be used for active learning activities such as in-class discussions, answering questions and group activities. Prior to embarking on the project, I identified a significant knowledge gap (based on the lack of published articles on this subject) in terms of the acceptability and adaptability of the flipped classroom concept among students, particularly at introductory-level multidisciplinary modules, which I sought to study in this particular project.

Implementation Methodology

It is widely accepted that when it comes to viewing video clips, the interest of students as well as their ability to comprehend the information presented in a video clip decreases with an increase in the clip’s duration. More specifically, in my opinion students tend to learn better and retain more of the information

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presented when the length of the video is 10 minutes or less. Taking this into consideration, I experimented with the flipped classroom approach in the introductory and interdisciplinary module GEK2505 “Introduction to Biomedical Engineering”, which had a total enrolment of 12 students. An introductory video of about 8 minutes was uploaded on IVLE about a week ahead of the lecture. The video encompassed the fundamental and theoretical aspects of the field of biomaterials. As many of the students taking GEK2505 were not from a science or engineering background, the introductory video gave them a fundamental overview of biomaterials. All the students were encouraged to view the video prior to the lecture so that they could do some reading/research on their own and come to class with questions that may be discussed during lecture time. To my satisfaction, most of the students had viewed the video at least once, which was obvious from their active participation and response to my questions during the actual lecture. A part of the ensuing lecture time was devoted to group activities and brainstorming, which are hallmarks of the flipped concept.

**Students’ Response Towards the Flipped Classroom Approach**

Based on an analysis of the student feedback conducted and collected from all the students who took GEK2505, we were able to group their qualitative responses towards the flipped concept under a few key points, as discussed in the next few sections.

*Flipped Classrooms Facilitate Student Learning and Preparation for the In-class Lecture*

The flipped classroom approach facilitates student learning and preparation for the in-class lecture session. As some students shared in their feedback, they found this approach useful in helping them be better prepared for the discussions during the lecture:

- “I like the [flipped] concept because we can have more time to go through the video and research before going for the lesson. The lesson will thus be more interactive and beneficial.”

- “The video was a good introduction to the lecture...I like the concept and I feel it will be beneficial to my learning curve.”

- “It allows students to utilise their time more efficiently.”

Students also recognised the benefits of being able to revisit the online resource (in this case, the video) pre-lecture. In fact, several students indicated that they found the ‘pause’ and ‘rewind’ functions in the video recording very useful in helping them revisit points in the lecture, something which is not possible to do so in a lecture delivered in the conventional way.

*Flipped Classrooms Promote Active and Deeper Learning During In-class Interactions*

Students also recognised and appreciated the fact that participating in the lecture’s active learning activities (e.g. group discussions and brainstorming activities) was beneficial to their learning:

- “It encourages active learning in the classroom.”

- “Open courseware or flip classroom concept is a fantastic idea which is well suited for people who are more inquisitive and get tired with lectures that aim to simply convey content.”

I also observed students being able to apply what they learnt beyond the lecture session. During the tutorial which immediately followed the exam for GEK2505, students were able to use the knowledge they gained from watching the video and participating in the learning activities during the lecture to come up with a novel design for a potential biomaterial to address a particular clinical scenario.
Students Were Willing to Adapt to the New Learning Approach

Some students responded that they are willing to adapt to and adopt the new pedagogical technique; they would like to see educators/lecturers implement the concept in other modules as well:

- “Although I have some concerns, I would like to see wider implementation of the flipped classroom concept.”
- “It allows the educator to experiment with more hands on stuff, instead of just going through theory of the subject taught and we should continue experimenting.”

Student Perceptions of the Flipped Classroom Approach

In addition to giving qualitative feedback, students were asked to respond to a series of statements (see Table 1) to gauge their understanding of and response towards the use of the flipped concept in the module, based on whether they agree, disagree or were neutral/did not respond to the specific statement (see Figure 1).

Table 1. Statements used to gauge students’ interpretation and response towards the flipped concept.

<table>
<thead>
<tr>
<th>Question</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>I like the flipped pedagogical concept, ie, the recorded pre-lecture videos, as it introduces us to the topic to be discussed during the subsequent lecture.</td>
</tr>
<tr>
<td>B.</td>
<td>I like the traditional lectures only, without the videos.</td>
</tr>
<tr>
<td>C.</td>
<td>A judicious combination may provide a better learning experience.</td>
</tr>
<tr>
<td>D.</td>
<td>I prefer the videos only and the lecture time may be used for hands-on activities, discussions etc.</td>
</tr>
<tr>
<td>E.</td>
<td>Although I have some concerns, I can and am willing to adapt myself to the new pedagogical technique.</td>
</tr>
<tr>
<td>F.</td>
<td>We should continue experimenting/implementing this new pedagogical technique in this and other modules.</td>
</tr>
</tbody>
</table>

Figure 1. Graphical representation of the students’ interpretation and response to the statements in Table 1.
According to the results collated in Figure 1, an overwhelming majority of the students (90%) agreed with Statement A, that is, they liked the flipped concept. In addition, every student who participated in the exercise preferred a judicious combination of the in-class lecture and an element of the flipped concept (Statement C). Meanwhile, almost 70% of the students responded that while they harboured some concerns about the concept, they were nonetheless willing to adapt to the new pedagogical technique (Statement E). Their concerns were primarily related to whether participating in flipped classrooms would result in an increase in their workload, whether it adds value to the learning outcome as well as its appropriateness to enhancing teaching effectiveness in larger classrooms. Nonetheless, once they were convinced of the immense potential of the technique, more than 90% of the students agreed with Statement F, that the instructors should continue experimenting with and/or implementing this approach in this and other modules.

Student Learning Outcomes Achieved

Towards the end of the instructional period, we evaluated students’ understanding of the fundamental concepts covered in the module via a written exam. The exam contained a combination of multiple-choice, “fill in the blanks” and “true-false” questions. The questions were set in a manner that students who watched the video and had participated in the in-class discussions may have an advantage over those who did not. To my satisfaction, most of the students did well in the exam. Thus, by applying the flipped classroom approach for GEK2505, I was able to convert the lecture time to a platform for active learning where students had the opportunity to discuss relevant aspects of biomaterials, which helped me attain my pre-identified student learning objectives.

Key Lessons Learnt

Based on the qualitative and quantitative feedback provided by the students as well as my own reflections, in the following sections I will address some of the issues I faced during the implementation of the project, and my suggestions to manage them for future cohorts taking GEK2505.

Getting Students Motivated

The Issue

Some students perceive watching the video before the actual lecture as an additional workload which may act as a deterrent to watching it. How can we motivate students to watch the video?

Suggestion

It should be articulated to the students early and clearly that the primary objective of having them watch the video before the actual lecture is to help them optimise the expected time they are required to study on their own. Moreover, the video clip will not be too long (usually less than 10 minutes) and will focus on the fundamental and theoretical aspects of the lesson. The material covered in the video will also not be too difficult to comprehend. To further motivate students, I told them that towards the end of the video, I have included a list of companies which may be their potential employers once they graduate.

The Issue

How do we ensure that students have watched the video?

Suggestion

This may be accomplished by introducing simple online quizzes based on the video content with pre-set deadlines for completion. These short quizzes may also be administered just prior to the lecture. The students should
be made aware of this aspect of assessment at the start of the module and it should not come as a surprise. As such, it needs to be conveyed clearly that the quiz would be based on the video content and students who have viewed and understood the concepts highlighted in the video would be at an advantage as far as answering the quiz is concerned. Students’ performance in the quiz may be included as part of their continuous assessment (CA). In my opinion, we as lecturers/educators have to devise a mechanism to incentivise students who go the extra mile and make this extra effort. The quizzes should be designed to reward students for their diligence. In lieu of the quiz, they may also be asked to write a half-page reflection on the video for which they may be awarded some participation marks.

**Applying Just Flipped Classrooms is Sufficient to Achieve the Learning Outcomes**

**The Issue**
Would using only the flipped classroom approach be sufficient to achieve the module’s pre-identified learning outcomes?

**Suggestion**
In my opinion, the flipped concept should be part of the entire educational package, used in conjunction with other modes of instruction and conveying information, like in-class activities, getting in guest speakers or providing consultations to individual students etc. Getting early exposure to new teaching methods can open the minds of students and makes them more receptive to them. Hence, foundational modules may be taught using this concept for early exposure. Striking a balance between traditional and new pedagogical methods would be necessary to optimise student learning.

**Incorporating Relevant Online Content to Achieve the Module’s Learning Outcomes**

**The Issue**
What should the instructor include in the video that would achieve the module’s learning outcomes?

**Suggestion**
The video should encompass fundamental and theoretical aspects of the subsequent lecture. For this particular video, I included a list of topics that would be covered followed by some basic definitions, relevance and importance of the topic, areas of ongoing research and significant findings, lots of practical examples and their images (if feasible) and eventually, a list of companies engaged in similar research areas which may be the students’ potential employers. This also helps motivate the students to attend the lecture and in doing so, become more active participants rather than passive listeners, thus helping the instructor to attain the module’s learning objectives.

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**A bout the Author**

Dr. Mrinal Musib teaches several modules in the Dept of Biomedical Engineering related to tissue engineering as well as cellular and introductory bioengineering. He is also involved in tutoring students in the engineering professionalism module. He believes that student learning outcomes can be achieved by leveraging on the synergistic benefits of implementing the flipped concept in conjunction with traditional teaching methods.
Using Online Resources to Scaffold Learning

The Issue

Using online resources, such as the video, to scaffold learning.

Suggestion

As mentioned earlier, the video was made so that students would enjoy viewing it; the video content was also conceptualised such that it was easy to comprehend, even for students who are not from science or engineering backgrounds. Nonetheless, any questions students may have about online resources, such as the video, may be addressed prior to the beginning of the lecture and before the quiz is administered. If all the students taking the module make the effort to watch the video before attending the actual session, they would be on a common knowledge platform or on the ‘same page’. As such, they are likely to become more engaged and participate actively during the actual lecture. The in-class activities (either during or following the lecture) were designed in a manner which allow for scaffolding of learning as well as giving students the opportunity to apply the knowledge they gained during the lecture.

Conclusions and Future Directions

The results of the experiment showed that the majority of the students who took these modules responded positively to the flipped classroom approach and they preferred faculty members to continue experimenting/implementing this concept in other modules. In my opinion, the flipped concept has a great potential to enhance the student learning experience. In addition, it has helped me save lecture time by allowing me to provide students with a topic’s fundamental concepts as a video prior to the lecture, which students can watch on their own time.

Acknowledgements

This project was funded in part by a Teaching Enhancement Grant (TEG) from CDTL. I would also like to thank Andy Tay for his help with the graph and Mr. Alan Soong (CDTL) for his valuable input and suggestions during the preparation of the manuscript.

References


Empowering Methods in Physics Education Research (PER) to Enhance Learning in an Engineering Physics Course

CHANG Sheh Lit & Nidhi SHARMA
Dept of Physics

Introduction

Physics Education Research (PER) (McDermott, 2001) has been an ongoing research programme for over thirty years and its main objective is to improve the students’ understanding of physics. Through their investigation of how students tend to misunderstand and experience difficulties grasping physical concepts, and developing effective resources accordingly for physics instruction (McDermott & Shaffer, 2002), physics instructors would be well-equipped with the tools to enhance students’ learning experiences. Besides developing useful instructional resources, introducing novel teaching methods in an introductory physics course could also result in enhanced learning (Mazur, 1997; Hake, 1998; Beichner et al. 2000). While these literatures focus on improving physics lectures, there are several approaches which focus on tutorial sessions (Otero et al., 2010). Inspired and delighted by the beneficial learning results derived from PER, we decided to employ some of these strategies in our tutorials rather than in lectures, as we wanted to achieve these learning outcomes in a small group setting.

The Current Approach and Its Challenges

The module, PC1431 “Physics IE”, is a calculus-based, introductory physics course covering mechanics and thermodynamics for Year 1 Engineering students, mostly from the Departments of Mechanical Engineering, Civil and Environmental Engineering, Bioengineering, Materials Science and Engineering, and Industrial and Systems Engineering. The tutorial is conducted once a fortnight, and the classroom setting as well as teaching style utilised the conventional seminar room method with the whiteboard. The tutors go into the class, conduct the tutorial like a mini-lecture, demonstrate how to solve problems on the board, and the complete solutions are then posted after the tutorial. Students are told to attempt the tutorial before class, fill up their blank worksheets with the tutor’s explanation and compare their approach with the tutor’s. Also, they could refer to solutions if they cannot follow the class. The tutors had been working hard to deal with students’ misconceptions and difficulties in the topics presented but the conventional approach seemed ineffective, so we decided to see if the strategies introduced by PER could improve students’ understanding and problem solving abilities.

Recommended Citation


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Incorporating Peer Instruction and Problem Solving Through Cooperative Grouping

We employed two strategies from PER in the PC1431 tutorials: peer instruction and problem solving through cooperative grouping. Peer instruction is a pedagogy developed in 1991 by Eric Mazur, a physics professor at Harvard University, in 1991. The idea is to set aside time for the students to discuss among themselves and explain their answers to their neighbours (Mazur, 1997). The outcomes of this method are the correction of students’ misconceptions and gains in students’ confidence in terms of their knowledge and understanding of the subject. The second strategy, getting students involved in problem solving through cooperative grouping, was first suggested by Patricia Heller and her colleagues from the University of Minnesota (Heller, Keith & Anderson, 1992). They divided the students in groups wherein they solved the problems together as a group. The outcome of this approach is the improvement in students’ problem solving abilities.

Methodology

In Semester 1 of AY2012/13, we were assigned to teach six PC1431 tutorial classes. Out of the six classes, three classes were chosen as experimental groups to adopt the methods suggested by PER, while the other three classes were the control groups, wherein the tutorials were conducted the conventional way. The questions were modified slightly, with the inclusion of hints, so that students will have a clearer idea when they attempt the questions. These were posted to the students at least one week before the actual tutorial and they are expected to attempt the questions before coming to class. The following are salient features of the two kinds of tutorial groups:

<table>
<thead>
<tr>
<th></th>
<th>Experimental Group (85 students in total)</th>
<th>Control Group (89 students in total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>They have weekly tutorials.</td>
<td>They have tutorials once a fortnight.</td>
</tr>
<tr>
<td>(2)</td>
<td>Students formed groups of three in random, irrespective of their abilities.</td>
<td>No groups were formed; students were seated at random.</td>
</tr>
<tr>
<td>(3)</td>
<td>The tutors (Dr Nidhi and I) walked around in class to listen in on their discussions and to clarify their misconceptions.</td>
<td>I demonstrate how to solve the problems on the whiteboard; I will stop and ask questions from time to time, to check whether they are still with me</td>
</tr>
<tr>
<td>(4)</td>
<td>Occasionally, I demonstrate how to solve the harder questions on the whiteboard when I feel that it is a commonly asked question from most of the class.</td>
<td>Additional questions are available on the website for them to download for their own practice.</td>
</tr>
<tr>
<td>(5)</td>
<td>Additional questions are provided during class for students who are able to finish the tutorial questions before the rest of their tutorial mates.</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Features of the two types of tutorial groups

In order for students to discuss effectively in groups, we require those in the experimental group to come for weekly sessions, so that they will have more contact with their group members and the tutors, making it easier to build rapport for better group dynamics. If there were only five tutorial sessions, just like the control group, we felt that by the time they actually got to know each other better, it would have been the end of the semester, and group discussions will end up playing a smaller role towards their learning.
During the semester, we spent 10 to 15 minutes in the first and the fifth tutorial sessions explaining to students the rationale behind the experimental group setting. This is to ensure that they understood our intentions, so that they will cooperate with a positive mindset, and make full use of the opportunities provided to them. This message was also communicated in the tutorial website where we had put up additional materials they could refer to.

**Evaluation**

Mid-semester feedback and end-of-semester feedback exercises were conducted for the experimental group to see how the students felt about the new approach. We did not conduct these feedback exercises with the control group because the statements are more applicable for the experimental group.

**Quantitative Student Feedback**

There are five statements in the mid-semester feedback exercise; for the end-of-semester feedback exercise, students answered the same five questions and an additional sixth question. Students responded to these questions using a 4-point Likert scale (from “Strongly Disagree” to “Strongly Agree”). The questions are shown below:

1. I am able to complete the tutorials with minimal help.
2. The hints provided in the tutorials are helpful.
3. I can get help from my peers during tutorial discussion.
4. I managed to clarify my misconceptions with the tutors during class.
5. I feel that this tutorial style is effective for my learning.
6. I will recommend this tutorial style for my juniors in the future. (End-of-semester only)

*continued on the next page ...*

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**ABOUT THE AUTHORS**

**Mr Chang Sheh Lit** was a teaching assistant in the Dept of Physics. He was keen in incorporate active learning in engineering physics tutorials. He will be pursuing a PhD in physics education research at University of Washington, Seattle.

**Dr Nidhi Sharma** is a lecturer for Engineering Physics courses in the Dept of Physics. She is keen on trying out new active learning teaching methods in lectures.
The survey results are shown in Figure 1. There were 65 respondents in the mid-semester survey and 40 respondents in the end-of-semester survey. From the responses collected for Statement 1 (“I am able to complete the tutorials with minimal help”), we can see that more than 50% of the students require help in completing the tutorials, which shows that students generally have difficulty in solving the problems given to them. Furthermore, there is a dip in the percentage of students who agreed to Statement 1, which corresponds to the higher proportion of students who require assistance in problem solving. We attribute this to the increase in difficulty level of the content, and the students’ lack of confidence in their ability to solve the problems on their own.

From the responses collected for Statement 2 (“The hints provided in the tutorial are helpful.”), more than 85% of the students felt that the hints provided in the tutorial were helpful; this shows that students welcomed our efforts in helping them understand the questions better. More than 90% of the students felt that they can obtain help from peers during tutorial discussions and managed to clarify their misconceptions with us during the class. This
shows that they found the increased interaction with their peers and tutors to be beneficial to their learning. There was a slight decrease in the percentage of students who were able to get their misconceptions clarified at the end of semester, which could be attributed to the increase in difficulty of the content after the Recess Week. Over 80% of the respondents felt that this kind of tutorial setting was effective for their learning. Lastly, 95% of the respondents in the end-of-semester feedback exercise would recommend this tutorial style to their juniors in the future. This shows that students in general welcomed this change in the tutorial format.

Qualitative Student Feedback

We also prepared open-ended questions for the mid-semester feedback exercise. They are as follows:

1. What was your expectation for PC1431 tutorials before the start of tutorial?
2. What do you love about this class?
3. What do you hate about this class?
4. If you could change one thing about this class, what would it be?

Based on their written responses, the students generally expected the tutorial class to be conducted mini-lecture style, where the tutor explains and demonstrates how to solve the problems in the class; discussions are favoured if there is time, and whenever possible, tutors should cover all the questions in the tutorial. In this tutorial format, they enjoyed having the tutors approach them during the small group discussion, where they had their doubts clarified and there were more interactions with their peers and the tutors. However, time is always in short supply, and some of them felt that this tutorial format was too time-consuming. Due to the large class size, sometimes it was impossible to clarify all of their doubts during the tutorial as the tutors might be preoccupied with other groups. As such, some students were unhappy that their doubts were not addressed on time.

We made some changes to the tutorial format in the second half of the semester based on their written feedback in the mid-semester feedback exercise. The changes made included:

1. Getting students to put up their doubts online before they come to class. We would take a look at their comments before going to class, and address them together if it is a commonly held doubt within the class. This was effective in helping to manage the time.

2. Providing a summary together with the tutorial, which we would go through with them if time permits.

Few students would put up their doubts in an online form, but we would still read through the ones who did submit something and answered them individually via email if we were not planning on going through the questions in class.

We also asked open-ended questions at the end of the semester, and they are as follows:

1. How do you feel about PC1431 tutorials so far?
2. Any improvements for PC1431 tutorials?

The respondents for the end-of-semester feedback exercise tend to be students who followed the weekly schedule faithfully and their written comments were generally positive:

- “The tutorials are more effective than standard tutorials where the tutor simply provides answers. Peers are more likely to ask each other questions then raise it in class. The tutorials with hints are very useful as well.”
- “The group format ‘forces’ everyone to do their work extensively before class which will aid in generating discussion during tutorial, a more productive method than ‘absorbing’ in class.”

Their comments sent us a strong message that we are heading towards the right direction in terms
of getting students to participate more actively in their learning journey. Effective learning can only happen when students are actively involved with the content, as compared to having them attend and passively listen to minilecture style tutorials. The conventional tutorial format, while efficient to some extent in helping students complete their assignments, may not be as effective in ensuring deep learning and understanding of the subject matter.

**Impact of PER Methods on Academic Performance**

Besides looking at students’ responses to the new format implemented for the PC1431 tutorials, we also wanted to find out whether this tutorial style has proved beneficial to their performances in test and exams. We extracted the test and exam scores of students in the control and experimental groups, and looked at the percentage of students who scored above the class average. The students that we selected were those who have garnered a tutorial attendance rate of more than 60% in both groups. This information is summarised in Table 2 below.

In both the control and experimental groups, more than half the group managed to get assessment scores that were higher than the class average. On taking a closer look, we observed that the students in the control group did slightly better than those in the experimental group, especially in the exam.

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of Students</th>
<th>Attendance &gt;60%</th>
<th>Test Score &gt; Class Average</th>
<th>Exam Score &gt; Class Average</th>
<th>Test + Exam &gt; Class Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>83</td>
<td>47 (56.6%)*</td>
<td>49 (59.0%)</td>
<td>48 (57.8%)</td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>72</td>
<td>41 (56.9%)</td>
<td>37 (51.4%)</td>
<td>39 (54.2%)</td>
<td></td>
</tr>
</tbody>
</table>

*Note: The values in parentheses refer to the percentage of students compared to the total number of students whose attendance is above 60% in the semester.

**Limitations of the Study**

PC1431 is a physics module with a large enrollment and this posed certain logistical challenges. For instance, as we needed two tutors to handle the discussion groups during class, it would be a challenge to justify an increase in manpower if the performances of the students do not improve.

In addition, some students in the experimental groups might not appreciate our rationale of having weekly sessions if they compare the relatively lower frequency of tutorials and the efficiency of the tutorial class (e.g. the number of questions discussed in class) with the control groups. Hence they may choose to skip our tutorials and attend other tutors’ classes instead.

Also, although having two tutors has made it easier to manage such a large class, we still encounter instances in which some students do not come to class prepared; in our opinion, the tutorial session would not be as beneficial for them.

In spite of these challenges, we were not keen to make big changes or revert back to the traditional mode of instruction, especially after we had obtained the generally positive responses from the mid-semester feedback exercise. This is because we felt that it would take time for students to get used to the new approach; hence, we decided to persist and make small changes to the new format instead.
As this was the first time we were making changes to our tutorial instruction, it would serve as a preliminary trial and this experience would be valuable in improving future tutorials.

Future Work

In this section, we would like to bring out one issue that arose when we conducted the discussion-based tutorials. Through our interaction with students, we found that it was difficult during the tutorials to correct students’ misconceptions or alternative conceptions to the physical ideas. These misleading ideas that they had were preventing them from learning more advanced concepts in the course, which led to students experiencing difficulties in solving the problems.

As physics instructors, it is our duty to make sure our engineering students gain an accurate understanding of physical concepts. In future semesters, we will continue to employ methods from PER, assess our effectiveness in our physics instruction in correcting students’ misconceptions, and continue to help our students be better problem solvers.

An Update on the Implementation of PER Methods in PC1431

We continued implementing this approach for the PC1431 class offered in Semester 2 of AY2012/13 and the author’s (Chang Sheh Lit) student rating (based on effectiveness) dropped from 4.203 (in Semester 1 AY2012/13) to 3.625 (in Semester 2 AY2012/13). We did not do a deep investigation into the reason for the decrease in the student rating by 0.6 points. However, we surmised that one reason for the higher student rating in Semester 1 was that these students were mostly freshmen who were open to any mode of instruction, whereas students taking PC1431 in Semester 2 had gotten used to the traditional mode of instruction and were less receptive to any deviation from the usual approach.

Conclusion

In summary, we have tried to use strategies from PER, such as peer instruction and problem solving through cooperative grouping, in three PC1431 tutorial groups and its effectiveness was compared with three other tutorial groups which served as the control. One main difference between the experimental group and control group was the increase in peer interaction among students, which those from the control group may not have had the opportunity to experience. Even though the performance in the test and exam did not reflect any significant improvements between the two groups, we believe we can continue to refine our approach and make this alternative tutorial style more effective in future semesters.

Endnote

1. The author (Chang Sheh Lit) incorporated the comments obtained from the student feedback exercise in AY2012/13 and made certain changes to his PC1431 tutorial instruction in AY2013/14, which will be reported in another article.

References


continued on the next page ...
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