Flipping the Classroom Compared to the Lecture Method: Students' and Lecturer's Perceptions

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Abstract

The current mode of delivery of engineering education at the Cape Peninsula University of Technology (CPUT) is the lecture, which has been shown by research not to be particularly effective for promoting deep learning. We argue that an alternative method of delivering curriculum may be needed in order to improve student learning. Underpinned by a developmental perspective of cooperative learning model, we present students' and their lecturers' perceptions of the benefits and challenges of the inverted classroom method of delivering instruction compared to the lecture method in a third-year hydrology course in civil engineering at CPUT. Quantitative and qualitative approaches were used for understanding the phenomena under investigation. Findings showed that 'inverting' or 'flipping' and moving the lecture to the homework domain, and saving application and one-on-one or group work for the classroom experience, makes the inverted classroom method more productive than the lecture method.

Keywords: Inverted classroom method (ICM), flipped classroom method, self-directed learning, civil engineering

1. Introduction

Most higher education institutions (HEIs) globally continue to rely on the lec-

ture method of delivering instruction (Bates & Galloway 2012; Butt 2014; McLaughlin *et al*. 2014); the main emphasis being on coverage of content (Strayer 2007). Johnson, Johnson and Smith (1991) report on several studies showing lectures to be relatively ineffective at promoting deep learning (see also Bates & Galloway 2012; Butt 2014). In lectures, seemingly, students are introduced to the materials and concepts; they have to process the information, solve problems, and practice with the course concepts and reach conclusions for application outside of the classroom (Talbert 2012).

Nguyen and Toto (2009) and Lord and Camacho (2007) report that in engineering education most classrooms still rely on the lecture mode to deliver course content. While this format has been effective, in practice we find significant problems with the pacing of instruction and that the most difficult tasks, in general, have to be performed by the students outside of class (in their own time), on their own and away from the instructor's help (Nguyen & Toto 2009; Talbert 2012). As elsewhere, this method is used to deliver engineering education at the Cape Peninsula University of Technology (CPUT).

We argue that HEIs need to use pedagogical approaches which have been shown to promote deep student learning and high performance. Such an approach is the 'inverted classroom method' (ICM) (Butt 2014; Gannod, Burge & Helmick 2008; Herreid & Schiller 2013; Lage Platt & Treglia 2000; Pierce & Fox 2012; Mangan 2013). In the schooling sector the ICM is often known as the 'flipped classroom' (White 2011). A lecturer at CPUT decided to pilot the ICM in a hydrology course, since the lecture was scheduled for 13h00 and he had noticed that most students were not concentrating then – there was a need, he surmised, to think of alternative ways of delivering instruction, which would improve student learning.

In this article, we present students' and their lecturers' perceptions of benefits and challenges of the ICM as compared to the lecture method in a third-year hydrology course in the civil engineering field at CPUT. The question that guides and gives focus to this paper is: 'What are students' and the lecturer's perceptions of the benefits and challenges of the ICM of delivering instruction compared to the traditional lecture method?

Quantitative and qualitative approaches were used, with a mixed method for collecting data. An in-depth interview was carried out with the lecturer, and a survey questionnaire was distributed to the 50 enrolled students to elicit their perceptions of the benefits and challenges of using the

ICM as compared to the traditional lecture.

We assume that this study will provide insights on the use of the ICM in an engineering field at a resource-poor university of technology in South Africa. These could be of benefit to other HEIs in South Africa and Africa, as there are limited research and studies on use of the ICM.

We present literature to unpack the ICM and its benefits, a conceptual framework which helped us understand the teaching philosophy used by the lecturer in the implementation of the ICM; the research methodology, results and discussion; and end with a conclusion and recommendations.

2. ICM for Curriculum Delivery

The ICM method uses technology to 'flip' or 'invert' the traditional lecture model (Strayer 2007), moving the lecture outside the classroom via technology and moving homework and practice with concepts inside the classroom via learning activities (Bishop & Verleger 2013; Herreid & Schiller 2013; McLaughlin *et al*. 2014). The defining characteristics of the ICM are online lecture materials (text, audio or video format) that students can access on demand, and a classroom environment conducive to working with peers and the lecturer, problem solving and answering questions (Gannod *et al*. 2008; Lage *et al*. 2000; Nguyen & Toto 2009; Strayer 2007). Outside the classroom, students engage with the online materials in preparation for lecture time, and classroom time is used to process the information and solve problems, and practice and apply concepts via guided learning activities, often done in groups under the guidance of the lecturer and peers.

According to Lage *et al*. (2000) the ICM is not a new idea. For example, in 2000 Baker provided lecture notes on a web page, extended classroom discussions through online threaded discussions and used online quizzes in Graphic Design for Interactive Multimedia and Communication in the Information Age courses. Kaner and Fiedler (2005) and Day and Foley (2006) used video lectures to invert their upper-level software courses, with no active component for students while watching videos; class time was not used for hands-on application of ideas, but for further discussion of concepts. Gannod *et al*. (2008) applied the ICM to offer instruction in a software engineering course through podcasts. Eric Mazur, a physicist at Harvard University, has been using the method for 21 years (Berrett 2012).

In the year 2000, staff members of the Centre for Culture, Communication and Media Studies at the University of Natal, Durban, where one of the authors of this paper studied, employed the flipped classroom method to teach honours and masters level students. Course work honours and masters students were given a course reader which clearly stated the topics to be covered in each of the study and guiding questions. Students were expected to engage with the readings in their own time and to respond to the guiding questions as a group before the lecture. In-class activities included student presentations of their understanding of the content, a class discussion guided by the lecturer on issues arising from the content, with the lecturer ending the session by responding to students' questions and reinforcing the main ideas emanating from the content covered. The abovementioned examples show that there is no one model of ICM; in fact, there are many forms (Sams 2011). According to Gardner (2012: 2) 'the modern version of inverted class, which is characterized by online videos, is already over a decade old' (see Lage *et al*. 2000). However, we argue that the newness of a pedagogical approach is subjective and contextual; for lecturers and institutions who have never engaged with the ICM before it is a new pedagogical approach.

Pedagogical benefits of the ICM are that the out-of-class activities (e.g. students watching online videos introducing course concepts, showing of examples, giving quizzes or exercises and modeling the problem-solving process) supplement and reinforce concepts presented in textbooks (Doering & Mu 2010; Roehl, Reddy & Shannon 2014; Talbert 2012). In this way, students who would have found the pace too slow may quickly work through material they already know, and delve into more interesting and challenging problems (differentiating instruction based on student needs). Students who would have struggled with concepts can access course materials when ready to learn, and are able to rewind and watch segments many times (extended engagement with course content) (Gannod *et al*. 2008; Gardner 2012; Mangan 2013; Strayer 2007). Students can also pause and reflect on lecture materials (Mangan 2013; Talbert 2012). Beyond using the online videos to prepare for class, they are available for later reference. Students who are absent due to illness or extracurricular activities do not miss out on learning (Bergmann & Sams 2012). By watching the videos in their own time, students arrive in class prepared to practice the ideas they have already been exposed to (McLaughlin *et al*. 2014). When an assignment is given on the

course content students work in groups; they are involved in active learning while the lecturer walks around observing their work and offering assistance (Butt 2014; Pierce & Fox 2012).

A primary element of learning is asking questions, and the ICM provides an environment where questioning is a primary classroom activity (Bain 2004). Students focus on internalizing the course materials with the help of their peers and their instructor (Bishop & Verleger 2013; Roehl, Reddy & Shannon 2014). Students who struggle with specific concepts can benefit from the instructor's time, which can be spent on identifying individual sources of a student's confusion, and to promote personalized instruction. Students who learn at a faster pace than their peers may also serve as peer mentors (Gannod *et al*. 2008; Strayer 2007) for other students in class; thus slower students have more help, while the faster learners achieve the deeper understanding that comes from explaining a concept to someone else.

The method has been criticized for assuming that every student has access to technology (computer, smartphone or tablet) and internet connectivity (Gardner 2012), especially in developing countries like South Africa. For the method to work well, most of the students must engage with the online materials before attending lectures, a scenario that is highly unlikely without an enforcement mechanism such as awarding marks for out-of-class activities. Furthermore, developing ICM materials is labour-intensive and time-consuming (Bates & Galloway 2012; Talbert 2012) for lecturers, who are expected to teach as well as to do research. However, the method shows the potential for making university classrooms more interactive, inclusive and effective (Talbert 2012), and, more importantly, it can be applied in many disciplines (Gardner 2012). However, Strayer (2007) reveals that there are few research studies that specifically investigate the ICM, particularly in Africa. This paper presents both student and their lecturer perceptions of the benefits and challenges of the ICM compared to the lecture method in a third-year Hydrology course in the Civil Engineering field at CPUT.

3. Conceptual Framework

The developmental perspective of a cooperative learning model, founded in a constructivist epistemology, was used to understand how the lecturer in this

study piloted the ICM. The hydrology course is a third-year module within Water Engineering and contributes 50% of the marks towards the subject. The Water Engineering module contributes towards attainment of a national diploma in civil engineering, and is a compulsory one-semester course taught in the second half of the year, with two, one-hour lectures per week. The course aims to impart the principles and practices of engineering hydrology through the use of examples and calculations. The lecture method is used to teach course content, supplemented by student interaction with information through homework, lab sessions, projects and discussions that take place out of class. The course was co-taught by two lecturers. The ICM was not implemented in the delivery of the entire course; just for selected topics in the course, namely, introduction to hydrology, meteorological data, evaporation and transpiration, and infiltration and percolation.

The lecturer implemented the ICM by providing students with basic materials related to the course content via online videos (using a shared drive on the institutional intranet for long videos and Dropbox for short videos), short documents on the course website, readings from the prescribed textbook, as well as supplementary notes. Students were continuously encouraged to engage with the materials through a closed Facebook group. They engaged with the above-mentioned materials at home in preparation for the in-class activities. In class, students' understanding of the materials they engaged with at home was tested, followed by small group discussions of the evaluation. Students then assessed each other's responses to the evaluation questions and commented on the answers. They then worked collaboratively in groups on more complex questions, with the lecturer assisting and guiding them as needed.

The in-class activities justified Johnson and Johnson's (1999) assertion that cooperative learning occurs when students work together to accomplish a shared learning goal. The class ended with a briefing on what was expected of the students in the next class, which was summarized in a post placed on the Facebook group. The in-class activities were used to reinforce understanding of the content learnt at home, with the aim of contributing to the course outcome.

Although cooperative learning has its premise in constructivist principles, in implementing it the teacher maintains complete control of the class, even though students work in groups. The cooperative teacher asks questions, provides additional texts or resources for the students to read and

analyze, and then asks the students to work in groups to answer the questions. Groups then present their results to the whole class and discuss their reasoning. In this type of learning the students do the work necessary to address the course content, but the teacher maintains control of the process at each stage. In piloting the ICM in the hydrology course a developmental perspective of cooperative learning which was largely teacher-centered (Lee 1997) (students did not provide input into what the class does and how it does it) seems to have been employed. The lecturer decided to change the method of delivering instruction from lectures to the ICM, but asked students to allow him to test his ideas. He decided on and designed materials to be studied out of class, and chose the platforms for accessing the materials and what students will do in class.

Fundamental assumptions of the developmental perspective on cooperative learning are that interaction among students around appropriate tasks increases their mastery of critical concepts. In Vygotsky's (1978) view, collaborative activity among children promotes growth because those of similar ages are likely to be operating within one another's proximal zones of development[1], and they are more likely to model the more advanced behaviors of the group than of those they would as individuals. The importance of peers operating within one another's proximal zones of development was also established by Kuhn (1972), who found that a small difference in cognitive level between a child and a social model was more conducive to cognitive growth than a larger difference. Furthermore, Piaget (1926) held that language, values, rules, morality and symbol systems can be learnt only in interactions with others. However, according to Slavin, Huerley and Chamberlain (2003), there is almost no research that explicitly links Piaget's conceptual work to classroom learning. The lecturer in this course, nevertheless, implemented ICM with the aim of achieving the fundamental assumptions of the developmental perspective on cooperative learning and to contribute knowledge to the field.

[1] The zone of proximal development is 'the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers' (Vygotsky 1978: 86).

4. Methodology

Both quantitative and qualitative approaches were used, to ensure that limitations of one type of data were balanced by the strengths of another, enhancing the significance of the findings (Caracelli & Greene 1997).

4.1 Context and Participants

The main participants in this study were the 50 students enrolled in the course and their lecturer, who implemented the ICM in a hydrology class in 2011 and offered a training workshop on the ICM to 11 lecturers in November 2012. Thus purposive sampling was used to choose the lecturer (Patton 1990); he had rich information gained through practice and was thought to be likely to reflect on the complexity of implementing the ICM as compared to the lecture method. The convenience sampling method was used to select the students for this study.

4.2 Data Collection

A qualitative approach was used for collecting data; data consisted of an in-depth interview with the lecturer, and a workshop facilitated by the lecturer to introduce the ICM to 11 lecturers from various disciplines in the university, an examination of the lecturer's perceptions of benefits and challenges of ICM for delivering instruction. Four, open-ended questions in the students' survey questionnaire elicited their perceptions of ICM's capability to facilitate active learning, group work and the time students took to get used to ICM. Quantitative data were gathered through a survey questionnaire distributed to the 50 students enrolled in this course to elicit their perceptions of the benefits and challenges of using ICM in comparison to the lecture method.

The survey questionnaire included both open- and closed-ended questions. Eight closed questions comparing students' perceptions of the ICM and traditional lecture method in terms of classroom attendance, level of enjoyment, understanding of problems, concentration in class, regular preparation for lectures and in-class activities for the flipped method, active involvement during class, enough time for study, levels of preparation for exams, finding answers to homework during the learning process, and the

mode of delivery students preferred for the rest of the semester. Parallel data gathering was used with the students and sequential data gathering with the lecturer (Caracelli & Greene 1997).

4.3 Data Analysis

Quantitative data were analyzed using a five-point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). The means and standard deviations were calculated to determine the central tendency (typical score) and variability (spread) of interval data. A paired sample one-tailed t-test was executed to test for significant differences in the perceptions of the ICM and the lecture method. Because quantitative data do not provide reasons or motives behind rating scores, the reasons given by participants are important to make informed decisions regarding the implementation and effectiveness of ICM. Consequently, qualitative data were analyzed inductively via a constant comparative method to probe the motivation behind the scores. Data from the lecturers' in-depth interview, workshop transcripts and open-ended questions from the students' survey were analyzed. Open coding, 'the process of breaking down, examining, comparing, conceptualizing, and categorizing data' (Strauss & Corbin 1990:61), was used to identify themes and insights emerging from the data, and insights to help understand the problem under investigation.

We acknowledge that the findings of this study are not generalizable, but offer valuable insights which others interested in implementation of ICM for curriculum delivery could draw from. Participant consent to take part in the study was sought, and the purpose of the study was explained to the lecturer and students. The interview and workshop transcripts were made available to the lecturer participant for scrutiny. Anonymity and confidentiality were adhered to as promised to the lecturer and students. Ethical clearance was given by the Fundani Centre for Higher Education and Development Ethics Committee.

5. Results and Discussion

The findings and discussion are presented under the following themes:

- Students' perceptions of the benefits of ICM compared to the lecture method;
- Lecturer's perceptions of the benefits of ICM compared to the lecture method; and
- Challenges encountered in the implementation of ICM and the critical conditions for successful implementation.

5.1 Students' Perceptions of Benefits of ICM for Curriculum Delivery Compared to the Lecture Method

Students' mean scores for class attendance and concentration in class were statistically significantly smaller at the 95% confidence level for the lecture method, whereas the mean scores for the level of enjoyment, understanding of problems, regular preparation for lectures, levels of preparation for exams, and finding answers to homework during the learning process were statistically significantly smaller for the ICM (See Table 1).

Thus, students' classroom attendance and concentration in class were better for the lecture method than the ICM. On the other hand, aspects on students' level of enjoyment, understanding of problems, regular preparation for lectures and in-class activities for the flipped method, level of preparation for exams, and finding answers to homework during the learning process were rated more favorably for the ICM than the lecture method. On the aspects of students having enough time for study, active involvement in class and preferred mode of delivery for the rest of the semester, there was no significant difference between the ratings for the two methods. However, aspects on students having enough time for study and active involvement during class were rated nominally better for the ICM than the lecture method. The converse was true for the preferred mode of delivery for the rest of the semester (Table 1).

Table 1: Mean score (± standard deviation) of aspects tested for the ICM and the lecture method

Aspects measured	ICM	Lecture method
Classroom attendance	1.94±1.42	1.6±1.92*
Level of enjoyment	2.12±0.689	2.4±0.901*
Understanding of problems	2.37±0.994	2.76±1.119*

Regular preparation for lectures and in- class activities for the flipped method	1.9±1.233	2.51±1.283*
Concentration in class	3.64±1.191	2.81±1.279*
Active involvement in class	2.44±1.053	2.65±1.159
Enough time for study	2.51±1.21	2.61±1.325
Levels of preparation for exams	2.49±1.12	2.87±0.992*
Finding answers to homework during learning process	1.56±0.884	1.85±0.882*
Mode of delivery students preferred for rest of the semester	2.9±1.358	2.81±1.345

*Asterisk indicates significant difference at p=0.05 (one-tailed t test for paired sample).

The analysis of the qualitative data showed that most students (35/50) liked[2] the ICM more than the traditional lecture method. Students gave varied reasons for liking the methods. A good number indicated that they liked the ICM more than the lecture method because it allowed them to engage with the course content before class as many times as they wished and in their own time.

> **Extract 20**: The advantage of the videos is that I can experience the lecturer over and over again. It is done in my own time at my own leisure. I strongly urge that more of our subjects are carried out in this manner.

The above findings show that the method enabled students to engage more with the subject matter outside the classroom which, according to Kuh

[2] The concept 'liked' is used in this study based on student perceptions of the lecture and the flipped methods of curriculum delivery. The perceptions were self-reported in open-ended questions contained in the student survey questionnaires used in this study. Reasons for liking either of the methods are given in the results and discussion section.

(2009), may lead to enhancing the students' understanding of the subject matter and hence, to support deep learning. Furthermore, a few students stated that materials provided to them on short videos allowed them to engage with concepts until they understood them; unlike in the lecture method which only provided one opportunity to grasp concepts. These results are in agreement with findings by Gannod *et al*. (2008), Gardner (2012) and Mangan (2013). These students stated that engaging with the subject matter before class discussions enhanced the retention of knowledge. Some reported that the ICM allowed them to actively participate in classroom activities (unlike the lecture method), which they indicated assisted them in learning and remembering content, as depicted in the following extracts from the student survey questionnaire:

> **Extract3**: The fact that my brain is active in class and understanding what has been taught and rectifying any misunderstanding while in class
> **Extract 4**: It gets the students involved and therefore learning and remembering the content is much easier

Another reason given by a good number of the students for liking the ICM over the lecture method was the fact that it enabled them to take responsibility for their own learning:

> **Extract 29**: You are treated as an adult; you as a student have to take responsibility for getting the information
> **Extract 9**: This method makes the student more interested in the work and eager to figure out what we given by the lecturer, by exploring the sources by yourself, it is intriguing and makes you understand the work.

Based on the aforementioned, it seems students appreciated the ICM because it gave them the power to control their learning (self-directed learning) (Pierce & Fox 2012; Roehl, Reddy & Shannon 2013), which enhanced their interest in, engagement with and understanding of the module content. However, a few students (15/50) disliked the ICM. Some key reasons given for not liking the method were lack of immediate feedback on problems encountered after engaging with course materials at home, the fact that the

method gave students more responsibility for their learning, and love of the lecture method. On the lack of immediate feedback, one student wrote:

> **Extract 40**: If you are unsure about certain contents you are not able to clarify immediately.

Regarding emphasis on self-directed learning, students were unhappy that the ICM shifted the role of learning to the students:

> **Extract 42**: It puts most of the responsibility on the student which in some cases is a bad thing.
> **Extract 44**: You have to teach yourself and sometimes that isn't easy.

These students may have disliked self-directed learning partly because they were used to being taught by the lecture method, where the teacher is the 'sage on the stage' and the students are passive receivers of knowledge (Lehmann & Chamberlin 2009). This method is used in most HEIs (Bates & Galloway 2012). Familiarity with the lecture method was given as a reason for liking it by six of the students. The following illustrate the students' feelings about the lecture method:

> **Extract 18**: It is the same way all the other subjects are taught
> **Extract 19**: It is a method that I am accustomed to and because of that familiarity; it makes it more enjoyable for me.

Immediate interaction with the lecturer in class was put forward as a reason for liking the traditional lecture method by 14 of the students. One had this to say:

> **Extract 45**: In class I can ask if the lecturer talks about something and feel more involved. Also calculations are better to understand when it is handwritten and to participate in the process of the calculation and to get to find answer.

Immediate feedback may also explain why students rated the lecture method statistically, significantly more favorably for class attendance and

concentration in class. However, the traditional lecture method was disliked by 28 of the students taking this course. Some of the reasons given by a substantial number of the students were lack of student involvement in the class, the time-slot of the lecture, lack of concentration, and the fast pace of teaching during the lecture. Students wrote:

> **Extract 7**: It is late in the afternoon, after attending a number of lectures. I find it a bit harder to concentrate for longer.
> **Extract 14**: Up till a certain point, one's concentration is broken by tiredness, due to minimal involvement.

The lack of students' involvement and the fast pace highlight some criticisms of teacher-centered methods of teaching like the lecture method (Butt 2014; Lehmann & Chamberlin 2009; Roehl, Reddy & Shannon 2013), which may lead to low student concentration.

5.2 Lecturer's Perceptions of Benefits of ICM for Curriculum Delivery Compared to the Lecture Method

It is commonsense that many faculty members would adopt a new pedagogical approach when it is perceived to help improve teaching and learning. According to Davis (1989) perceived usefulness is the degree to which a person believes that using a particular system would enhance his/her job. The lecturer in this study believed that the ICM was more beneficial than the lecture method because it facilitated deep learning and enhanced his job, as evidenced in the following quotes:

> … the things I did right was the whole idea of giving the material beforehand, basic material and then coming to class and then carry on with a little bit more advanced examples… questions that require cognitive engagement, when I'm there to prompt them and help them and they help each other obviously. They help each other actually a lot. Sometimes they don't even want the lecturer to give them help ... what happens in normal classrooms is the lecturer stands up and …does basic examples and then he tells students to go back do homework and the homework is then more advanced…

> … it [ICM] enriched my job because I'm unfortunately in the situation that I will probably be stuck as a lecturer … till I retire. I have to enrich my own life and I have to use new methods. And it definitely did … I'm getting some exposure, meeting some new people…and I'm making new contacts all the time now…

By adopting the ICM the lecturer enhanced student involvement in the class, which may have improved students' concentration and addressed the disadvantage of the time-slot, student engagement with the course content outside of class, peer learning and student-teacher interactions. Student involvement (Astin 1984), engagement (Kuh 2009), peer learning and student- teacher interactions are some characteristics of deep and meaningful learning (Anderson 2003).

5.3 Challenges Encountered in Implementation of the ICM and Critical Conditions for Ensuring Successful Implementation

Based on some students' reasons for not liking the ICM (familiarity with the lecture method, lack of immediate feedback, and self-directed learning method promoted), it can be deduced that it is a challenge to introduce a new method of teaching and learning in an environment where the lecture method is the norm. A lot needs to be done by the lecturer before introducing a new method of teaching and learning. On the issue of students not liking the self-directed learning promoted by the method, it may have helped to explain to the students what the ICM and the lecture method entailed, and the kind of learning both methods support. Raising students' awareness of the two methods could assist in acceptance of the ICM. Also, exposing students to the ICM for one semester in selected topics in a course is not enough time for them to fully appreciate the method. A long period of exposure to ICM and wide application in different disciplines/subjects may help in acceptance of the method by students.

The challenge of lack of immediate feedback while engaging with content materials at home may have been due to the fact that the lecturer provided such content with no questions for the students to test their understanding. We argue that provision of short videos or content covering a concept/s in conjunction with self-assessed or multiple-choice quizzes that

provide for formative assessment would allow for mastery of learning and would complement the optimal attention span of students (Khan 2012; McLaughlin *et al*. 2014). The quizzes promote self-assessment, an important skill for effective and lifelong learning and future professional development (Taras 2010). Furthermore, self-assessment is said to facilitate greater autonomy in learning and is particularly effective in developing self-learning skills (Boud & Falchikov 1989) required for achievement in online learning (Garrison 2003). The cognitive benefits of self-assessment include improved understanding, performance and ability for self-analysis (Gordon 1992). Furthermore, more constant communication between lecturer and students and student-student interaction is crucial to ensure that students engage with course materials outside the classroom, as underscored by the lecturer:

> I believe that this inverted classroom needs to go hand in hand with a good communication tool, because if you want to give students stuff to do outside the classroom there needs to be constant communication … I think a major problem would be just to let the student be and when he comes to class again then he says 'Well I didn't understand what I was supposed to do' or whatever ... I set up Facebook …for the subject and I had all 50 students actually in the group and it was a closed group… we had constant questions from students, posting of things that's happening, go look on the shared drive for this thing and do that. So the instructions didn't only take place in the classroom, the communication went right through the week.

The lecturer stated that the method was not easy to implement because it was labor-intensive and time-consuming to make the online materials, and that one needed to motivate students to ensure they engaged with course materials at home:

> I don't think it's easy because it takes a lot of preparation… you have to prepare new material where you could have just stuck with the old, … it takes time to make little videos and editing it.…to actually shoot the video it takes probably four/five times as long to edit it…

These results are similar to findings by Bates and Galloway (2012), Talbert (2012) and McLaughlin *et al*. (2014). According to the lecturer, a mind shift on how one teaches is needed to embrace the ICM. The lecturer also reported that it was not easy to use the ICM at the university because of contextual and social issues, which Chai *et al*. (2015) call the intrapersonal dimension of context:

> …let's say two lecturers lecture the same subject, we have to agree on the assessment. Now this deeper learning that took place might not be assessed because we're back to the old way of let's say we taught in class and we have to assess those basic things.
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> …I don't know about other places but you can come and look at our classrooms. They're terrible …I want to show a little video of something … using a data projector, I don't have sound, then you could hardly see because there's no way I can make the classroom a bit darker. It's very noisy and it's uncomfortable…
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> … what is happening is because our facilities are so poor, if I have to go to class and use technology there, I bought myself a trolley. In the trolley I put my laptop, data projector, my two speakers, my extension cord... Now I trolley this to the classroom…tea time I would go 15 minutes before the time …and set up my things. …at lunchtime when we stop I have to take down all this lot again – put it in my trolley and off I go back. Now that in itself is really a big stumbling block for anyone who wants to implement this, because it's really too much hassle.

Co-teaching a course, poor classroom conditions, and lack of technology and technical support in use of technology in teaching and learning are put forward as some of the factors that may hinder lecturers' use of ICM at the university. The provision of good teaching facilities[3] and technical support

[3] The lecturer's comment on facilities is included because physical facilities and technological provision influences lecturers' decisions of using the current model or the flipped classroom method. Poor and insufficient

when using technology would make it easier for lecturers to implement ICM. Emerging from the above mentioned is the challenge that most academic staff members in this institution (as elsewhere) are hesitant to embrace new pedagogical practices like the ICM, in part due to lack of teacher/lecturer self-efficacy (Tschannen-Morana & Hoy 2001) and technological self-efficacy (Compeau & Higgins 1995). The lecturer in this study said:

> … although I've studied engineering I also come from a very strong IT background …I did three-year software diploma and I've always been interested in technology. I think I'm not scared of technology. I find it sometimes a stumbling block for lecturers to get because they are a little bit scared of technology...

The ICM relies heavily on technology, but most faculty at this university (as elsewhere) have not learnt their subject content with such technologies and hence do not have the essential experience in it; nor have they been prepared to teach their content with these new and emerging technologies (Niess 2011). Proper technical training, exposure and support are needed for faculty to embrace technology in teaching and learning. To embrace new pedagogical approaches like the ICM a mind shift is needed from faculty, which would include looking at their current pedagogical practices and seeking approaches that address students' teaching and learning needs, as evidenced by what the lecturer in this study did:

> … I had a particular problem this year that they gave me …two hour slots after lunch two days, consecutive days. So the students arrived tired, struggled to concentrate… So I thought you know I cannot use normal techniques here, it's not going to work, you know because they'll fall asleep … Now I can get them involved, I can hear them talking and engaging, I feel that's a great way of stimulating conversation and learning more…

Teacher reflection on their practices and continuous professional development is needed because teaching is complex and requires

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provision may cause new users of the method to regress towards use of the lecture method.

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considerable teacher training (which most lecturers in this institution do not possess) and continuous refinement of skills and procedures (Johnson *et al.* 1991).

6. Conclusion and Recommendations

This study found that students rated the use of the ICM in curriculum delivery significantly more favorably than they did traditional lectures in terms of level of enjoyment, understanding of problems, regular preparation for lectures and in-class activities, levels of preparation for exams, and finding answers to homework. Furthermore, students indicated that they liked the ICM since it enabled them to engage with course content as often as they wished and at their own pace before attending class, which enhanced their understanding. The method was perceived to have promoted self-directed learning, as students felt it enabled them to take responsibility for their learning. However, results showed no significant difference between the two methods on aspects of students having enough time for study, active involvement in class, and preferred mode of delivery for the rest of the semester. The lecture method was rated statistically significantly more favorably than the ICM for class attendance and concentration in class. The lecturer liked the ICM because it facilitated deep learning and enhanced his work efficacy.

Results showed that lecturers' self-efficacy and technological self-efficacy were important in implementing the ICM, and will be a challenge if the method is to be up scaled. This method requires lecturers to reflect on their own teaching methods and the context of teaching and how it impacts on students' learning, in order to be able to adopt and implement new pedagogical approaches to suit their contexts and student learning needs.

We recommend that for wider adoption of the ICM, staff training strategies which emphasize technological pedagogical content knowledge (TPACK) (Koehler & Mishra 2008) are implemented in the institution, as development of TPACK among lecturers is critical for effective teaching with technology. TPACK is a complex interaction among three bodies of knowledge: content, pedagogy and technology. Lecturers need content knowledge – knowledge of a discipline and what it means to teach it to learners, given what they require at a specific point of their development.

Lecturers must also possess pedagogic knowledge – general principles of teaching and learning that apply to any discipline. Lecturers need pedagogical content knowledge, including knowing the subject matter, curriculum, pedagogy, learners and schools/universities, and understanding how content fits together and how to present it so that it is meaningful to students. They also need to possess technological content knowledge – understanding of the manner in which technology and content influence and constrain one another. Lecturers need to understand which technologies are best suited to address learning in their domains, and how the content dictates or even changes the technology or vice versa.

Since the lecture method of curriculum delivery is so pervasive in higher education teaching, any lecturer introducing an innovative pedagogical approach must acknowledge that it will not be easy to change the way students are taught, because they have mainly been schooled using that method and most lecturers continue to use it. We suggest that any lecturer implementing the ICM should explain what the method entails and its benefits for students. Expectations of students should be explained. The lecturer should implement the method incrementally using a research-based approach, and the results should be used to improve the practice.

We also suggest that provision of short videos or content for engagement at home in preparation for in-class activities should be used in conjunction with self-assessed or multiple-choice quizzes, as they provide for formative assessment and allow mastery of learning. Short videos match the optimal attention span of students (Khan 2012). To ensure feedback to students during out-of- class activities, we emphasize the importance of communication tools such as Facebook to help students obtain help with problems, assessment or understanding (Darabi *et al*. 2011) from lecturers and peers. Students learn just as much from their interactions with each other as from the course materials (Thomas 2002).

We argue that grounding implementation of the ICM on a more teacher-centered approach to cooperative learning has positive impacts on learning, as shown by this study. However, we believe a more learner-centered approach of cooperative learning will yield even better results if used in implementation of ICM. Further research will need to be carried out to devise a learner-centered approach of cooperative learning for implementation of ICM suitable for CPUT. Research will also have to be undertaken to measure the impact on student performance.

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