**The learner-generated podcast: Engaging postgraduate engineering students in a mathematics-intensive course**

In this paper we discuss perceptions of the benefits of learner-generated podcasts for supporting postgraduate engineering students in a mathematics-intensive course. The course under study had previously been highlighted as one in which students had struggled to attain knowledge that formed an essential underpinning to their degree programme. Podcasts were used as a means of concretising abstract mathematical knowledge so that students could access and share such concepts in a meaningful way. The experiences of three students (in a single cohort) were examined qualitatively at every stage of the exercise: introduction, pre-test, podcast creation, podcast peer-evaluation, post-test, and focus-group session. The data suggest that this specific technique led to improvements in mathematical learning through the analysis of podcasts rather than through the creation of them.

**Key words**: podcasts, postgraduate, mathematics, engineering, concepts

**Introduction**

Many engineering courses require fundamental mathematical knowledge and students without such knowledge may encounter difficulties in grasping and mastering core concepts. Part of the difficulty here might be that many aspects of mathematics are abstract yet teaching mathematics to engineering students is best done through concrete experiences (Sakshaug and Wohlhuter 2010; Raines and Clark 2011; Dzuiuban, Hartman and Moskal 2004). More specifically postgraduate students tend to benefit from making connections between their actual lived experience and their learning experience (Bilgin and Crowe 2008; Beattie and James 1997) such that knowledge that is presented in the abstract might be difficult to assimilate.

This paper discusses the development and analysis of an intervention in a mathematics-intensive postgraduate course at The University of the West Indies, St. Augustine, Trinidad and Tobago. Typically, students enrolled on the Master of Applied Science (MASc) Electrical and Computer Engineering programme study on a part-time basis and occupy engineering positions in the local industry where their work hours may extend well beyond the average 40 hour week. It can therefore be a challenge for them to attend the two scheduled three-hour evening lectures each week for 13 weeks. This is one of the reasons why students might be absent from class. Their missing class then feeds into a vicious cycle as there is a constant challenge for them to catch up with the course material which tends to be sequential in nature. When they do attend class they must contend with fatigue, and hence struggle to concentrate on the material presented. To exacerbate the situation, a number of these students enter the programme after being out of the academic system for a number of years, so that they may have forgotten some mathematical concepts that are fundamental to the programme. Besides this, some of the students do not have undergraduate degrees in engineering and may have gaps in their mathematical knowledge in relation to engineering. This makes it difficult for them to grasp higher-order, abstract concepts which are necessary for them to master so as to be successful on the programme.

Postgraduate education is adult education. There is still no conclusive research on how adults learn, but there is agreement on general principles. Adult learners are likely to benefit from: opportunities for self-direction; clear relationships between their learning, life and professional experiences; conscious reflection; and action or expression as a result of learning.

 (Beattie and James, 1997, 179)

Principles of Communications is one of the first mandatory courses that the MASc students study for. It is highly theoretical and requires a strong foundation in mathematics. This course (and others taught be the same lecturer) is usually taught along ‘traditional’ lines: key information is covered through lectures and tutorials; students hold in-class and online discussions; notes are given out in hard copy and posted online, and there are lab sessions in which students complete hands-on exercises to simulate digital communication algorithms that were previously derived (theoretically) in the classroom. The lecturer had not previously attempted to use podcasts as a teaching and learning tool. Throughout the history of this course students have been found to struggle with the foundational mathematics, especially in areas such as Random Processes. An understanding of Random Processes is indispensable for modelling the real-world uncertainty in which electronic communication systems operate. Therefore, to design, analyse and evaluate the performance of such systems in such a context, students must develop competence in the use of this tool. Their answer to the simple question, ‘What are Random Processes?’ provided a reasonable baseline indicator of their mathematical readiness or this course. The class sizes are very small (for this course iteration, there were only three students enrolled in the course) which allows for direct interaction between the students and the lecturer and between the students and their peers. With this confluence of circumstances and learning challenges, it is difficult for a university lecturer to effectively teach this particular group of students so that they succeed in the programme. No direct and explicit intervention had been adopted in the past. Typically sessions involved the explanation of worked examples student exploration of problem sets. Some of the questions were attempted in the classroom, first by the students individually and then collectively, guided by the course lecturer. Students were also directed to key resources but much depended on the student’s own initiative. It was this situation that lead to the design of this research project. What was required was a multi-faceted and incremental approach that examined the core literature; students’ perspectives of mathematics before, during and after an intervention, and the reflections of the course lecturer so as to develop a tool that would offer an effective mathematics learning experience. If learning about abstract mathematics is thought to be challenging then it was felt that developing a process where students were able to take an experiential approach (Kolb 1984) would help form a link between their concrete experiences and their theoretical understanding. Adopting an Action Research paradigm (Kemmis and McTaggart 1988), an intervention centred around learner-generated podcasts was designed and implemented to meet the specific needs and constraints of these postgraduate students. Because there were only three students enrolled on this course it was possible to capture a rich data set that embodies the full experience throughout this intervention. Open-ended student questionnaires were used alongside pre- and post-intervention testing, peer-evaluations, and a focus group session to offer a thick description (Geertz 1973) of the students’ experiences through every stage of the exercise.

**Mathematical learning and learner-generated podcasts**

Mathematics is perceived to be difficult to learn (Brown, Brown and Bibby 2008); difficult to teach (Borko et al. 1992), and there is a persistent subject matter versus pedagogy debate (Ball 2000). To help address these concerns the teaching of mathematics through problem solving has been commonly adopted as a strategy for helping students to become actively engaged (Sakshaug and Wohlhuter 2010). Here it is believed that when mathematics is contextualised and students are taught to solve problems that are relevant, they will develop a healthier perspective about the subject. However Englebrecht, Bergsten and Kagesten (2012) found that, in order to contextualise mathematics in this way it was important that lecturers do not teach mathematics using a merely procedural approach since what was demanded of the students was a conceptual grasp of the mathematics involved. The procedural approach simply addresses the ‘how’, i.e., processes, rules and formulae, whereas the conceptual approach addressed the ‘why’, required higher-order thinking skills and led to an understanding of the mathematics in relation to its application. From this we can see that it is not enough for students to simply be taught to solve problems but that they should be encouraged to examine why a solution works and how learning to solve one problem relates to their wider learning experience.

In developing a teaching approach that encourages the reflective conceptualisation of problem solving Sazhin (1998) reported that, in the teaching of mathematics to engineering students, there needs to be a balance of theory with practical applications allowing for concretisation. According to Scherman and du Toit (2008) students are fully engaged if the activity involves a mixture of analysis, organisation, personalisation and visualisation, and Hacker and Burghardt (in *The Technology Teacher,* November, 2008) advocate such multi-faceted contextualisation of mathematics through the use of engineering design such that the abstract can be made ‘visible’.

Felder et al. (2000) reported that cooperative learning activities such as group work could further support the understanding of the link between concrete and abstract aspects of learning. Cooperative learning in mathematics, according to Chan and Ismail (2010), promotes thinking skills among students and provides a support system by which they can assist one another in solving problems, thereby helping them to master foundational skills. Scherman and du Toit (2008) showed that cooperative learning improved student achievement at the postgraduate level and that through working together students became accountable at the individual and collective level. Previously the extent to which cooperative learning was encouraged within the MASc programme had been limited to when the class worked on problem sets in the classroom itself. After having attempted questions on the problem sets, students were asked to present their solution to their colleagues on the board but there was no mechanism to support and develop this outside of class-time. In developing an intervention for the MASc students it was felt that, in order to accommodate their unique circumstances a more distributed form of cooperative learning may be required; therefore a blended learning approach seemed plausible.

Blended learning is a mixture of face-to-face and online teaching strategies that allow for effective learning alongside effective socialisation (Dziuban, Hartman and Moskal 2004). Some tools that bring blended learning to fruition include: blogs, wikis, podcasts and instant messaging and these are used in conjunction with ‘traditional’ classroom-based activities. Safdar et al. (2011), however, highlighted that there is a need to first train students in ICT before they can benefit from these tools and we are reminded by Raines and Clark (2011) that technology is just a tool and could be used effectively or poorly in teaching. Severinsen (2004) advocated the need for teachers to first develop a well-grounded teaching and learning philosophy so that they could effectively incorporate technology into their work and conceded that to implement such interactive constructivist methods of teaching and learning will require more time than traditional methods.

Raines and Clark (2011) reported that the pedagogical use of such technological tools should be purposeful and well-designed so as to ensure that students engage in and understand conceptually the mathematics involved; however, Smith Risser (2011) discovered three main fears among teachers in using technology in the teaching of mathematics: (1) technology could cause unsuitable changes to the curriculum so that essential pencil-and-paper work for students’ learning may be eliminated; (2) technology could negatively impact students’ cognition making it more difficult for them to think abstractly and to even interpret calculations accurately; (3) the adoption of technology itself in teaching and learning may be time-consuming and a challenge. Others, though, were more optimistic about the role of technology in mathematics education and suggest that technological tools can allow students to develop reflective cognitive skills (Raines and Clark 2011). One of the main advantages advanced for such technological instruction and practice was that it allows students to become more independent and self-motivated in their learning. It also provides the means for immediate feedback so that students could correct their own mistakes. As a result, students would be more inclined to practice more and this in turn would build their confidence as concepts are correctly reinforced. Liang and Sedig (2010) found that the use of interactive visualization tools helped students better understand foundational mathematical topics and that students were able to interact independently and more meaningfully and thus becoming more engaged with the subject matter. One such interactive tool is the podcast.

Podcasting is the automatic downloading of audio and video files to compatible media devices. One advantage of podcasting is that it enhances student reflection on a topic of interest as students can download and replay the content (reinforcing learning). It also offers mobility and portability and supports independent, personalised learning (Sutton-Brady et al. 2009). Griffin, Mitchell and Thompson (2009) investigated the pedagogical effectiveness of podcasting on students’ learning and found that audio-visual synchronised presentations were more beneficial than separate, stand-alone PowerPoint presentations and audio files. Interestingly, in their survey they found that although students appreciated podcasts, they did not want computer-based learning to completely replace face-to-face lectures.

Kay’s (2012) meta-analysis found that the three main reasons students use video podcasts were: (1) to improve learning, (2) to increase control over the learning, and (3) to make up for missed classes. Kay also found that students’ attitudes were generally positive with regard to video podcasts and that video podcasts are likely to foster independence and increase self-reflection. Kay and Kletskin (2012) found that over 90% of undergraduate students who used problem-based video podcasts found them useful or very useful, citing reasons such as the step-by-step explanations, the ability to control the pace of learning and the helpful visualisation of a problem.

Chan (2010) found that students tended to refer to video instruction first before any other online method and highlighted the role of user-generated content, the advantages of which would include discussion and collaboration among learners which in turn would capitalize on the social aspects of learning. Since it was felt that this social cooperation would help reinforce student learning, the development of learner-generated podcasts seems to offer scope for supporting the MASc students. Developing podcasts involves synthesising and communicating information which are procedures that increase knowledge retention (Heileson 2010) and, in attempting to help students access and attain underpinning knowledge, they seemed to be a meaningful tool since the true value of podcasting as a pedagogical tool is realised when learners themselves generated content for their peers (Lee, McLoughlin and Chan 2008; Frydenberg 2006; Armstrong and Massad 2009; Alpay and Gulati 2010; Dale and Povey 2010; Kao 2008; Özdener and Güngör 2010).

 There seems to be some agreement in the literature that for students to do well in mathematics they must be actively engaged, exploring for themselves the concepts involved through direct interaction with immediate feedback. This builds self-confidence. But there is greater enhancement in learning when this is done collaboratively with peers and facilitated through the appropriate use of technology undergirded by a sound teaching philosophy.

By having students explain mathematical concepts to their colleagues through developing and sharing podcasts it was hoped that they, together with their colleagues, would become more engaged with the material and so improve their mathematical competence. There would be a level of independence as they sought out ways to make sense of the material themselves. There may be greater levels of motivation to accomplish the task since they must coherently and accurately present this material to their colleagues. There would be a level of interdependence and shared responsibility to which, as professionals and postgraduates, they were already accustomed. It was hoped that by having students actively and cooperatively participate through the exchange of information, through the critique of one another’s work, and even by the contribution of assessment exercises, that a sense of community would also develop thus further enhancing their engagement and consequently their learning in the topics. To realise this cooperative learning among part-time students, the development of podcasts, sharing them online and soliciting feedback via the same medium, seemed to constitute the most convenient approach to accommodate their busy circumstances.

**Methodology**

An Action Research methodology was adopted as a means of systematically and incrementally improving the teaching and learning practices of the MASc course. This method involved a cycle of planning, action, observation and reflection (Kemmis and McTaggart 1988) in the hope that developing and enacting new teaching and learning techniques (podcasts); observing their outcomes, and reflecting on their effectiveness would help develop a practice that supported the concretisation of abstract mathematics. During this cycle there were five points where data was collected from each individual student: initial questionnaires, pre-tests on fundamental mathematics, mid-intervention questionnaires, post-intervention questionnaires and reflections on peer evaluations of completed podcasts. Data was also collected from a focus group discussion held at the end of the intervention and from the course lecturer’s reflective account of relevant interactions throughout the entire exercise.

On the first day of class the aims, learning outcomes and schedule of the course were outlined to the students and there was some input on the challenges previous students had encountered, particularly their lack of preparation in foundational mathematics. Students were also presented with a written copy of the podcast project and were guided step-by-step through the entire action research proposal and process/methodology. The reasons for the intervention were stated and initial questions and concerns were addressed. A letter was issued to each student, asking them for their permission. The letter stated that pseudonyms would be used to protect their identities and that participants’ rights would be protected. At the end of the letter student were to indicate (with a signature) whether they were happy to be part of this project and whether or not they gave permission for the data generated about themselves to be published. The participants were offered the right to withdraw at any time and all gave full informed consent. Additionally, on that first day of class, a ‘Getting to Know You’ questionnaire was administered to determine students’ motivation, background and expectations coming into the course. Also from the questionnaire were determined the students’ familiarity with technology and the technology resources available to them.

A pre-test on fundamental mathematics was also conducted during the first day of class. This provided a measure of students’ competence coming into the course and helped later to determine how effective the podcast intervention had been. Topics included curve sketching, vectors, complex numbers, trigonometry, differentiation, integration, probability and statistics. The students were then asked to choose a subset of these topics on which to create their own podcasts and were given a demonstration showing them how to use the podcasting software (Camstudio).

Over the first few weeks students developed their initial ideas for their podcasts through a combination of PowerPoint slides and a presentation transcript that reflected the way the student understood the material. The students also formulated three questions on their topic and the solutions to these questions. The students then sent these (PowerPoint slides, transcript, questions and solutions) to the course demonstrator for review and feedback. Once the demonstrator’s comments had been incorporated the students recorded their podcast using Camstudio and the demonstrator uploaded them onto the university’s virtual learning platform so that other students in the course could access them. The other students were then able to view, evaluate and comment on the podcasts using an established grading rubric.

Halfway through the course the students completed a mid-intervention questionnaire aimed at eliciting their experiences of the podcast creation process. These questionnaires allowed for a clearer view of the students’ individual experiences and thoughts that they may not have necessarily shared in open discussion.

At the end of the course another questionnaire was administered. This questionnaire solicited the students’ experiences of evaluating their colleagues’ podcasts. Additionally, a post-test was administered on foundational mathematics that followed the same topics as the pre-test. Finally a fifteen-minute focus group session was conducted with the three students in order to provide the students with an opportunity to be more open about their experiences with podcasting. In reviewing the data, the researchers were careful to protect the identities of the participants: the data was scrutinised for confidentiality and all the research data was kept in secure files. No participants were harmed in any way and it was assessed that their involvement in the research project did not negatively impact upon their studies but that, in the end, their involvement had actually been beneficial to their academic development.

**Results**

The data here is presented in three parts: firstly, in offering a ‘thick description’ of the students’ experience of this intervention the combined data (initial questionnaires, pre-tests on fundamental mathematics, mid-intervention questionnaires, post-intervention questionnaires and peer evaluations of completed podcasts ) for each student is presented. Secondly, the data from the focus group is presented. Finally, the data from the lecturer’s reflective account is presented.

***Student 1***

Three years ago Student 1 completed his undergraduate education in Telecommunications. He successfully completed five mathematics courses at the undergraduate level and considered his background in mathematics to be strong although he reported that he found calculus to be the most challenging conceptually. Coming into the course he did not know much about the topic Random Processes, which is a key foundational topic for the course. His main reason for enrolling in the programme was to become more employable. His course load was rather heavy but he claimed that getting to class would not be problematic and that the 5:00 – 8:00 pm time slot was convenient for him. At the start of the year he saw the need for theoretical (i.e. mathematics-intensive) courses, since according to him it was essential to understand the theory first in order to fully appreciate the telecommunications.

Student 1 had suitable electronic devices and Internet access, so that developing the podcast would not be a problem. He also had basic IT skill but had never created podcasts. He reported that he preferred classes which used technology extensively and that he had a generally positive experience with technology in the classroom. Student 1 was asked to create three podcasts: one on Complex Numbers, one on Integration and one of Vectors. Student 1 found that reviewing his topics was the most useful aspect of the exercise but that explaining the topics was difficult. It took two weeks for him to review the topics for which he was responsible and about a week to prepare, write and record the podcasts. He stated that, after completing his podcasts, he felt more confident with the material. What he liked least about the exercise and what proved difficult for him was recording his voice clearly.

During the podcast-evaluation phase, Student 1 reported that he felt much more confident about the topics after reviewing his fellow students’ podcasts. Their podcasts, he said, reminded him of concepts he had forgotten and that he found that some slides in his colleagues’ podcasts had too many words and some of the podcasts were too long. He reported that he found the rubric for grading the podcast to be a fair method and that it helped him understand specific aspects of the podcast and the material contained within it.

When comparing Student 1’s performance on the pre-test with that on the post-test, he attempted and was able to answer more questions on the post-test than on the pre-test. He did not improve much on the Probability and Statistics questions which were a problem for him both before and after the intervention. Though Integration was one of his podcast review topics he still faltered on this in the post test. This was still an improvement though, since he had not attempted that question at all in the pre-test. He handled Complex Numbers and Vectors reasonably well both times. For the topics he reviewed using other students’ podcasts he showed improvement.

***Student 2***

Student 2 was a recent graduate– completing his undergraduate education just a year before. His specialisation was also in the area of Telecommunications. His main motivation for enrolling in the postgraduate programme was to upgrade his current qualification. He had successfully completed two mathematics courses at the undergraduate level but had a modest view of his mathematical background in that he believed it to be only average. He identified his weakest subject as Probability and Statistics. Of Random Processes he knew nothing. He was a part-time student with a load of two courses. He said that he would have had a ‘slight’ challenge getting to class on-time but stated that he would make a valiant effort to do so. The value he saw in theoretical courses was that they would make him more efficient in solving mathematics-based communication systems problems.

Student 2 was technology enabled with adequate Internet access, and skilled in basic IT although he was unfamiliar with creating podcasts. He reported that he preferred to take classes that used limited technology but had, by and large, positive experiences with technology in his classes. Student 2 stated that he enjoyed developing the podcast-creation skills and that he found the review aspect of the exercise most useful. He said that he had spent considerable time writing the presentation scripts first to make more fluent presentations. He took two weeks to review the topics and two days to prepare the slides and write the scripts. On the downside, he reported that he found doing the equations in PowerPoint onerous. Overall, he reported that he was much more confident about his mathematics review topic after the intervention. Student 2 created two podcasts: one on Differentiation and one on Probability and Statistics Part II. He did, however, make the valid point that the person who did Part I should have also done Part II.

During the podcast-evaluation phase, Student 2 found that his colleagues’ podcasts were helpful, easy to understand and that he especially benefitted from the diagrams and animations. He also found the rewind feature of the podcasts helpful. He found the assessment rubric well developed and stated that it made the grading process easier. When asked what he liked least, he was not able to identify anything specific but suggested that more advanced mathematical topics should have been covered in the intervention.

Several improvements were found between Student 2’s pre- and post-test performance and he attempted more questions. Though he made some errors in the post-test there was clear evidence that he was on the right track and applying the appropriate principles. Significantly, he fell short in the Probability and Statistics – which had been one of his podcast topics!

***Student 3***

Student 3 graduated from the undergraduate programme in January 2010, her area of specialisation being ICT and Telecommunications Engineering. In her undergraduate programme she successfully completed four mathematics courses and believed that her background in mathematics was strong. The most conceptually challenging topic for Student 3 was Probability and Statistics. She was, however, able to provide a simple but correct definition of Random Processes. Student 3’s main motivation in joining the MASc programme was to become more marketable and wished to develop skills in wireless communication. Student 3 was enrolled in the programme as a part-time student with a load of two courses. She indicated that she would have some challenges attending lectures as she was pursuing another course simultaneously but reported that the 5:00 to 8:00 pm time-slot was convenient for her. She saw this course relevant to her current and future work and research endeavours, but was not sure about the immediate application of theoretical mathematics-intensive course to the workplace.

Student 3 had adequate access to electronic devices and the Internet. She stated that her IT skills were sufficient but that she was unfamiliar with creating podcasts. Student 3 was assigned two podcasts: one on Trigonometry and one on Probability and Statistics Part I. Student 3 reported that she preferred attending classes that used a moderate level of technology. For the podcast-creation phase, Student 3 found that relearning topics that would be used in the course was most valuable. It took her two weeks to review the topics, five days to prepare the slides, three days to write the scripts and three days to record the podcasts. What she liked most about the exercise was that the review helped her in both of the courses she had to take over the semester. What she liked least (and also found most difficult) about the exercise was the recording aspect. According to her, it was extremely time consuming.

Student 3 found that the other students’ podcasts provided her with good revision in key areas and that she also learned some new concepts although she stated that the podcasts could have been improved through the use of diagrams. What Student 3 liked least about the exercise was the grading as she found it difficult to align the quality of his peers’ work with the descriptions in the marking rubric. Interestingly Student 3’s confidence in topics covered in her colleagues’ podcasts did not increase by much as a result of watching them.

Student 3’s performance in the post-test was better than in the pre-test. Whereas in the pre-test she had not completed the questions on trigonometry, in the post-test she had. She did not attempt the Differentiation and Integration questions in the pre-test and although she attempted these questions in the post-test she still faltered. She did not attempt the questions on Complex Numbers in the pre-test but was mostly correct in her attempts in the post-test. Interestingly, Student 3 did not attempt the Probability and Statistics questions substantially in either the pre-test or the post-test. This was in spite of the fact that Student 3 was responsible for creating the podcast on Probability and Statistics Part I.

***Focus Group Session***

Overall, the students reported that they found learning and reviewing the material using podcasting to be useful in supporting their mathematical knowledge and reported improvements in their foundational mathematics having gone through the exercise: ‘the post-test was much better, was much, much better because of the podcast’.Students acknowledged that they had forgotten many aspects of foundational mathematics since completing their previous studies and that it had been important for them to recap these subjects. There was also evidence that they felt the podcasts were an appropriate tool in supporting this:

…looking back at it, it really helped because after coming from a three year break after the first degree I really did not remember all of the material. So watching their podcasts really brought out a lot of the things I knew before.

Although it was noted that creating a podcast was a new skill and that it took time to understand and apply the process, all three students indicated that they had benefited from the cooperative learning enabled by the podcast exercise:

…even though it took some work to do it was worth it. And I am seeing it helping my colleagues in that particular area, the area that I did. And also my colleagues’ work helped me.

…it helped me in a sense that I did not have to do all the revision on my own…That saved me time so it was like a trade-off. You had to put in a lot of time to do your podcast. However if you had been putting in that time to do all the revision on all the topics on your own it probably would have taken a longer time.

It had been hoped that developing a teaching approach that encouraged reflective conceptualisation of problem solving would lead to increased student self-analysis so that students would be able to move beyond merely thinking that they either knew or did not know a concept, but were able to examine their understanding of the various aspects of the mathematical concept:

…you might know a topic but when you are trying to explain it you realise that you really did not know it as well as you thought.

Since postgraduate students benefit from making tangible links between their studies and their wider life experiences (Bilgin and Crowe 2008) it was encouraging to hear that students saw the benefit of the podcast skill extending into professional life:

… but also one advantage of it is that it adds a professional skill to our skill set because now we know how to make a podcast.

Nevertheless the main drawback was that the podcast-creation phase of the exercise was very time-consuming such that students ‘spent a lot of time on the presentation aspect’ and that this may have countered the ‘convenience’ point for podcasts:

I think script writing took the majority [of time] and also well we had a lot of equations so we had to use the equation editor and that took up a lot of time also, if it was just typing… it would just flow... but the incorporation of the equation editor that also took up a lot of time.

I think [it] was very time-consuming for me but the hardest part for me was basically the time-consuming aspect for me was writing the equations, the typing the equations with the equation editor ... and I guess that the time to do that could be reduced as you get more skilled on using the software or word editor to type ...

***Lecturer’s Reflective Account***

When students were given the pre-test on the first day of class, they were amazed at how much fundamental mathematics they had forgotten but it was felt that this test could be used in formative way so that the students could see the areas that needed focus. The lecturer recorded that, ‘the pre-test really helped to crystallize in the students’ minds their predicament’ and it was hoped that they would then be open to using podcasts as a tool to address this predicament.

During the course, especially at the earlier stages, students were diligent about the podcasting exercise because they saw the value of the exercise although the lecturer noticed that, ‘They did complain that it was time-consuming.’ Attendance was consistent and students were present for almost all the classes. The lecturer felt that there were two possible reasons could be that (1) since students realised they had to generate the podcasts themselves, they had to become proficient with the material themselves, and coming to class, asking questions and participating in the sessions would aid them to this end; (2) upon realising for themselves that their mathematical background was not strong; that the mathematics was necessary for success in the course; that their fellow colleagues were in the same position as they were, and that the lecturer demonstrated an interest in their academic wellbeing and was willing to assist them get up to speed, students may have become more engaged, more motivated to continue with the course despite the hurdles involved. In this instance, the lecturer felt that the learner-generated podcasting exercise encouraged students to make an effort to attend class despite the various difficulties students initially reported they might have in doing so.

During the teaching of the mathematics-intensive portion of the course the lecturer reported that they still encountered impediments with the topic Probability and Statistics. The lecturer commented that this was a topic that students did not merely need to review but to learn from close to the start and that, ‘I must address this in the next iteration of the course.’ Nevertheless, it was felt that this time, unlike previous iterations of the course, there was the flexibility of having students refer to their recently conducted review of the topic themselves (a tangible experience) without the lecturer having to teach them all the fundamentals – moving beyond the procedural to the conceptual. The lecturer felt that such an approach also encouraged cooperative learning as students drew from each other.

The lecturer noticed that, ‘because students were responsible for individual topics in the course, they became the “point-persons” to whom their peers resorted for clarification and explanations on that particular topic.’ It was reported that this was particularly evident when the students had to revise for their written final examinations. Overall, the lecturer reported that the students’ mathematical learning seemed more contextualised and that there was an improvement in some of the theoretical understanding:

I would say the students better managed the theoretical components of the course. I believe they tackled it with more confidence, and there was a gradual improvement as they progressed through the course. They were able to conceptualise and appreciate the math involved and performed reasonably well in the course.

**Findings**

The triangulation of the data shows that there was broad understanding of the need for foundational/theoretical mathematics and that the initial questionnaire and pre-test helped both students and the lecturer highlight gaps in understanding. The lecturer felt that this helped students to understand that they were in need of intervention and the literature suggested that podcasting would be a likely tool for such. Through analysing the data from the various sources, we can see three key findings:

1. All three students showed general improvement in their mathematics.
2. The expected lateness and absenteeism did not occur.
3. The logistics of podcast generation were rather burdensome.

There was agreement that learner-generated podcasts helped participants feel more confident in their mathematical understanding but that this was generally through using each other’s podcast as a revision point. Alongside general improvement in these core areas the lecturer felt that the students seemed more confident and that their mathematical learning seemed more contextualised – something that was offered support during the focus group discussion where one of the students reported feeling more analytical in the way he considered the various mathematical concepts covered. The use of podcasts was intended to help these postgraduate students revisit mathematical concepts that they may have forgotten since completing their undergraduate studies. In total the students created seven podcasts. All the students showed some improvement in five of the fundamental mathematical knowledge topic areas and one improved on Probability and Statistics. Interestingly it was the two students who had created podcasts on Probability and Statistics who fell short in these topic areas!

The podcasting intervention was initially introduced as a method to deal with any pre-supposed absenteeism. Two of the three participants initially reported that getting to class might be difficult and the literature highlighted various issues that might cause this – specifically in reference to postgraduate students. The lecturer’s reflective account notes that the students were present for most of the class and attributes this to the ‘need’ for students to attend so that they could question each other and answer questions posed by the others. Here we can see two features at play: 1) there seems to be a positive peer-pressure effect, where students may have made the effort to attend out of a desire to help their peers; 2) whilst developing their own podcasts and reviewing their peers’ podcasts, students had generated a number of questions and may have made an extra effort to attend in order to have these questions dealt with.

The process of developing the podcast was reported as burdensome with both the students and lecturer recognising that it took some time to master the technical skills needed to create podcasts. All of the students felt that reviewing their individual subjects was the most helpful part of the creation process but all of them reported procedural issues: explaining things in a clear manner; forming equations on PowerPoint, and recording their voice-over. Whilst the literature suggested that teaching mathematics to postgraduate engineering students was best done in a practical manner (Sazhin 1998; Sakshaug and Wohlhuter 2010; Raines and Clark 2011) we might consider that the creation of the podcasts meant that too much time was given to the practical development of the podcast and this limited the time left for conceptual analysis. The most effective learning here occurred through students watching their peers’ podcasts, which suggests that the cooperative aspects of this task were limited to the review of the podcasts rather than the creation of them. The greatest area of difficulty was in forming the equations on PowerPoint – an application that is not particularly designed to handle equations.

The nexus of these findings suggests that the logistics of making the podcasts may have distracted individuals from the content but that when students reviewed each other’s work they only got the information and were not distracted by the production process. To this end, a collaborative approach seems to have been semi-successful as a review tool as there was more learning through interaction than there was through intra-action. The attendance of the students was not an issue – it is hoped that the intervention may have driven students to want to attend (for one reason or another) but it is difficult to tell what the attendance would have been like if the students had not been asked to do the podcasting activity.

**Conclusion**

Overall, the ‘learner-generated podcast’ intervention for mathematical review yielded some positive results and the attendance and post-intervention results of this cohort were higher than normally would have been be expected. Students reported that they appreciated the intervention, but their major complaint was that podcast-creation itself was time-consuming, especially attempting to form equations on PowerPoint. However, students did acknowledge the trade-off between creating the podcast with workload-sharing and conducting the entire requisite review on their own. In this regard, the learner-generated podcast facilitated cooperative learning in a distributed way. Since this was situated as an Action Research project these findings will be fed into the next iteration in an effort to further improve the students’ learning experience. For the next iteration the use of mathematically-friendly hardware such as tablet PCs or smartphones will be explored so that equations can be formed in a more straightforward manner. Through this it is hoped that the logistic workload will be decreased so that student have more time to spend of the concept rather than developing the technical skills to develop podcasts per se. This study found that interaction tended to come at the end of the process; therefore, to facilitate discussion and clarification during podcast development topic, the idea of introducing a blog during the next iteration may be explored so as to log student’s thoughts from the earliest stages. The next cycle of this action research project will also pay closer attention to the teaching and learning of Probability and Statistics as only one of the students improved in this area. It is hoped that this might suggest a reason for this area of weakness that can then be addressed.

In this paper we navigated through the research literature to demonstrate a technique (the learner-generated podcast) for the review of mathematics among postgraduate engineering students in a mathematics-intensive course at The University of the West Indies. Using Action Research we designed and implemented this intervention, and used qualitative data instruments to capture in detail the experiences through every stage of the exercise of the three students in the current cohort. This study did not seek to correlate students’ opinions of their peers’ podcasts with their own performance on a given topic. Neither did it quantitatively measure the level of dependence among the students. This study was only ever meant as a thick description of the experiences of the postgraduate students on this course, so that the findings drawn from the analysis of their experiences would lead to some improvement in the future development of the Principles of Communications course.

**References**

Alpay, E. and S. Gulati. 2010. Student-led podcasting for engineering education. *European Journal of Engineering Education* 35(4): 415-427.

Armstrong, G. and V. Massad. 2009. Interviewing the experts: student produced podcast. *Journal of Information Technology Education: Innovations in Practice* 8: 79-90*.*

Ball, D.L. 2000. Bridging practices intertwining content and pedagogy in teaching and learning to teach. Journal of teacher education 51(3): 241-247.

Beattie, K. and R. James. 1997. Flexible coursework delivery in Australian postgraduates: how effective is the teaching and learning. *Higher Education* 33(2): 177-194.

Bilgin, A. and S. Crowe. 2008. Approaches to learning in Statistics. *Asian Social Science* 4(3): 36-42.

Borko, H., M. Eisenhart, C.A. Brown, R.G. Underhill, D. Jones and P.C. Agard. 1992. Learning to Teach Hard Mathematics: Do Novice Teachers and Their Instructors Give up Too. Journal for Research in Mathematics Education 23(3): 194-222.

Brown, M., P. Brown and T. Bibby. 2008. ‘‘I would rather die’’: reasons given by 16-year-olds for not continuing their study of mathematics. Research in Mathematics Education 10(1): 3-18.

Chan, S.W. and Z. Ismail. 2010. Peer Interactions in Computer-supported Collaborative Learning using Dynamic Mathematics Software. *Procedia - Social and Behavioral Sciences* 8: 600-608.

Chan, Y.M. 2010. Video instructions as support for beyond classroom learning. *Procedia Social and Behavioral Sciences* 9: 1313-1318.

Dale, C. and G. Povey. 2010. An evaluation of learner-generated content and podcasting. *Journal of Hospitality, Leisure, Sport & Tourism Education* 8(1): 117-123.

Dziuban, C.D., J.L. Hartman and P.D. Moskal. 2004. Blended learning. *EDUCAUSE Center for Applied Research Research Bulletin* 7: 1-12.

Englebrecht, J., C. Bergsten and O. Kagesten. 2012. Conceptual and Procedural Approaches to Mathematics in the Engineering Curriculum: Student Conceptions and Performance. *Journal of Engineering Education* 101(1): 138-162.

Felder, R.M., D.R. Woods, J.E. Stice and A. Rugarcia. 2000. The future of Engineering education II. teaching methods that work. *Chemical Engineering Education* 34(1): 26-39.

Frydenberg, M. 2006. Principles and pedagogy: the two P’s of podcasting in the information technology classroom, in the Proceedings of the Information Systems Education Conference 23rd annual, ISECON. Dallas: Texas.

Griffin, D.K., D. Mitchell and S.J.Thompson. 2009. Podcasting by synchronising PowerPoint and voice: What are the pedagogical benefits? *Computers & Education* 53(2): 532-539

Geertz, C. 1973. “Thick Description: Towards an interpretive theory of culture”. In The investigation of cultures, edited by C. Geertz, 3-32. New York: Basic Books.

Heilesen, S.B. 2010. What is the academic efficacy of podcasting. *Computers & Education* 55(3): 1063-1068.

Kao, I. 2008. Using video podcast to enhance students’ learning experience in engineering. Proceedings of 115th Annual ASEE Conference and Exposition, Pittsburgh: Pennsylvania.

Kay, R. 2012. Exploring the use of video podcasts in education: A comprehensive review of the literature. *Computers in Human Behavior* 28(3): 820-831.

Kay, R. and I. Kletskin. 2012. Evaluating the use of problem-based video podcasts to teach mathematics in higher education. *Computers & Education* 59(2): 619-627.

Kemmis, S. and R. McTaggart, eds. 1988. *The Action Research Planner*. 3rd ed. Deakin University Press.

Kolb D. 1984. *Experiential learning: experience as the source of learning and development*. Englewood Cliffs, New Jersey: Prentice Hall.

Lee, M.J.W., C. McLoughlin and A. Chan. 2008. Talk the talk: learner-generated podcasts as catalysts for knowledge creation.  *British Journal of Educational Technology* 39(3): 501-521.

Liang, H. and K. Sedig. 2010. Can interactive visualization tools engage and support pre-university students in exploring non-trivial mathematical concepts. *Computers & Education* 54(4): 972-991.

Özdener, N. and Y. Güngör, Y. 2010. Effects of video podcast technology on peer learning and project quality. *Procedia Social and Behavioral Sciences* 2(2): 2217-2221.

Raines, J.M. and L.M. Clark. 2011. A brief overview on using technology to engage students in mathematics. *Current Issues in Education* 14(2): 1-7.

Safdar, A., M.I. Yousuf, Q. Parveen and M.G. Behlol. 2011. Effectiveness of information and communication technology (ICT) in teaching mathematics at secondary level. *International Journal of Academic Research* 3(5): 67-72.

Sakshaug, L.E. and K.A. Wohlhuter. 2010. Journey toward Teaching Mathematics through Problem Solving, *School Science and Mathematics* 110(8): 397-409.

Sazhin, S.S. 1998. Teaching Mathematics to Engineering students. *International Journal of Engineering Education* 14(2): 145-152.

Scherman, V. and P. du Toit. 2008. Cooperative learning in postgraduate lectures: possibilities and challenges. *South African Journal of Higher Education* 22(2): 423-438.

Severinsen, G. 2004. Learning through information communication technology: critical perspectives. *Australian Educational Computing* 19(1): 15-20.

Smith Risser, H. 2011. What are we afraid of? Arguments against teaching mathematics with technology in the professional publications of organisations for US mathematicians. *International Journal for Technology in Mathematics Education* 18(2): 97-101.

Sutton-Brady, C., K.M. Scott, L. Taylor, G. Curabetta and S. Clark. 2009. The value of using short-format podcasts to enhance learning and teaching. *ALT-J, Research in Learning Technology* 17(3): 219-232.