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Towards Overcoming Millennial Classroom Barriers: Reflections from Engineering Students on Blended Teaching and Learning Innovations

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(Submitted 21 June 2017; accepted 22 June 2018)

Abstract
A proposition for the use of a blended teaching and learning approach maintains that (a) ease of access and flexibility, (b) an increase in the degree of active learning, and (c) an improvement in learning experiences and learning outcomes for students are expected accomplishments to implementation success. In this paper, we present an analysis of how a blended teaching and learning approach influenced the experiences of engineering faculty students. Our empirical analysis found that a blended teaching and learning approach is students' preferred teaching strategy, and traditional face-to-face teaching strategies alone are no longer sufficient for achieving success with new generation engineering students. Further, we show how the blended teaching and learning approach can enhance understanding of engineering knowledge and support students who would otherwise lag behind. We also show how active support from faculty management enhances the implementation subtleties and advance the development of a dynamic pedagogy. Our findings offer lecturers important insights into students' preferences, as well as how lecturers can endorse and design a teaching and learning approach that is agile and adaptable, meeting the challenges of the environment in which they are working, which is similarly in endless flux.

Keywords: blended teaching and learning implementation, case study, faculty influence, face-to-face approach

Incorporating technology with face-to-face classroom activities can be complex and challenging under adverse conditions such as in the lack of supportive infrastructure (Bath & Bourke, 2010), the absence of managerial support (Diaz & Brown, 2010), and negative perceptions to change (Ngwenyama & Nielsen, 2013). Generally, the contemporary view of blended teaching and learning (BLD-TL) holds that positive outcomes are achieved when BLD-TL is implemented and used (Bath & Bourke, 2010). A search through empirical studies highlight the lack of impact studies during the implementation and use of BLD-TL, specifically in an engineering education context (Sharp et al., 2006; Bladergroen & Buckley,

Vol.6, No. 1 (2018): pp. 18-34
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doi: 10.14426/cristal.v6i1.140

2016). Consequently, there is a need for an empirical investigation into the experiences of both lecturer and student during the implementation of a BLD-TL approach arose.

A definition of a BLD-TL approach refers to a strategic and systematic integration of time and modes of learning. During this integration, the best aspects of face-to-face and online interactions for each discipline through the appropriate use of information and communication technologies (Saliba et al., 2013) are encouraged. Traditional face-to-face combined with online learning activities and formats through the use of well-established technologies as seen during lecture capture, and/or social media and emerging technologies (Saliba et al., 2013) are but a few examples.

A search through empirical studies highlighted a void on the impact of a BLD-TL in tertiary engineering teaching and learning contexts. A need was identified to capture engineering students' perceived experiences during exposure to various BLD-TL innovations. A total of 3472 students were exposed to the innovations, and a 22% impact assessment response rate was achieved. The innovations included podcasts, i.e. full lectures and lunch time revision lectures [n = 6], videos of key topics and formative assessments [n = 5], formative assessments [n = 2], videos as preparation for laboratory practicum [n = 4], prescribed textbooks 'publisher' animations [n = 1], simulations [n = 1], clickers and online pre-reading [n=1], and Wiki pages for group work [n = 1]. Both students and lecturers completed a structured questionnaire to probe both sample groups about their experiences during the implementation of, exposure to, and use of the BLD-TL initiatives. The experiences and reflections of the lecturers was the second leg of the project and are reported on elsewhere.

What is regarded as the methodology for this research is a combination of various research paradigms to inform the research questions. The research paradigms (discussed later in the paper) include a naturalistic inquiry, grounded theory, and phenomenography.

Case Study Research Paradigms

The context of the case study research was stimulating as two phenomena (namely engineering knowledge and information and communication technologies) both comprise tangible constructs dealing with abstract concepts. However, merging the positivistic approach followed in engineering teaching and learning and the constructivist epistemology in broader education research posed a challenge. These challenges were addressed by allowing the researchers' view on teaching and learning to determine the method used during the project. However, research methods are systematic, rigorous, objective, and repeated use of procedures. During the practise of research procedures, we test what we think about reality against what we observe in reality. However, what we observe is viewed in the light of what we know. To know and to speak about knowledge is to know what knowledge is, and to know what knowledge is, is exactly what epistemology involves it with (Bladergroen, 2009). Therefore, phenomenography can best be described as an empirical study of the differing ways in which people understand, conceptualise, experience, perceive, and apprehend various phenomena and aspects of the world around them. Whatever term we want to use to describe these 'experiences' of the world are nonetheless used interchangeably. These phenomena, although different in their references, can be found either in immediate experience of the phenomenon or in reflected thought about the same phenomenon.

The analyses and categorising of students' different ways of understanding or conceiving of a BLD-TL intervention were aimed at describing, analysing, and understanding experiences as these manifest themselves in different BLD-TL exposures. The relatively distinct field of inquiry indicated by such an orientation is considered phenomenography. Phenomenography has played an important role in suggesting to the research team an agenda for researching and improving the engineering educational practice. Nevertheless, the researchers do not claim to study what is there in the engineering teaching and learning reality, but we do claim to study what is in students' conceptions of the engineering teaching and learning world. For that reason, the researchers aimed at describing various aspects of the exposure to the intervention world from the second-order perspective, where we attempted to describe students' experiences and perceptions that developed during exposure to and use of the various BLD-TL innovations (Bladergroen, 2009).

Although a statistical design was not pre-selected, it emerged during the research process. The project started with a specific problem and theory emerged from the inquiry. The case study samples were conditional (all staff members and students from the engineering faculty) and serial (i.e. anyone could join at any given time during the course of the project). This was specifically done to maximise the scope and range of information obtained. Instrumentation was internal (i.e. subjective), so the instruments became refined and knowable as salient elements were sorted out and targeted in on; data analysis was open ended and inductive; timing, budgets, and expected results remain unspecified. This implies that the research design of a naturalistic inquiry emerged, developed, and unfolded during the research process. There is a close link between naturalistic inquiry and constructivism, and because the philosophical stance that informs the methodology of this study, i.e. the theoretical framework of this study is based on constructivism, using naturalistic inquiry became an obvious choice (Bladergroen, 2009; Ngwenyama & Nielsen, 2013).

The goal was to develop an inductively derived grounded theory about the experiences of engineering students upon exposure to a BLD-TL intervention. Strauss and Corbin (1990) provide four central criteria to validate a good grounded theory. The case study research satisfies all criteria as (1) analysis was derived from diverse data and is true to the everyday reality of the context; (2) the analysis provides understanding, and is comprehensible to the phenomena under study (BLD-TL) and to everyone else involved in the context; (3) it provides generality, because the data is comprehensive, the interpretation conceptual and broad, the theory includes extensive variation, and the theory is abstract enough to be applicable to a wide variety of contexts in the area of study; and (4) it provides control by stating the conditions under which the theory applies and providing a basis for action in the area of study.

A systematic set of procedures was applied. (Strauss & Corbin, 1990). An analytical procedure in which the theory developed from the data, rather than the other way around, was followed (i.e. inductive approach). Because the theory is developed from the conceptualisation of data, concepts became the key elements of analysis. This implies that the actual data are not used, rather the conceptualisation of the data. The phenomena under study was explained, expanded on by identifying the key elements of that phenomenon, categorising the relationships of those elements to the context. The goal was to go from the specific to the general without losing sight of what makes the phenomena under study unique

(Bladergroen, 2009). The analysis involved three processes: open coding (where data was broken open to identify relevant categories); axial coding (where categories were refined, developed and related); and selective coding (where the 'core category' or central category that tied all the categories together, was identified and related to other categories).

The researchers' constructivist epistemology allowed the generalisation of results within the engineering context. For instance, a positivist epistemology warrants the application of constructs universally, which is highly unachievable in our case study research which involved both humans and 'things'.

To conclude, this study was firmly based in a constructivist view on learning. Additionally, we view our research findings as useful and meaningful constructions, as our methodology was guided by a constructivist epistemology, where epistemology is concerned with the nature of the knowledge generated in the research.

Case Faculty Context

The case faculty is part of the larger tertiary institution for the previously advantaged groups in the country. With the aging of democracy, the face of student enrolments and subsequent increase in class sizes happened at an alarming rate; a consequence is that lecturer:student ratio has become out of sync. Adding the challenging research output requirements for lecturers to this, creates the possibility for burnout and dissatisfaction with the teaching and learning context.

Although the case faculty is located in a developing country, it did not escape the impact of the millennials, also referred to as 'digital natives (Prensky, 2001). The millennials' need development was partly due to the high presence of cellular phones in classrooms. In fact, cellular phones are pervasive in the region with nine in ten having a cell phone (PEW Research Center, 2015). Not all of these students have computers at home, but it is highly likely that they will have a cellular phone. A study done by Strauss and Howe (1991) suggested that millennials use digital technologies and social media extensively, more than their parents. Prensky (2001) suggests the single biggest problem facing education today is 'our digital immigrant instructors, who speak an outdated language (that of the pre-digital age) and are struggling to teach a population that speaks an entirely new language'. The faculty itself are dealing with students who are 1) used to receiving information really fast, 2) like to parallel process and multi task, 3) prefer their graphics before their text rather than the opposite, 4) prefer random access (like hypertext), 5) function best when networking, 6) thrive on instant gratification and frequent rewards, and 7) prefer games to "serious" work (Prensky, 2001). On the other hand, the digital native instructor (lecturer) tends to stand with one foot in the past whilst adapting to the trending digital environment. The lecturers are overstretched to produce high research outputs whilst maintaining a high level of adequately skilled graduates. Buying time for both lecturer and student in a traditional teaching and learning context poses an ideal opportunity to introduce and assess the impact of a BLD-TL approach.

Furthermore, the case faculty has an added challenge to the trendy millennials, namely the impact of a socially culturally diverse student cohort. The remnants of an 'apartheid system' and failure of a new democratic government supported the existence of students with varied secondary education development. This disparity causes a mismatch of tertiary education successes on tertiary level. The case faculty was hard pressed to rethink the didactics of engineering teaching and learning.

Since the nature of the tertiary institution is that of a traditional face-to-face environment, blended teaching and learning had to become an option. The objective was therefore to (1) improve teaching productivity of lecturers given the large, diverse class sizes and the demand for higher research outputs; (2) improve learning productivity of students by amongst others 'creating available time', whilst still maintaining or improving the educational standards and throughput rate; and (3) make students more accountable for their own learning (Faculty strategic plan, 2014). In addition, assistance was needed by those students who lag behind because of limited one-on-one time with lecturers or tutors.

Research Methodology

We used questionnaires to gain information on students' perceived experiences on the BLD-TL innovations. Grounded theory was used to theorise whether the use of BLD-TL in an engineering context benefitted the engineering teaching and learning context.

Case study approach has been the preferred method for this study. Although there are scholars who argue that the contributions of a case study findings are limited to the context only, Ngwenyama and Nielsen (2013) argue that nomothetic case study research offers the power and possibility to generalise from empirical research to theoretical statements.

The process of implementation followed two approaches namely a top-down approach and a bottom-up approach. The top-down approach started at institutional level, as the broader institution embraced the idea of BLD-TL. The various deans of the faculties then each developed their own unique broad aims and objectives in line with that of the tertiary institution at large, and the various departmental heads were encouraged to identify their unique challenges and to identify participants whose work load is heavy and who may benefit through the use of a BLD-TL approach. This case study involved all five departments in the faculty. The blended teaching and learning coordinator was an active participant in the preparations of the BLD-TL innovations and the executions of the questionnaires. The direct and active involvement of the Vice-dean in the large project gave the participants the necessary authority, access to resources, and uniformity of faculty hierarchy. This was specifically significant to encourage collaboration and collegiality amongst participants. The departmental managers played an active role in encouraging and allowing lecturers to be creative and innovative in their innovations.

A bottom-up approach was then followed where lecturers were encouraged to choose their own BLD-TL intervention strategy and their specific focus area. During the course of the project, additional members joined based on their own interest in new and innovative use of technologies in the classroom.

The questionnaire was developed by the research team and shared with all participating lecturers for critique and input, upon which recommended changes were made. The time span of the project was determined by the availability of funding. The participants were involved in other areas of the research; for example, giving critical feedback on the questionnaires and the development of *posteriori* categories.

The first set of questions explored time spent per week on a BLD-TL intervention and the amount of time spent if the intervention was not available. The second set of questions explored the reasoning behind students' quantitative responses. The questions specifically explored the impact on students' preferred style of learning, and the degree of learning. Students were also requested to highlight helpful and less helpful matters about the various innovations.

The questionnaires were distributed through either paper-based copies or through electronic versions (i.e. the Moodle platform or Survey monkey software). Irrespective of the mode of data collection, the questions were all identical. The choice was left to the lecturer to decide how he/she wanted to collect the data. The questionnaires were all completed the last two weeks before completion of a module; some modules ran in the first half of the year and other modules in the second half of the year.

Lecturers were also offered additional funding to compensate for the initial addition to their workload. Students were not offered any financial or physical compensation as it was against institutional ethical conduct. Students did, however, receive an in-depth written explanation on the ethics of participation in the research project.

Ethical clearance was achieved through the tertiary institution, allowing the participants the additional advantage of a formal research study and sharing of their findings with the broader academic communities.

To date, two years of intervention impact analysis was done. The project is currently in its third year of investigations.

Findings of Empirical Analysis

This section provides a detailed quantitative and qualitative account of students' responses to their experiences of and perceptions on the use of the BLD-TL intervention. The results are presented on two levels: firstly, the results are presented between various modules and year groups, and secondly, the qualitative relations between the various academic year levels are explored. The researchers then introduce a framework for engineering faculties who envisage to follow a blended teaching and learning approach.

The three questions which allowed students to quantify their experiences were:

(a) How much time on average, per week they spend using the ICT intervention?
(b) In the absence of the BLD-TL intervention how much time would they have spent to achieve similar outcomes?
(c) Do they recommend that the BLD-TL intervention be continued with?

Time spent on the use of the ICT intervention

This section deals with the average time students spent using or consulting the ICT innovation (Figure 1). A total of 128 students indicated that they used the BLD-TL innovation for 60 minutes a week. The second highest total number of students (74) consulted the videos for 30 minutes per week, whilst 62 indicated that they consulted the videos for approximately 2 hours per week. In summary, students spent between 30 minutes to 2 hours on an innovation, depending on their unique needs.

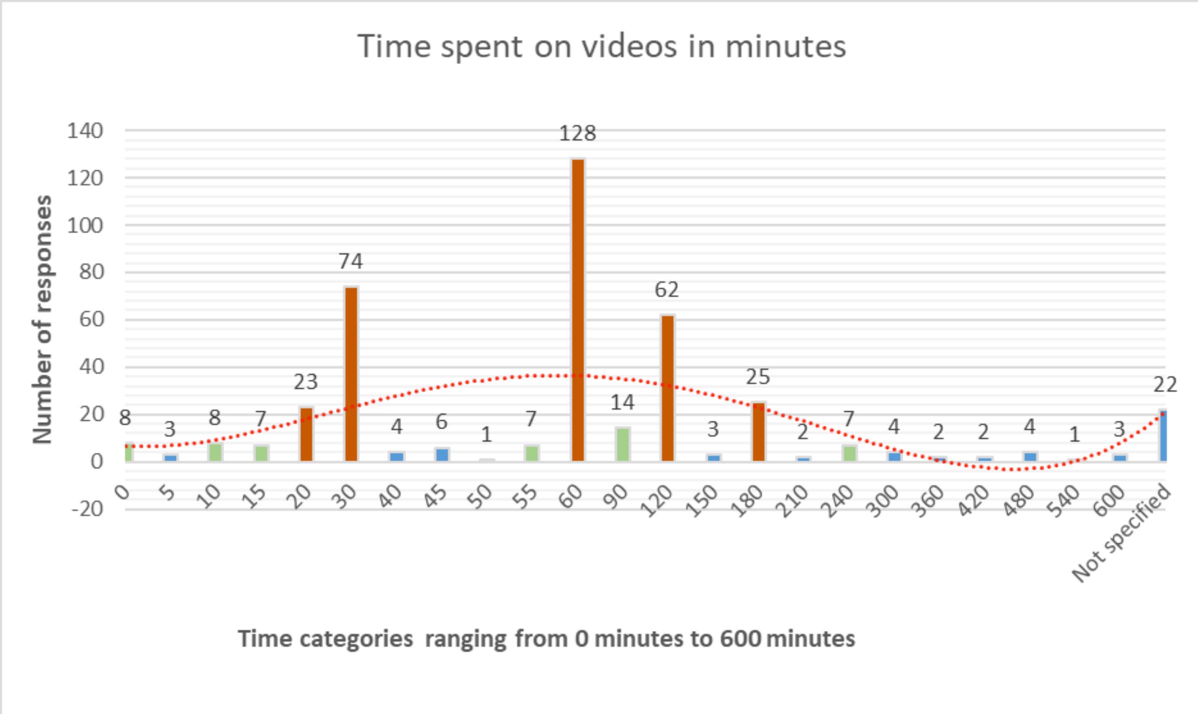

Figure 1: Time spent on the use of the intervention

The data further indicate that students used the BLD-TL innovation either to re-watch the entire video or to consult a specific part where assistance was needed. Students alluded that when circumstances prohibited them from attending a face-to-face session, they were not anxious about it, because there was a 'backup system' available. The students who did not use the innovation did so because they felt that the lectures were sufficient to develop a clear understanding of the focus area. It is interesting that in those cases, students mentioned they could see the value of the innovation specifically for those students who needed additional assistance in the focus area.

The most-watched BLD-TL innovations were also in line with the case faculty's concern about specific modules. First-year Strength of Materials is traditionally a challenging module to pass. The revision lecture recordings proved to be a student need satisfied (n = 1 914, views of 14 550 minutes with an average watch time of 13 minutes 40 seconds). This was followed by Engineering Mathematics and Applied Mathematics (Table 1). The same is true for the total number of views of full lecture recordings (podcasts).

The revision lecture podcasts proved to be a staggering success (see Table 1). According to the students the advantages of the revision lecture podcasts offered were:

1. Some students had clashes with other modules and couldn't attend the lunch time revision lectures
2. It provided a concise summary of the weeks work
3. It assisted with revision before tutorials and examinations
4. It made it easier to understand new work covered
5. Students used it as a 'warm-up' before doing a tutorial
6. It serves as a summary and reminder of key concepts done the previous week
7. It assisted in understanding key concepts

8. It did not affect the way they learn, but how well they understand the work
9. They were able to view information from different perspectives and apply their knowledge in a more scholarly way

Table 1: **Revision lecture podcasts views and watch time**

	Watch time (minutes)	Views	Average time in playlist
Strength of Materials 143	14, 550	1, 914	13:40
Engineering Mathematics 242	6, 323	965	09:27
Applied Mathematics 154	2, 621	322	12:39
IW 214	1, 061	304	07:20
Thermodynamics	354	100	06:40
Engineering Mathematics 145	327	69	06:48
Electrotechniques 143	183	43	05:43
Computer Programming 143	81	47	02:02

The response of one student summarise students' perspective on the intervention:

> *'I like getting the perspective of another lecturer on the topics we cover in class. I especially liked the man who took the revision classes for Applied Mathematics B154 because he summarised everything we covered in a week in one lecture. The summaries were quick and to the point and offered me the chance to really bring the bits and pieces of work I had learned in class together (in my mind). I wish we had something like the revision lecture videos before starting a new chapter in class. Then I could have an idea as to what we would be learning. Also being able to pause the video was really helpful. I can't stop a lecturer trying to teach a hundred other students and ask her to explain a concept three times before I get it, but I can pause and press play a video!'*

Table 2 captures the views of the podcasts for Thermodynamics; one of the most challenging modules for students which traditionally has a low pass rate.

Table 2: Podcast views

Module	Podcast views for 1 semester
Thermodynamics	1 998
Full lecture video	1 101

Students indicated that they could access the innovations at their own time, pace and space. Table 3 summarises students' feedback with regards to the benefits offered by time, pace and space. These findings are in line with findings from other authors (Graham, 2006;

Heinze & Procter, 2004) arguing that the responsibility of teaching and learning are with both lecturer and student. O'Byrne and Pytash (2015) argue that both lecturer and student need to be empowered to work collaboratively to redefine the constantly changing and evolving teaching and learning space.

Table 3: Students' identified benefits to category time, pace and space

Time, pace and space
Own time, pace and space
Save time
Pause and rewind
Faster
Time used more efficient and effective
Easy way to get information
More time given
Retain information in shorter convenient time
Well summarised
Right method shown
Content specific information

Additionally, in their feedback students indicated that the innovations assisted with their understanding and had a positive effect on learning (see extracts in Tables 4 and 5).

Table 4: Students reflection on the innovations impact on their understanding development

Impact on Understanding
Easier, quick, effective, fill the gap
Learn more from written test
Limits my learning/shallow learning
Group work/ Peer learning
Positive and constructive learning
Provide example to analyse and understand

Table 1: Effect of podcasts and revision lecture videos on their developing understanding

Improvement in Understanding
Improvement
Help with focus, revision, understanding, remembering, application, insight
Integrated learning of the other roles as well (improve own role) i.e. integration of learning content
Easier, faster to grasp concepts, effective learning
More practical application of theory

Videos required theory (self-study) – good
Understanding the syntax caused limited understanding
Could relate knowledge to other modules
Must work through theory to do tutorial
Practical approach consolidate theory

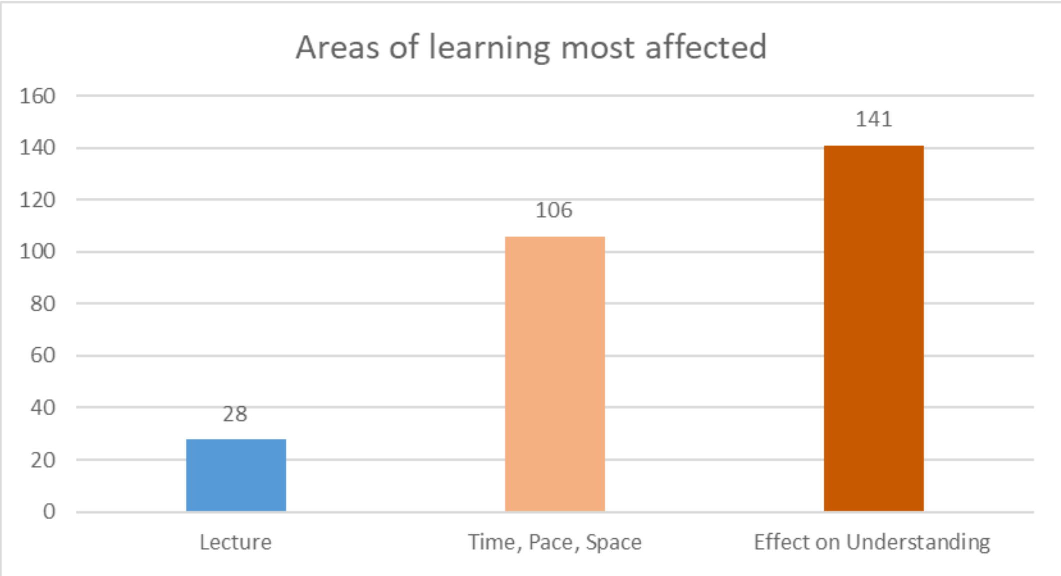

Figure 2: BLD-TL innovation affordances affecting learning

The affordances that the BLD-TL innovation had for students are demonstrated in figure 2. Upon comparison between the various year groups the data indicated that the first-year engineering students were consistently making use of the innovations. An example is the first years' use of the engineering drawings model which showed consistent high use ranging between 30 minutes to 2 hour. Use of the first year one-hour revision lectures podcasts were most significantly used for one to two hours across the four participant modules.

Second year Engineering Mathematics were the second largest users of the BLD-TL intervention (podcasts). Due to the low pass rate, this module was identified as one of the most challenging for students. The active use of the intervention by the students strengthens faculty's endeavour to support students in this module.

At third-year level the intervention took place in the Industrial Management module. Students, through the use of Wiki pages and group work, had to move 'their company' from unprofitable to profitable. Wiki pages with formative feedback replaced a once-off summative final project report. Accelerated learning by providing formative feedback (comments on student Wiki pages) on student's learning on their management strategies were given. Students consistently operated on the Wiki pages for four to five hours per week.

Students affirmed that they found it easier to learn theory through the practical application, as it allowed them the opportunity to reason through the arguments better. The fact that previous information was continuously available for review and editing meant they remembered the theory better, learning was more integrated, and they were allowed the opportunity to connect theory and practice. They emphasise learning more from the practical experience then from textbook theory.

Students bridged the theory-practice divide through the innovations that focused on an integrated, practical approach, that elicited accountability and collaboration.

Time spend in the absence of the intervention

The next section deals with the question 'If you did not have the ICT intervention, would you have spent more or less time to achieve the same level of learning'? Respondents from all twelve modules indicated that the intervention either saved them time (Figure 3 [2015] and Figure 4 [2016]) because they could spend less time on preparations than previous, or that it did not bring about any change in the amount of time spend on preparations.

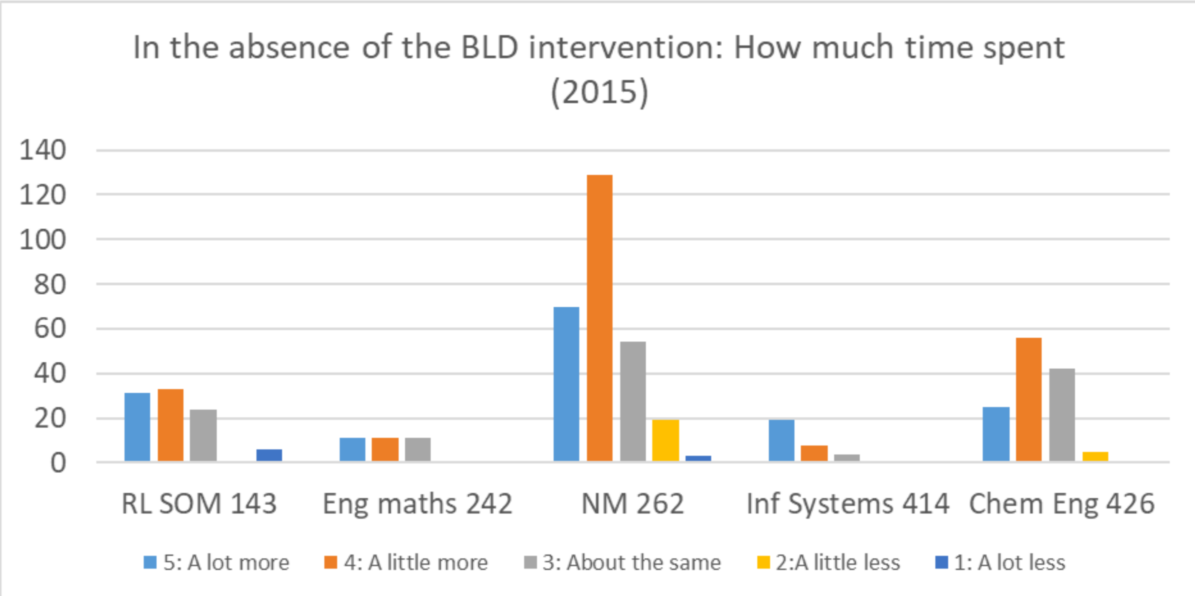

Figure 3: Time spent in the absence of the BLD-TL innovation (Year 2015)

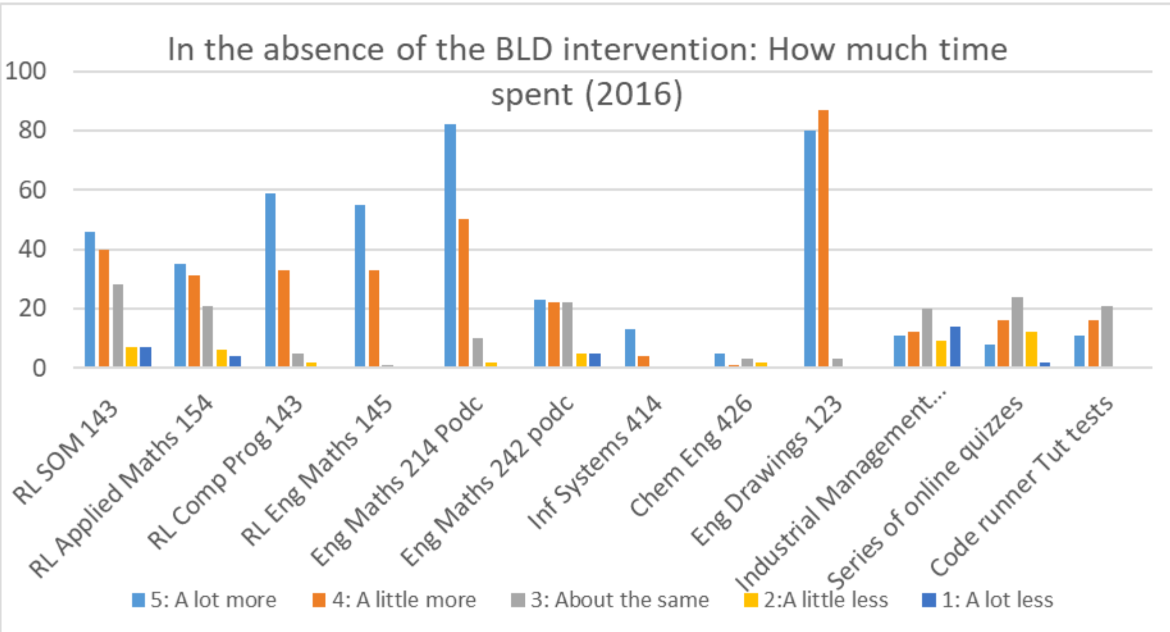

Figure 4: Time spent in the absence of the BLD-TL innovation (Year 2016)

In one incident, namely the Industrial Management third-year module where Wiki pages were used to generate learning outcomes, students pointed out that they spent more time on learning than before; they did, however, make reference to learning being more in-depth, integrated, and practical. They appreciated the continuous formative feedback which resulted in integrated learning occurrences.

In summary, students indicated that the BLD-TL innovations saved them preparation time. Where it was not the case (e.g. Industrial Management), the integrated learning approach opened an opportunity for deeper learning and understanding, reinforced by (1) having to take on the various roles occupied in the 'business', (2) constant consultation on historical data which assisted in decision making, and (3) regular feedback given. The combination of these factors also created a more integrated and organised approach to business engineering tasks.

Keep or discard

In the last question, i.e. whether the innovation should continue, students were unanimous in their responses: the innovation must continue, and, to a lesser degree, small changes be made (see Figure 5). The main reasons were that the innovations offer them the opportunity to (1) revise and catch up in a very short period of time, (b) study and do revision at their own time, pace and in their own space, (c) strengthen and deepen their knowledge base, (4) consolidate information, (5) practice calculations with step-by-step guidance readily available, and (6) improve problem solving skills (Table 6). In addition, students requested the innovations extend to other modules.

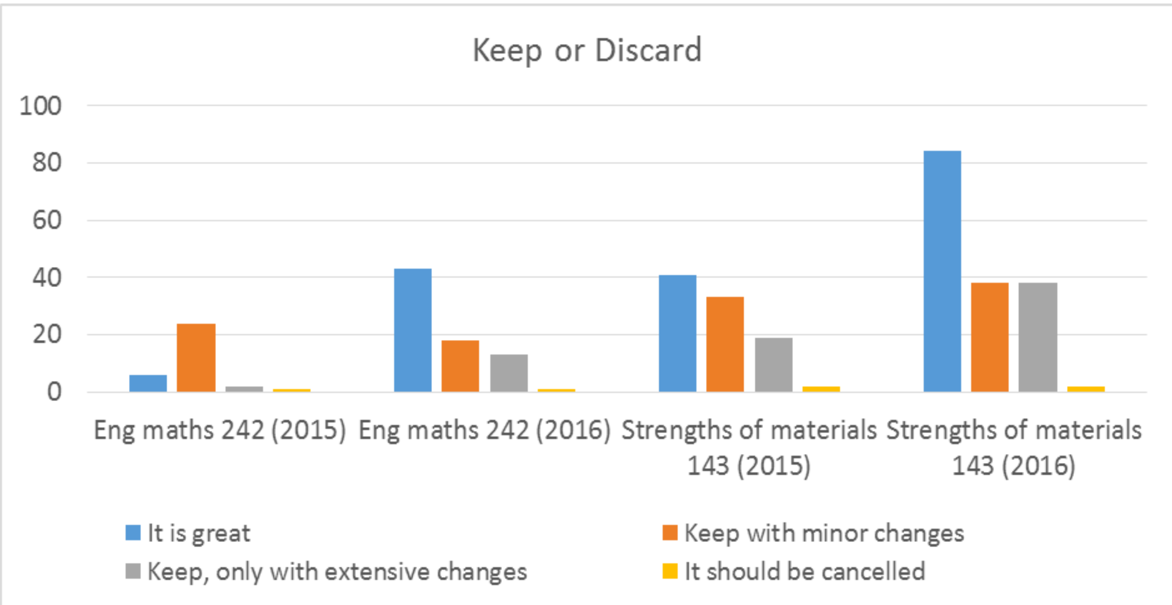

Figure 5: To Keep or discard the BLD-TL innovations

Table 2: Student motivations to retain the BLD-TL innovations

Positive effect on Learning
Own time, pace and space
Pause and revisit aids learning
Learned more/improved learning
Assist in preparation for test and tutorials
Saved time - less frustration
Could start immediately/knew what to do/less time wasted
Learned more than lectures
Learned relevant things
Good summary, short, to the point
Learning process more effective and productive
Guidance allowed faster progress
Learning is interactive and fun
Learn to do practical correctly
I leave a lot out, hence an increase in volume of work
Effect how much you learn
Learn from both written and on-line tutorials
Decreased my workload
Conclusions could be made immediately
Made less mistakes
Aid preparation
Summarised and compact the work

Negative aspects of the BLD-TL innovations

Students also highlighted the negative aspects that need improvement. All of their concerns were related to technical (ICT) aspects, and not pedagogical aspects. These cover the sound quality that needs improvement. They preferred the use of a document camera over free standing video camera, and they favoured 3-5 minutes demonstration videos that capture essential information over full lecture recordings (that average 55 minute). Finally, they preferred BLD-TL activities to be posted shortly after or before the applicable contact sessions.

Discussion

This research explored engineering students' experiences with blended teaching and learning (BLD-TL) innovations from the first to fourth (and final) year of study in a degree programme. The three aspects reported on focussed on the notion of 'buying additional time' for the students, deepening of students' knowledge acquisition, and possible value and sustainability of a continuation of the BLD innovations. This article only reports on students' experiences and perceptions on the use of the innovation. The reflections of the lecturers are presented elsewhere.

Our empirical analysis revealed that students from all four academic year groups viewed the innovative blended teaching and learning experiences as positive. The average amount of time spent on these innovations varied from 30 minutes to two hours. The time spent was determined by the students' own need for either information to assist the study process or to consolidate information, deepen understanding, and subsequently learn faster. Motivation and aspirations for time spent were internal, as the BLD-TL innovations did not specify the time to be spent on the BLD-TL activity. The technology uptake produced important positive experiences, and the need for flawless technology exposure is worth mentioning. At time of the project, the ICT available for usage by staff was limited and fairly dated. The findings do support the need to fast track ICT infrastructure, since students see the use of the innovation as a means to solve perceived challenges within a broad curriculum.

The main arguments for continuation of the innovation was the ability to study at their own time, pace and space, having a back-up system during unforeseen circumstances, or when consolidation, confirmation, or revision for formal testing, tutorials, and practicum were needed.

Even though one specific group indicated that more time was spent on the activity, it is significant to note that (1) it replaced the traditional project approach, and (2) by their own account, students highlighted the opportunity to merge theory and practice, thereby deepening their learning, understanding, and practical skills. Despite more time spent, they preferred the innovation to remain as the assessment method rather than traditional formative and summative assessments.

Conclusion

Engineering curricula across the globe are often perceived as very broad and students often feel overwhelmed with the degree of theoretical and practical work. With class sizes, student diversities, and millennial needs that are rapidly increasing, students often feel discouraged when they see their academic results. BLD-TL innovation offers an opportunity to evaluate teaching and learning strategies, and to alleviate the above-mentioned challenges.

Millennials' need to receive information rapidly did not seem to influence their need to learn at their own time, pace, and space. Millennials' have the need to, at times, withdraw and spend time in their own space. On the other hand, millennials also prefer to work collaboratively, and the innovations which focussed on collaboration was equally well received.

The students never questioned the use of 'new approaches' to teaching and learning. In fact, they embraced the innovations and invested time and energy into the use of the innovations. This supports the view that the millennials are preoccupied with technology and using it as a tool to enhance learning appears to be rewarding to the student.

The focus on time, pace, and space is also in line with the millennials' need for 'individualistic support'. The innovations allowed each student to satisfy that need. But typical to the quintessential millennial, our students prefer graphics before their text rather than the opposite and prefer random access (like hypertext). The time, pace and space also afford the students the opportunity to network.

Not all students made use of the innovations as they found the traditional face-to-face exposures sufficient to support learning. These students did, however, confirm the value of the BLD-TL innovation to fellow students' experiencing the aforementioned challenges. This signals to the characteristic of millennials as social custodians and defenders of social justice.

Those students who made use of the innovations had an overall positive experience and preferred continuation and expanding of the BLD-TL innovation in non-participating modules. The need for face-to-face exposure is not unexpected since it has been the mode of teaching and learning for these students for over twelve years of formal schooling prior to entering university. Millennials also have a need for self-improvement and prefer regular feedback. Face-to-face contact time allowed for regular and immediate feedback but so did the innovations that focussed on formative feedback. Millennials' individual needs directed him/her towards the teaching and learning approach that satisfies that need.

A good collaboration between and within departments to manage BLD-TL innovations is extremely important as students have limited study time available. Time management of the curriculum where BLD-TL teaching and learning will be used is under research and necessitates more exploration.

Using technology to create unique, stimulating, fun, and innovative learning experiences speaks to the needs of the millennial engineering student. Although the students did not complain about any negative experiences with the lecturers' presentation itself, it may be useful to invest in a well-resourced ICT system, since the possibility exists that the negative technical aspects may overshadow any other negative impacts of a BLD-TL innovation. A longitudinal study will give insight into a current novel innovation.

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References

Basson, A.H. 2014. *Fakulteit ingenieurswese strategie en projekplan vir inligting-en kommunikasie-tegnologie (IKT) in leer & onderrig*. Faculty working document. 27 July 2014

Bath, D. & Bourke, J. 2010. Getting started with blended learning. *Griffith Institute for Higher Education*. http://www.griffith.edu.au/gihe (Accessed 12 January 2017).

Bladergroen, M. & Buckley, S. 2016. *Management of ICT in education: A meta-study on the local (South African) and International research landscape*. 2016 International conference on information resources management (Conf-IRM 2016), Cape Town, South Africa

Bladergroen, M.C. 2009. *A Study of the Reflective Abilities of Physics 1 Tutors drawn from their Conceptual Understanding of a Co-operative Tutoring Environment* (Unpublished doctoral thesis). University of the Western Cape. Bellville, South Africa.Diaz, V. & Brown, M. 2010. Blended learning: A report on the ELI focus session. ELI Paper 2. Educause Learning Initiative. http://net.educause.edu/ir/library/pdf/ELI3023.pdf (Accessed 12 January 2017).Graham, C.R. 2006. Blended learning systems: Definition, current trends, and future directions. In Bonk, C.J. & Graham, C.R. (eds.). *Handbook of blended learning: Global perspectives, local designs.* San Francisco, CA: Pfeiffer, 3-21.

LTEU Blended Learning staff quick guide. 2010. http://www.canterbury.ac.uk/Support/learning-teaching-enhancement-unit/Documents/BlendedLearning.pdf (Accessed 12 January 2017)

Minocha, S. 2009 Role of social software tools in education: a literature review. *Education + Training*, 51 (5/6): 353-369.

Ngwenyama, O. & Nielsen, P.N. 2013. Using organizational influence processes to overcome IS implementation barriers: lessons from a longitudinal case study of SPI implementation. *European Journal of Information Systems*, 1–18

O'Byrne, W.I. & Pytash, K.E. 2015. Hybrid and blended learning: Modifying pedagogy across Path, Pace, Time, and Space. *Journal of Adolescent & Adult Literacy,* 59(2):137–140.

PEW Research Center. 2015. Cell Phones in Africa: Communication Lifeline. http://www.pewglobal.org/2015/04/15/cell-phones-in-africa-communication-lifeline/ (Accessed 15 June 2018).

Prensky, M. 2001. Digital Natives, Digital Immigrants. *On the Horizon* https://www.marcprensky.com/writing/Prensky%20-%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part1.pdf (Accessed 15 June 2018).

Saliba,G, Rankine, L and Cortez, H. (2013). Fundamentals of Blended Learning. Learning and Teaching Unit. University of Western Sidney (UWS). https://www.westernsydney.edu.au/__.../pdf.../Fundamentals_of_Blended_Learning (Accessed 1 January 2017).

Sharpe, R., Benfield, G., Roberts, G. & Francis, R. 2006. The undergraduate experience of blended e-learning: A review of UK literature and practice. *The Higher Education Academy*. http://www.heacademy.ac.uk/projects/detail/lr_2006_sharpe (Accessed 1 January 2017).

Smythe, M. 2012. Toward a framework for evaluating blended learning. In Brown, M. Hartnett, M. & Stewart, T. (eds.). *Future challenges, sustainable futures*. Proceedings Ascilite Wellington. 854-858.

Stacey, E. & Gerbic, P. 2008. Success factors for blended learning. Proceedings Ascilite Melbourne. http://www.ascilite.org.au/conferences/melbourne08/procs/stacey.pdf (Accessed 1 January 2017)

Strauss, A. & Corbin, J. 1990. *Basics of qualitative research. Grounded theory procedures and techniques*. Newbury Park: Sage.

Strauss, W. & Howe, N. 1991. *Generations: The history of America's future, 1584 to 2069*. New York: Quill/William/Morrow.

Woltering, V., Herrler, A., Spitzer, K. & Spreckelsen, C. 2009. Blended learning positively affects students' satisfaction and the role of the tutor in the problem-based learning process: Results of a mixed-method evaluation. *Advances in Health Sciences Education,* 14: 725. DOI: 10.1007/s10459-009-9154-6