AN APPRAISAL FOR APT TEACHING AND LEARNING METHODS FOR EFFECTIVE STUDENT LEARNING IN ENGINEERING EDUCATION

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INTRODUCTION

As teaching and learning methods evolve with the incorporation of new ideas, innovations and technologies, arguments and debates emerge regarding the apt methods of teaching and learning. The higher education community at large has been debating over the issue for a long time and is trying to unearth appropriate methods that could be effective and enhance student learning (Braskamp, and Ory, 1994; Braskamp, and Ory, 2000; Collins and Robert, 2004; Dash, Patro, Behera, 2013; Khurshid and Ansari, 2012). In this process different methods have been put to practice. Despite the debates and these efforts to put different methods to practice, no unanimity on the effective learning methods has been achieved. For some scholars, it could be a method or process that produces beneficial and purposeful student learning through the use of appropriate procedures (Centra, 1993). Other scholars argue that it is the creation of situations in which appropriate learning occurs (Braskamp, and Ory, 1994; Braskamp, and Ory, 2000; Felder, and Brent, 2004). Similarly, according to McCarthy (1992) an appropriate teaching and learning method is that which presents factual material in a direct and logical manner, inspires the students from experiences, stimulates thinking to open discussion, and develops creativity among the students. This supposition is supported by several other scholars (Kochhar. 2000, p.345; Sullivan & McIntosh 1996). Consequently to achieve effective student learning a large number of ideas and innovations have been incorporated in the teaching and learning process particularly over the last two decades. The ideas and innovations which are largely influencing the teaching and learning process include modulating the behavior and attributes of teachers/ presenters, creation of suitable environment, moving to student centric learning approach, deciding the size and composition of classes, evolving various teaching methods and incorporation of digital technology and e-learning system (Bradford and Wyatt, 2010; Caywood and Duckett, 2003; Khurshid & Ansari, 2012; Rowe, 2006; Teo & Wong, 2000). However, despite the efforts central key points remain unresolved as to how effective teaching and learning can be achieved. The scenario becomes more complex in engineering education because of its nature and type of content it deals with.

Apparently it is evidenced that teaching and learning methods in engineering education have also evolved significantly over the past few decades. Conventional methods of teaching,

particularly classroom teaching, which essentially constitutes a typical classroom environment with a presentation from the course teacher with direct contact with the students and the use of the typical medium of a board and marker (chalk) has its own merits. In such methods the teachers and students are both actively involved, and the method is found to be particularly successful in the subjects that need analysis, design and mathematical expressions and modelling that require an explicit explanation from teachers' explicit explanation (Khurshid & Ansari, 2012). However, in recent years teaching and learning in engineering education is gradually shifting from these traditional methods of education to modern digital modes, involving Information and Communication Technology (ICT) and digital tools and techniques (Bradford and Wyatt, 2010; Caywood and Duckett, 2003). Scholars have argued that digital content acts as a catalyst for education and learning. It assists in enhancing traditional educational content; for example, incorporation of multiple media facilitates self-learning and continuous education by providing easy access (anytime and anywhere), supports various learning styles (self-paced, collaborative, team-oriented, etc.), and enriches the static content with narratives, game-playing, hands-on activities, and so on (Anderson, & Cartafalsa, 2010; Bradford and Wyatt, 2010; Subramanya, Jolla, 2012; www.digitallearningday.org; VanderArk & Schneider, 2016). However, the effectiveness of these methods depends on the context, mode of presentation and nature of content. on the other hand, the effectiveness of the traditional method of teaching largely depends on the communication attributes of the presenter/ teacher such as voice, gestures, movement, facial expressions, and eye contact, which can either detract or complement the content (Adunola, 2011; Ganyaupfu, 2013).

Although, both conventional and digital methods have advantages and limitations, the effectiveness of both methods has not been conclusively established. So there is a necessity to appraise the aptness of these methods towards effective student learning. However, instead most of the research in this field has tended to focus on student satisfaction (acceptable to students) rather than on performance, unaware of the fact that student satisfaction and performance are two different aspects and are linked to teaching/learning relationships or interactivity (Anderson & Cartafalsa, 2002; Anderson & Cartafalsa, 2010; Anderson & Cartafalsa, 2012; Bradford & Wyatt, 2010). This apparently presents a research gap in the effective teaching and learning landscape. Therefore, while the debates for appropriate teaching and learning methods still continue, and in the wake of the prospect of unavoidable and increased invasion of digital technology in teaching and learning, an investigation regarding the apt teaching and learning method particularly in engineering education is warranted, which has not seen much research. Therefore, the objective of the paper is to examine the significance of current teaching and learning methods related to students' performance and students' perception in engineering education. The study was conducted by using a survey research method framed within a case study of engineering education in a University of Technology in South Africa.

THEORETICAL PERSPECTIVE FOR EFFECTIVE TEACHING AND LEARNING

According to scholars comprehensive instruction that includes attention to propositional knowledge (what to do), procedural knowledge (how to do it) and conditional knowledge (when and why to do it) is of paramount importance for successful student learning (Brophy, n.d; Meichenbaum & Biemiller, 1998; Pressley & Beard El-Dinary, 1993; Weinstein & Mayer 1986). It is asserted that many students do not develop effective learning and problem solving strategies on their own but can acquire them through modelling and explicit instruction from their teachers (Brophy, n.d; Meichenbaum & Biemiller, 1998; Pressley & Beard El-Dinary, 1993; Weinstein &

Mayer, 1986). Arguments also have emerged that effective learning can be achieved be clearly outlining the outcomes of the intended learning based on Outcome based education (OBE) system (Biggs, 2007; Biggs and Tang, 2007), which includes activating relevant background knowledge; identifying major points in attending to the outline and flow of content; monitoring understanding by generating and trying to answer questions about the content; or drawing and testing inferences by making interpretations, predictions and conclusions. In this regard, instruction should include not only demonstrations of and opportunities to apply the skill itself but also explanations of the purpose of the skill and the occasions on which it should be used (Brophy, n.d; Meichenbaum & Biemiller, 1998; Pressley & Beard El-Dinary, 1993; Weinstein & Mayer, 1986).

With regards to engineering education, Felder and Silverman (1988) found that learning styles of most engineering students and teaching styles of most engineering teachers are incompatible in a number of dimensions. For example, many engineering students are found to be visual, sensing, inductive, and active, as well as some of the most creative students are global. On the other hand most engineering education is auditory, abstract (intuitive), deductive, passive, and sequential (Felder and Silverman, 1988). This mismatch consequently leads to lower cognitive learning, poor student performance, and teacher frustration. The authors have suggested that incorporation of a small number of techniques, such as motivating learning; providing a balance between concrete information and abstract concepts; balancing material that emphasizes practical problem solving methods with material that emphasizes fundamental understanding; providing explicit illustrations of intuitive patterns and sensing patterns and encouraging all students to exercise both patterns; following the scientific method in presenting theoretical materials (through concrete examples); using pictures, schematics, graphs, and simple sketches liberally before, during, and after the presentation of verbal material; showing films and videos; providing demonstrations and hands-on exercises; providing opportunities for students to do something active; assigning some drill exercises to provide practice in the basic methods being taught without overdoing them; and appreciating creative works even if incorrect should assist effective learning in engineering education (Felder and Silverman, 1988). Also, Felder and Silverman, (1988) highlighted the use of computers in other words digital technology as an integral part in the teaching and learning process for effective learning. These findings are in corroboration with the findings of Brophy and Good (1986) who suggested that structuring of information, questioning of students, reacting to students' responses, handling student assignments and home works, and quantity and pacing of instruction are essential ingredients for effective learning. Combining the findings on time, content covered, work groupings, teacher questions, student responses and teacher feedback Rosenshine, & Stevens, (1986) have labeled the method as Direct Instruction Model, or Structured Approach, which could be appropriate for effective teaching and learning. In addition, some scholars argue that teachers must be aware of the fact that teaching aims at the development of a learning disposition and imbibing meta-cognitive skills instead of mere transfer of knowledge (Verschaffel & De Corte, 1998). Furthermore, other constructivist scholars have developed a set of instructional techniques, which includes modeling, coaching, scaffolding and fading, articulation, reflection, exploration, generalization, collaboration, goal orientation and situation, and provision of anchors that are supposed to enhance the learning disposition of students (Bolhuis and Kluvers, 1996; Choi & Hannafin, 1995; Collins et al., 1989; Savery & Duffy, 1995; Verschaffel & De Corte, 1998). Although, not necessarily all the techniques or methods are needed to be used in each subject to attain effective teaching and learning (Brophy and Good; 1986), particularly in engineering subjects (Felder and Silverman, 1988). As it is observed that in addition to conventional teaching methods, incorporation of innovative instructional techniques and use of digital technology have been stressed upon for effective learning, this study is premised upon the theoretical frame work

of outcome based education oriented blended method of learning that includes use of both conventional and digital method as suggested by scholars such as Biggs, (2007); Biggs and Tang, (2007); Brophy and Good (1986); and Felder and Silverman, (1988). The central thesis revolves around that appropriate mix of conventional and digital method (blended method) of teaching and learning would be more beneficial for effective learning in engineering education than use of conventional methods or digital methods in isolation.

METHOD

An explorative inductive research approach followed for this study. A mixed method of research that includes both quantitative analysis and qualitative discussion with students and peers and case study analyses were used to conduct the study.

CASE STUDY CONTEXT

The study was framed within a context of teaching and learning in Civil Engineering subjects such as Transportation Planning, Traffic Engineering, Water and Waste Water Treatment Technology, and Urban Planning and Design at the fourth year Bachelor of Technology (B. Tech) level in the Central University of Technology, Free State, South Africa. These subjects need theoretical explanation, development of arguments, mathematical analysis, development and evaluations of simulated scenarios based on field study, and design. Therefore, they offer specific challenges of intensive engagement of teachers and students both in the class rooms and off the class rooms; and requirement of an appropriate method of teaching for effective learning and better performance by the students. Moreover, the teaching and learning methods include both conventional and digital methods (use of e- learning systems) to varied degrees. The students are given lectures and instructions in the conventional class rooms as well as encouraged to use e-learning systems. The methods of teaching in class rooms consist of lectures by instructors by use of conventional board and markers as well as use of PowerPoint presentations, Videos, and web based learning to different degrees. The assessment includes formative (continuous evaluation through two tests and a number of assignments/projects) and summative (one main assessment) methods. However, the instructors and students are encouraged and given opportunity to use digital method by using e- learning platform available in the university. For example, the lecturers provide information and course materials, evaluate assignments and make interactions with students by use of e- learning system. Similarly, students are encouraged to access e-books, videos and other learning materials through the e- learning system. Moreover, in addition to class room discussion, students were given opportunities to discuss through discussion boards available in the e-learning system. Besides, in some subjects students are also asked to submit their class work, assignments and projects through digital assignment submittal system (SafeAssign) available in the e-learning platform. The use of digital assignment submittal system discourages students to resort to plagiarism and duplicating the works of their peers and encourages them to learn deeply and make original contributions. In this context, two subjects where blended learning- both conventional and digital methods were used to fairly reasonable proportions such as Transportation planning and Traffic Engineering were used to evaluate the performance of the students. In this regard student performance on two constructively aligned indented learning outcomes (ILOs) was evaluated. The performances were evaluated based on the results of assignment and project works. To make the assessment the students were asked to perform different tasks to attain the outcome of the ILOs such as learning and understanding the theories and principles; collect data required, make necessary conceptual and quantitative analysis and then design. Before the tasks were given, students were provided with a thorough discussion on

the theories and principles and case study analyses in the class by using conventional methods as well as use of digital platforms. They are also provided with adequate learning materials and literature sources through e- learning platform. The students have also submitted the assignments and projects by using SafeAssign platform. The assessment was conducted by using a rubric developed based on revised Bloom's taxonomy of cognitive learning. In terms of assessment the students were made acquainted with the rubric to be used to assess their work as well as made aware of the level of knowledge, competency and output they have to show. The assessment was made on six levels of cognitive learning (remembering, understanding, applying, analysing, evaluation and creating in a hierarchical manner using revised Bloom's Taxonomy). Performances were measured in four levels such as ($\leq$49%- poor, 50-64%-adequate and needs improvement, 65-74%- good, $\geq$75%- excellent) based on the practices of different subject teachers and peers.

DATA AND ANALYSIS

To obtain data a survey was conducted among the B. Tech Civil Engineering students over four consecutive semesters from the year 2012 to year 2015 using convenient sampling with a sample size of 320 (n = 320). Students from five subjects such as Transportation Planning, Traffic Engineering, Water Treatment Technology and Waste Water Treatment Technology, and Urban Planning and Design were chosen for the purpose of the survey. The sample size varies in different subjects from a minimum of 10.94% (Waste Water Treatment Technology) to a maximum of 29.06% (Transportation Planning), however is proportionate to number of students in the subjects. Survey questionnaires have been prepared and distributed among the willing students at the end of the semester to provide their feedbacks on different attributes of teaching and learning process and methods of a particular subject. The survey questionnaire includes teaching learning attributes like the students' preference of teaching methods, level of use of digital technology, use e-learning resources, use of e- learning platforms, participation and engagement level in the class under different teaching processes (particularly during discussions, explanation by writing on the boards by teachers, watching Videos, presentation and instructions though PowerPoint presentations) by the students and their perceptions on the influence of different methods on their effective learning and performance in the subjects. The survey questionnaires were prepared by the researcher based on his teaching experience and discussion with peers and students. Before the questionnaires were finalized for the survey a pilot survey was conducted among about 25 students and discussions were held with the peers. The questions were then reevaluated and finalized based on the responses and feedbacks of students and suggestions of the peers. The attributes were evaluated by using a five point Likert scale ranging from 1 to 5 where 1 indicates very low influence and 5 means very high influence (1= very low, 2= low, 3=acceptable, 4= high and 5 = very high). This scale was used for the evaluation as it offers the facility to objectively quantify the perceptions of respondents (Allen and Seaman, 2007; Coldwell & Herbst, 2004, p. 65). Besides, data on students' performances from different Intended Learning Outcomes (ILOs) from different subjects were collected from the years 2012 to 2015 and were evaluated. However, as a case study the performance of students on the two ILOs on which data was collected and evaluated in detail are (1) the students will able to apply trip distribution models by following the principles of Gravity model (from Transportation Planning subject); and (2) the students will able to design a traffic signal for a junction on the roads of a city by using automated traffic signal design principles (from Traffic Engineering subject). In this regard student performances on assignments and project works of 145 students with respect to ILO 1 and 139 students with regards to ILO 2 were quantitatively analysed.

Besides, qualitative discussions were conducted with 68 students and 16 peers regarding the use and effectiveness of different teaching and learning methods including the use of e- learning

platforms and resources as well as their influence on student performances. The discussions were done in semiformal and non-structured ways by following a snowballing approach to compile the opinions over time. While the discussions with peers were conducted individually, discussion with students was conducted in small groups of 5 to 8 students in each group.

The quantitative data collected were initially analyzed statistically by using descriptive statistics. The reliability of the data was checked by Chronbach α test. Consistency in the performance was checked by Standard Deviation (SD). From the students perception data collected, Likert scale indices (LI) were developed by using simple statistical techniques (average value) for different teaching and learning methods and tools and techniques. The performance of students in the two ILOs - ILO 1 and ILO 2 was analyzed by using histograms and normalization. Significance tests between the effective learning and the three different teaching methods based on the performance in different ILOs in different subjects were conducted to establish the most appropriate method of teaching and learning conclusively.

The information collected from the qualitative discussions was analyzed by using manual interpretative method. However, once the initial results of the qualitative discussions are gathered, they were discussed with the same peers and some of the willing students (available respondents) to check the veracity and correctness of the interpretations.

RESULTS AND DISCUSSION

The influence of various attributes of different teaching and learning methods and use of various tools and techniques were assessed based on the mean scores obtained from the results of the Likert scale evaluations. The evaluations were done under four crucial teaching and learning challenges, such as acceptance by students, student engagement, level of use by students and perspective influence on effective learning. The important attributes evaluated were use of conventional method, use of digital method in general, use of blended method, PowerPoint presentations, use of Videos, e-learning platform- Blackboard, e- learning resources through Blackboard, Web-linked resource, and assessment through Blackboard.

Table 1 presents the Likert scale Indices (LI) and standard deviations (SD) obtained from the Likert scale evaluations of different attributes of teaching and learning methods and tools and techniques on the four teaching and learning challenges. The Chronbach α values range between 0.79 and 0.85, which indicate that the data is reliable and can be used for analysis. The lower SD values indicate that the results obtained are consistent and can be used for assessment of the influence of the teaching and learning methods and their attributes on effective learning process. The examination of the results revealed that students accept both conventional and digital methods of teaching and learning although the digital methods (LI=4.01) is relatively more acceptable than the conventional methods (LI=3.38). However, the blended method of learning with appropriate mix of conventional and digital method is most acceptable (LI= 4.24) by students. Similarly, use of PowerPoint presentation (LI= 4.08), Videos (LI= 3.84), use of e- learning platform (Blackboard) (LI= 3.85) and e- learning resources through Blackboard (LI= 3.91) have definite acceptance. However, Web-linked resources (LI= 2.6) and assessment through Blackboard (LI=2.53) are not preferred. Student engagement in the class is found to be relatively higher in case of use of blended method (LI= 3.60) followed by conventional method (LI= 3.57) than use of digital method in general. Also, an acceptable level of student engagement is observed in case of use of Blackboards. However, the student's engagement is found to be lower in case of PowerPoint presentations, use of Videos, accessing e-learning resources from Blackboard, Web-linked resources and assessment through Blackboard. This finding was also supported by both students and peers as obtained from qualitative discussions[2]. Findings also

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2   According to majority of students and peers discussed with

suggest that both conventional method (LI= 3.56) and blended method (LI=3.56) are equally used in the teaching and learning process. Digital method independently (LI= 2.97) is relatively less used. However, PowerPoint presentations (LI= 4.05) is the predominant mode of instructions in the classes closely followed by accessing of e- learning resources through Blackboard (LI= 3.83) and use of Blackboard (LI= 3.81) for other different purposes in general. Accessing of Web-linked resources and assessment through Blackboard are marginally used. On the issue of influence of the teaching and learning methods and use of tools and techniques on the effectiveness of the learning and student performance, students perceive that blended/mixed method (LI= 3.50) influences most. Both conventional method (LI= 2.70) and digital method (LI= 2.98) independently have relatively less influence, which was corroborated from both the students and peers opinions[3]. Besides, use of Blackboards, PowerPoint presentations, accessing resources from Blackboard have acceptable level of influence on the effective learning. The influence of Video presentations, Web-linked resources and assessment through Blackboard on effective learning is observed to be low.

Table 1 Perspectives of teaching and learning methods towards acceptance, engagement, level of use and effectiveness in learning

Teaching and learning methods and tools and techniques	Likert scale evaluation results (LI)							
	Acceptance by students		Student engagement		Level of use by students		Perspective influence on effective learning	
	LI	SD	LI	SD	LI	SD	LI	SD
Conventional method	3.38	0.60	3.57	0.57	3.56	0.54	2.70	0.37
Use of digital methods in general	4.01	0.93	3.03	0.29	2.97	0.40	2.98	0.44
Blended method	4.24	1.05	3.60	0.59	3.56	0.55	3.50	0.54
PowerPoint presentations	4.08	0.96	2.97	0.31	4.05	0.94	3.10	0.34
Video presentations	3.84	0.78	2.93	0.30	2.60	0.28	2.95	0.31
Use of e- learning platform/ Blackboard	3.85	0.81	3.35	0.51	3.81	0.77	3.32	0.47
Accessing e-learning resource through Blackboard	3.91	0.78	2.98	0.29	3.83	0.73	3.17	0.40
Accessing Web-linked resource	2.61	0.15	2.50	0.11	2.41	0.33	2.40	0.17
Assessment through Blackboard	2.53	0.17	2.25	0.23	2.24	0.14	2.21	0.20

(Chronbach α range between 0.79 and 0.85) (SD: Standard Deviation)

The students' performances in the two case study ILOs in two subjects are given in Figure 1 and Figure 2. An analysis of the histograms with normalisation of the marks indicates that a significant amount of students (63.4%) performed well having scored more than 65% of the marks. Simultaneously, the share of poor performing students (≤50%) is found to very meagre 6.2% (Figure 1) in ILO 1 (Transportation planning). Similarly, Figure 2 indicates that a significant amount of students (66.9%) performed well having scored more than 65% of the marks and the share of poor performing students (≤50%) is found to very low (10.1%) in ILO 2 (Traffic

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3   According to majority of students and peers discussed with

Engineering). Majority of the students could able to provide evidence of higher performance in both subjects in which use of blended learning was resorted to.
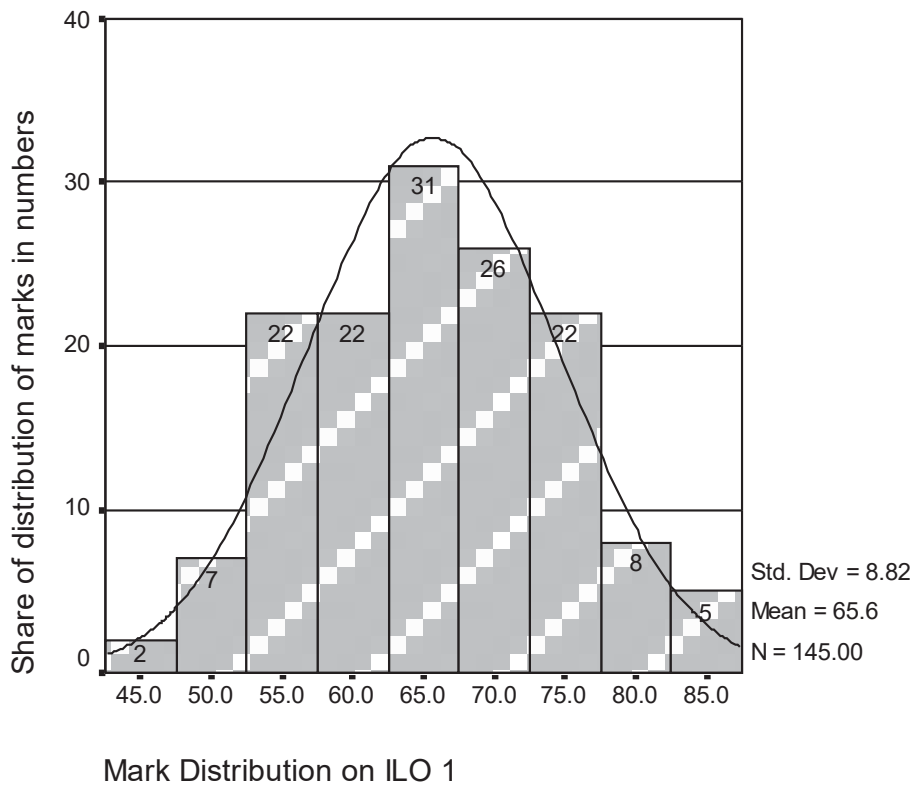

Figure 1. Performance of students in terms of mark distribution on ILO 1
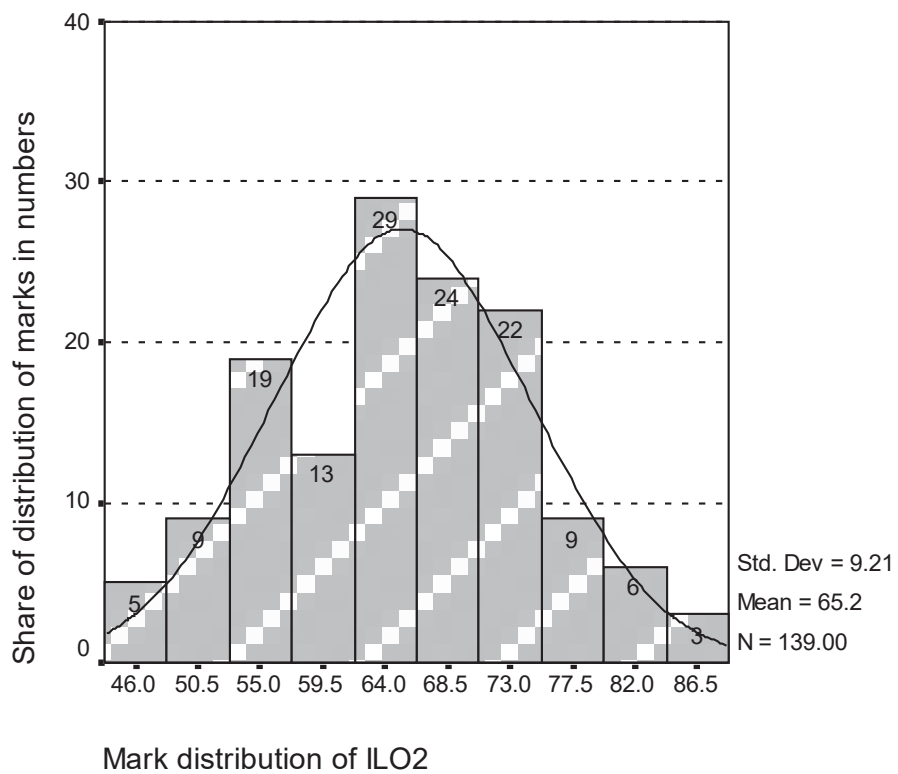

Figure 2. Performance of students in terms of mark distribution on ILO 2

However, significance tests between the effective learning and the three different teaching methods were conducted to establish the most appropriate method of teaching and learning conclusively. For the purpose effective learning is measured by the student performance (marks acquired after the assessment on ILOs that includes either formative or summative assessment or both). Since no subject is taught purely by use of digital methods, performance of students on ILOs in which teaching and learning activities and assessment tasks were conducted by predominant use of digital method (e-learning platform) and minimal use of conventional method including class room teaching was considered for t test with respect to use of digital method and effectiveness of teaching and learning. Similarly, performance in the ILOs where digital technology was used minimally (meager use of e- learning platform) was considered for t test with respect to use of conventional method and effectiveness of teaching and learning. The ILOs where an appropriate mix conventional method and digital technology (varying between 40-60%) was used was treated as blended method of learning. The t- tests for $\alpha < 0.05$ was conducted on aggregate basis based on the perceptions of the students regarding the level of use of the teaching and learning methods and their performance after the final assessment of different ILOs in the subjects. For this purpose the students' perception on the level of use and their performance in the subject are grouped into ten groups on an aggregate basis. The t- test result is found to be significant (p values for both one tailed and two tailed ≤ 0.05 for $\alpha < 0.05$) in case of blended teaching and learning method establishing that higher student performance or in other words effective student learning can be attained through blended method of teaching and learning (Table 2). However, the t-test results are found to be insignificant (p values for both one tailed and two tailed ≥ 0.05 for $\alpha < 0.05$) in case of relationship between either conventional method or use of digital methods alone and effective learning indicating that effective student learning may not be attained if either method is used independently.

Table 2 Relationship between effective learning and methods of teaching

Teaching and learning methods	Effective learning				
	df	T values	p*	p**	Significance
Use of blended method and Performance of students	18	-5.59	0.000013	0.000026	Significant
Use of conventional method and student performance	18	-0.66	0.26	0.52	Insignificant
Use of digital methods alone	18	-0.52	0.31	0.62	Insignificant

(Note: * one tailed, ** two tailed p valued for $\alpha < 0.05$)

The critical examination of the results have shown that students although accept both digital and conventional method of teaching and learning, the student engagement and effective student learning are conclusively higher when blended method of teaching and learning is practiced. Students also accept, and use all the modern tools and techniques such as e- learning platforms, accessing e-resources through Blackboard, PowerPoint presentations and Videos at an acceptable level, although they apparently participate and engage less, particularly in the class rooms. The discussion with the students point out that their level of participation and engagement increases, they understand better and learn more when critical elements of the subjects such as mathematical expressions, analysis, modelling and design elements are explained by the teachers by use of conventional methods[4]. They argue that since many engineering subjects encompass a significant amount of mathematical, analytical and design components, PowerPoint presentations, Videos, and e- resources although enable them to access the materials repeatedly and at their own time do not substitute the explanations usually made by the teachers

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4   Qualitative discussion with students

in the class rooms through conventional methods, which was corroborated by the peers[5]. In this context, teachers (peers) opine that it is more convenient and easy to explain such elements by use of conventional methods than use of digital methods alone and according to their experience students learn more under such practices[6]. As argued by scholars digital technology has taken learning and teaching into a new realm (Anderson & Cartafalsa, 2012; Caywood and Duckett, 2003; Subramanya and Jolla, 2012). Keeping pace with the incorporation of technology in teaching and learning process, there is a need for change of the style, shift in attitude, and adoption of appropriate methodology to achieve effective learning[7] (Brophy and Good; 1986; Felder and Silverman, 1988; Subramanya and Jolla, 2012). Consequently, an argument has emerged based on the ground realities that engineering subjects because of their nature and content need teachers' explanations in the class rooms through use of conventional method that is evidenced from this study[8]. This supports the view that traditional deductive way of teaching and learning, which begins with presentation of basic principles in lectures, explanation- may be by use of conventional board and marker, repetition and application of the lecture content by the students augur well for engineering subjects[9] (Felder and Silverman, 1988; Prince, Felder, 2006; Rosenshine, & Stevens, 1986). Thus, it is advocated that although digital methods of teaching and learning is on the rise and continue to get strengthened in future, the role of conventional teaching and learning method cannot be undermined particularly for engineering subjects[10]. So, as evidenced from this study a blended method of teaching and with appropriate mix of digital modes such as PowerPoint presentations, Videos, use of e-learning platforms, use of e- learning resources, and conventional way of explaining in the class rooms by use of board and markers would engender effective learning by the students.

CONCLUSION

Finding an appropriate method of teaching and learning, particularly in engineering education is a challenge. The increasing invasion of digital technology and the aggressive promotion by the academic managers and educational technology industry for its increased use in almost every sphere of teaching and learning make it more complex. There is no denying about the benefits and specific advantages of both conventional and digital methods of teaching and learning; however, there was a need to examine if these methods engender effective learning and higher student performance when adopted independently and what are the students' perceptions towards them. Besides, most of researches on the teaching and learning methods are directed towards investigating students' satisfaction than finding out their influence on effective learning and students' performance. These research gaps warranted this investigation. A mixed method (both quantitative and qualitative) approach was adopted for this purpose. Findings suggest that there is definite acceptance of both conventional and digital methods of teaching and learning by the students. Students accept and use digital technology methods and tools and techniques such as PowerPoint presentations, Videos, e learning platforms and e- learning resources at an appreciable level. However, the level of participation and engagement of students particularly in the classes are appreciably less when digital method and tools and techniques are adopted. This happens because of the availability of the resources and contents at hand of the students, and students think that they can use them at any time and at their convenience. In the process

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5   Qualitative discussion with students and peers
6   Discussions with peers
7   Discussions with peers
8   Discussions with peers
9   Qualitative discussion with students and peers
10   Discussions with peers

they fail to get engaged with the critical explanations and discussions that are made in the class, which in fact hinder their learning later on. Besides, use of Web-linked resources and assessment through use of digital platforms are yet to be profusely accepted by the students. Conversely, students also preferred conventional form of teaching- explanation of critical aspects of the subjects such as elements involving mathematical expressions, models, analysis and design through use of age old board and marker systems. Findings of this study also suggest that effective learning or enhanced student performance cannot be attained if either conventional or digital method is employed alone in teaching and learning process; however, on the contrary this study conclusively establishes that effective learning and higher student performance can be achieved by use of blended method of teaching and learning with appropriate mix of both conventional and digital methods.

The study has its limitations. It is conducted based on predominantly students' perception and convenient sampling within a framework of a case study and performances obtained on different ILOs in a few Civil Engineering subjects at the B. Tech fourth year. Besides, the scope was limited to observing the apt method of teaching and learning and influence of different tool and techniques for effective student learning. The relative influence and contribution of different methods, tools and techniques towards effective student learning were not investigated, which are the further scope of the research. However, despite the limitations the study established that student learning is unquestionably higher if mixed or blended method (appropriate mix of traditional and digital), is practiced in teaching and learning process in engineering education.

REFERENCES

Allen I. E., and Seaman C. A. (2007). Likert scales and data analyses, *Quality Process*, 40(7), 64-65.

Anderson, L. E., & Cartafalsa, J. S. (2002). Factors that make faculty and student relationships effective*, The College Teacher*, 50(4), 134–138.

Anderson, L. E., & Cartafalsa, J. S. (2010). Virtual teaching/learning relationships, *International Journal for Digital Society*, 1 (1), 10-11.

Anderson Lynne and Cartafalsa John. (2012). Practical Lens for Teachers in Their High Tech Learning Environment*, Journal of Research in Innovative Teaching*, 5(1), 39-44.

Adunola, O. (2011). *The Impact of Teachers' Teaching Methods on the Academic Performance of Primary School Pupils in Ijebu-Ode Local cut Area of Ogun State*, Ego Booster Books, Ogun State, Nigeria.

Bolhuis, S., & Kluvers, C. (1996). *Op weg naar zelfstandig lerende leerlingen* [Towards independent learning students], Katholieke Universiteit Nijmegen: Vakgroep Onderwijskunde.

Bradford, G., & Wyatt, S. (2010). Online learning and student satisfaction: Academic standing, ethnicity and their influence on facilitated learning, engagement, and information fluency, *The Internet and Higher Education*, 13(3), 108–114.

Braskamp, L. A. (2000). *Toward a more holistic approach to assessing faculty as teachers. In K. E. Ryan (Ed.), Evaluating teaching in higher education: A vision for the future. New directions for teaching and learning,* vol. 83, pp. 109-123. San Francisco, Ca: Jossey-Bass.

Brophy, J (n.d). Educational Practices series-1, Teaching, International Academy of Education, http://www.ibe.unesco.org

Brophy, J., & Good, T.L. (1986). Teacher behavior and student achievement. In M.C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed, pp. 328–375). New York: MacMillan.

Centra, J. A. (1993). *Reflective faculty evaluation*. San Francisco, CA: Jossey-Bass.

Caywood, K., & Duckett, J. (2003). Online vs. on campus learning in teacher education*, Teacher Education and Special Education*, 26(2), 98–105.

Choi, J. I., & Hannafin, M. (1995). Situated cognition and learning environments: roles, structures, and implications for design, *Educational Technology Research and Development,* 43(2), 53-69.

Coldwell, D., and Herbst, F. (2004). Business Research, Juta and Co Ltd, Cape Town.

Collins, A., Brown, J. S., & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing and mathematics. In L.B. Resnick (Ed.), *Knowing learning and instruction* (pp. 453–495). Hillsdale, MI: Lawrence Erlbaum.

Collins, A., and Robert J. J. (2004). *Enhancing Student Learning Through Innovative Teaching and Technology Strategies*. Kogan Page.

Dash, S. K., Patro, S., Behera, B.K. (2013). *Teaching Methods and Its Efficacy, An Evaluation by the Students J Indian Acad Forensic Med*., vol. 35, no. 4, October-December, pp. 321-324.

Digital Learning Day website. http://www. digitallearningday.org/.

Felder Richard M., Silverman Linda K. (1988). Learning and Teaching Styles in Engineering Education, *Engineering Education*, 78(7), 674–681.

Felder, R.M. and Brent, R. (2001). Effective Strategies for Cooperative Learning*, Journal of Cooperation and Collaboration in College Teaching*, 10(2), 69–75 <http://www.ncsu.edu/ felderpublic/ Papers/ CLStrategies (JCCCT).pdf>.

Felder, R.M., and Brent, R. (2004). The Intellectual Development of Science and Engineering Students. 2. Teaching to Promote Growth*, Journal of Engineering Education*, 93(4), 279–291, <http://www.ncsu.edu/felder-public/Papers/IntDev-II.pdf>.

Ganyaupfu E. M. (2012). Teaching Methods and Students' Academic Performance*, International Journal of Humanities and Social Science Invention*, 2(9), 29-35, www.ijhssi.org.

Kochkar, S.K. (2000). *Methods and Techniques of Teaching*, New Delhi: Sterling.

Khurshid F., & Ansari U. (2012). Effects of Innovative Teaching Strategies on Students' Performance, *Global Journal of Human Social Science Linguistics & Education*, 12(10), 2-9.

McCarthy, P. (1992). *Common Teaching Methods*. Retrieved July 24, 2012.

Prince, M. J., Felder, R. M. (2006). Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases*, Journal of Engineering. Education*, 95(2), 123–138.

Rosenshine, B., & Stevens, R. (1986). Teaching Functions. In M.C. Wittrock (Ed.), *Handbook of Research on Teaching* (3rd ed., pp. 376–391). New York: Macmillan.

Savery, J.R. & Duffy, T.M. (1995). Problem based learning: an instructional model and its constructivist framework, *Educational Technology,* 35(5), 31-38.

Schwartz A. Donald. (2012). Effectiveness of Learning in Online Versus On-Campus Accounting Classes: A Comparative Analysis*, Journal of Research in Innovative Teaching*, 5(1), 63-77.

Subramanya S. R., Jolla, L. (2012). *Enhancing* Digital Educational Content Consumption Experience, *Journal of Research in Innovative Teaching*, 5(1), 106-115.

Sullivan, R.L. & McIntosh, N. (1996). *Delivering Effective Lectures*. Retrieved, August 27, 2014 from ttp://cte.umdnj.edu/traditional_teaching/traditional_lecture.cfm*.*

Teo, R. & Wong, A. (2000). *Does Problem Based Learning Create A Better Student: A Reflection? Paper presented at the 2nd Asia Pacific Conference on Problem Based Learning: Education Across Disciplines*, December 4-7, 2000, Singapore.

VanderArk Tom & Schneider (2016). *Carry How Digital Learning Contributes to Deeper Learning* by GettingSmart.com, retrieved on 12 January 2016.

Verschaffel, L. & De Corte, E. (1998). Actief en constructief leren binnen krachtige leeromgevingen (Active and constructive learning in powerful learning environments]. In L. Verschaffel en J. Vermunt (eds)., *Het Leren van Leerlingen* [Student Learning], Alphen aan de Rijn: Samsom, Onderwijskundig Lexicon Editie III, pp. 15- 29.