Developing Student Driven Learning: Impact on Knowledge and Attitude

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***Abstract*—It has been identified that some teaching strategies when applied encourage behavioral changes among students that will lead to better performance. Current teaching strategy in most engineering curricula is teacher-centered which gives scope to invent ways to enhance students learning by training them to self-consciously adopt behaviours that can generate excellent outcomes. The main objective of this study is to investigate if self-driven learning, within a course format, can generate higher level of learning, motivation and attitude. In this view, the investigation was conducted on two levels. Firstly, students were given autonomy to self-select the laboratory work within the scope of the study in contrast to the traditional way where the laboratory work is assigned to the students by the lecturer. Secondly, in most cases students have little prior experience of the topics that are covered in the lecture thus, students were required to do pre-lecture reading on those specific topics to assess if it resulted in better understanding. Later, students submitted reading summaries on specific topics prior to the lecture and participated in quiz later on. The strategies executed were developing a multidimensional survey, that was run twice, that is pre-laboratory and post-laboratory to evaluate any measureable effect on student's learning, motivation and self-efficacy. The results indicated a growth in self-efficacy and motivation and ability to perform task right from collection of data to interpretation and projecting application of knowledge. Pre- and post- survey data plugs at statistically significant margin in self-efficacy of students with $p < 0.03$. In addition, pre-lecture reading led to a better understanding of the assigned topics which became evident by extensive questions, arguments taking place during the class. Survey of post- strategies also showed motivation and confidence in the subject resulting in median=5 out of 5 and mean=4.19. Additionally, evidence suggest boosting the quality of learning generates positive attitudes, higher levels of confidence and problem solving abilities. Survey results and classroom discussions also indicate that students can engage into more in-depth and need-based learning that can improve the overall quality of both learning and teaching.**

***Index Terms*—teaching strategies; Student motivation; enhanced learning**

I. Introduction

Excellence in teaching is of prime importance since it produces positive learning outcomes. Nurturing excellence in teaching is a challenge for the higher education sector. Institutions need to ensure that the quality of teaching will meet the expectations of both students and employers [1] thus it is desirable for evolving institutions to develop an effective learning culture and adopt excellent pedagogical practices. There have been efforts to recognize outstanding educators and document what they do [2], [3]. The term "excellence" in higher education teaching is ambiguous and can be challenged; however, there is a degree of commonality found in previous research focusing on common practices of successful teachers. For instance, committed teachers try various ways to bring not only depth to their content but also enhance student interest [4]. Moreover, the quality of lectures remains one of the most important factors contributing to quality teaching and has been documented as playing an integral role in attendance rates and motivation [5], [6]. It has been perceived as being long, unfriendly and constant talks by a lecturer, calling into questions whether lectures are effectively utilized in the teaching and learning process [7]. In contrast, for an effective lecture the lecturer implements interactive and participatory approach that involves students with the help of using diverse teaching techniques. Lecturing can be made effective to enhance engagement if it is blended with classroom discussions, group tasks, and some other relevant activities. In the past, it has been reported that, students enjoy interactive classroom activities to manage meaning of the lecture content [8]. Researchers have identified some teaching strategies that can be used to encourage behavioral changes among students that lead to better performance. Motivated education [9], transparency and teamwork [10], [11] are some of the strategies recognized as being effective. These strategies are based on the rationale that there can be an increase learning, when there is an improvement in in-class communication methods. To introduce motivated education, strategies are formulated to encourage students to learn independently and teach them to define their goals and ways to achieve such goals themselves. Regarding teamwork, it means initiatives fostering quality teaching is a collaborative process. For instance, multidimensional motivation instrument [12] examines the relationship between the learning environment and students' motivation affecting the behavior. Past work on learning environment and motivational theories [13,] [14] show that components such as self-efficacy, the individual's goals toward tasks, and the learning

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environment normally will control students' motivation. Self-efficacy is understood as individual's insight of their ability in accomplishing learning tasks [15]-[18] and helps in determining effort students exert in a certain activity, and their adherence to effort in adverse situations. Students believing in their capabilities while doing certain engineering tasks are typically more motivated and inclined to accomplish them. Researchers [19], [20] have stressed on investigating student's expression of motivational behavior when studying specific subject content areas. Therefore, it is necessary to build up a questionnaire to look into students' learning motivation in engineering subject area.

In this research developing student driven learning specific teaching strategies are considered to be the foundation to bring about a degree of distinction in the education by developing a student driven learning attitude. We describe results from the implementation of student driven learning strategies in a course on product testing in the department of mechanical engineering. The course has a format comprising of lecture cum laboratory, covering areas in destructive and non-destructive techniques for product testing. The number of students involved in laboratory assignments so far were N=20. For research on pre-reading outcomes, the students involved have been 46 in number.

II. Deficiencies and Drawbacks of the Current Teaching Strategies

Generally speaking, in engineering education, the current teaching strategy is teacher-centered, discipline-centered and lecture-based. Specific to a teacher-centered approach, teachers deliver content to students where students acquire concepts of the discipline to a certain degree only due to their learning method which is are rote-learned thus leaving them with surface level of understanding of the subject. This gives reason and also, there are sufficient opportunities for the students to involve themselves in self-directed learning.

In addition, when teaching strategy is discipline-centered, because of limited preparation time and some reasons the teaching materials comes from textbooks and in most cases students have little prior experience of the topics covered in class, thus, students simply pay extra effort to the lecturer, trying their best to hear what is being taught. In other words, students fall into the pattern of simply listening to lectures without any conversation with teacher or being allowed for any active learning. There is also a general complaint among lecturers is that students simply fail to learn much of the material presented in the class. A discrepancy between what lecturers teach and what students actually learn has also been observed. It is evident from past years that due to overloaded content of engineering subjects that needs to be covered in a limited time frame, as a consequence leads to students going for a straight forward approach in their studies focusing on passing their exams with an objective of obtaining a degree instead of taking interest in learning [8, 21]. Hence, teacher-centered approach leads to students becoming a passive recipient. Moreover, for some good reasons, most of the lecturers have a tendency to stress on delivering substantial knowledge, methods and techniques on specific areas where their expertise lie.

III. Strategies for Motivated Learning and Self-Conciously Shaped Behaviours

Enhancing and Inspiring student motivation- Autonomy and motivation go hand in hand. If individuals are subjected to greater autonomy in their work, they are additionally expected than other to display greater levels of motivation. Our assessment instruments for student learning are homework, assignments and laboratory work. Traditional way is that assignment work is given to the students by the lecturer. An inference is that students should be offered more freedom and opportunities to choose, within a framework, both the topics they choose to work on its approach to work on, by their course lecturers. For example, in case of laboratory work, the students can be given a choice to design their own experiments in the course(s) that will be selected in this study. Design of experiments will enhance the student's work methodology give practical experience in search, analysis of technical/scientific information and can be an effective way not only for problem solving but also enhance interest in the course [22].

Directed work behaviors- where students are required to write short summaries on some important topics prior to attending the class which is a way to deal with the unending problem of unprepared students coming for lectures. Preparation and submissions from students can be an effective way to make the lecture more productive and increase the lecture value overall.

Moreover, the feedback on student submissions is normally given on their final submission which does not give them any opportunity to improve. However, in the proposed teaching and learning strategies, feedback will be given to the students at each stage of their work as it is a powerful tool that helps students to understand their assets and faults in their work. It has been explained that feedback tool is most appropriate than any other tool in the context of learning [22].

IV. Research Plan and Methodology

As an initial pilot study, we designed, developed and delivered a student led laboratory work which is a part of assessment component in a course on Product testing technology. Students as participants were enrolled in this course during the research period. The objective was to engage students in their assignment on laboratory work in a group format comprising of four students, get them interested and motivated in the course. While extensive technical information was deliberately not presented to the students in terms of experiment execution, students were introduced basic theoretical knowledge on the subject they would encounter during their work. The topic of experiment was selected by the students. Altogether, five groups of students were given two weeks to design, during the research periods to conduct the experiment and write a detailed report on the topic of "tensile test" and "impact test". A laboratory manual was provided to the students that contained the following: experiment outline, criteria and specifications, list of available materials for testing, safety considerations and software operations guide. Since no formal classroom lectures were conducted, students had to recall their knowledge on for example, concepts of stress, strain, plasticity from previous courses and apply to a new context – conduct the tests on at least two different materials. The whole laboratory work was designed and built on the core requirements of this study: occurs in a small group, the learning is student centered, experiment to be conducted prior to any classroom teaching but on the basis of prior learning of the topic in previous years and self-directed learning is encouraged. The technician was available all the time who acted as a facilitator during their laboratory work.

A questionnaire for the survey was passed to the students with an objective to achieve the following: assess the respondents' perception and objective information towards the new learning strategies, its impacts on their learning, their motivation towards learning and general attitude towards the course and strategies implemented. A multidimensional survey was developed and conducted two times during the two-week laboratory period, that is first day of the laboratory (pre-lab), later after the completion of laboratory (post-lab). Similar survey questions have been used as the published ones [23]. The objective of the survey was to evaluate whether or not the self-directed laboratory assignment had any quantifiable effect on attitude, student's self-efficacy, and motivation which is based on two factors namely, active learning strategies and learning environment. Self-efficacy or effectiveness according to Bandura [17] relates to how student perceive their capabilities to perform specific tasks. By means of a 6-point Likert-like scale (1= absolutely uncertain, and 6= absolutely certain) students indicate that they can perform a specific task I engineering. Moreover, we also need instrument to measure attitudes towards overall exercise. There are numerous techniques employed to scale student's attitudes towards learning certain subjects or in engineering. An intentional survey specific to the course was designed and made. The initial objectives of the survey were to identify students' attitudes about the course specifically reflecting the strategies introduced for learning. The items were rated using scale (1= strongly disagree and 5= strongly agree). The examples of the items adapted from [24] included in student's self-efficacy, motivation and attitude are listed in Table I. The questions in each survey covered three aspects: Self and team assessment questions, evaluation of the laboratory and class, and assessment of the course on product testing. The pre- laboratory had 10 questions and were focused on students self-assessment regarding experience, knowledge and skills within the context of the course on product testing technology. Whereas post- laboratory had 15 questions comprised of team performance questions in addition to the pre- laboratory questions. In addition, as part of self-directed learning, students were asked to do the pre-reading and submit assignments of the topics that were taught subsequently to understand if there can be any improvement in their level understanding of the topic. The impact of pre-reading on student's knowledge was realized through short quiz.

TABLE I. EXAMPLE OF ITEMS IN SELF EFFICACY, MOTIVATION AND ATTIUDE SCALES

Factors	Example Questions
Self-efficacy	Whether the engineering content is difficult or easy, I am sure that I can understand it
	No matter how much effort I put in, I cannot learn engineering
	When certain activities in engineering are difficult I give up or only attempt easy ones
Motivation (Active learning strategies)	When learn new engineering concepts, I connect them to my previous experiences
	On facing difficulties I would discuss with teachers or other students to clarify my understanding
Motivation (Learning environment)	I am willing to participate in engineering course because the content is exciting
	I am willing to participate in engineering course because the content is challenging
Attitude	How much a student likes involving in testing materials
	Preference for working in groups

V. RESULTS AND DISCUSSION

Since the student involvement is minimal in teacher-centered approach thus it was observed that there is a discrepancy between what lecturers teach and what students actually learn. Therefore, to bridge such as a gap we introduced another component in study where the student participation was accelerated. The student was given the responsibility for their own learning by self-initiating learning topics. Thus, method explained in the previous section was adopted involving survey questions before and after the implementation of strategies.

On comparing the data obtained from pre- laboratory survey with post laboratory survey, it is found that the student's efficacy increased statistically with a margin (p-value < 0.03). Moreover, increased motivation and self-confidence to finish the work was seen in the students after the laboratory assignment was completed. The mean scores out of 5 obtained were: pre-laboratory 3 and post laboratory 4.19 indicating gain in effective problem solving and critical thinking skills. A significant improvement in student's self-efficacy is observed. The results are consistent with previous research in engineering and science subjects where experiments are part of teaching curriculum [23, 24]. The self-efficacies statistically are comparable. Past research shows a positive relationship between self-efficacy and academic achievement [25, 26]. Increased motivation was based on the importance of the course for their career in product testing and urge to learn as primary cause. The post-survey on the impact of self-directed learning on motivation show varied results. Out of N=20 students, 10 students scored 5 (out of 5), 3 students scored it 4, 6 students scored 3 and 1 student scored it 2. The results indicate that self-directed learning in laboratory work does help in increasing the motivation for the course. With an aim, consequent student performance on an important associated tasks can help us to understand whether encouraging a culture of excellence among students can have an encouraging and continuous impression on their distinct practices or not.

As part of the evaluation of the student –driven laboratory work, students were required to give a presentation outlining their basis of design, approach in conducting the experiment. Moreover, they were also asked to retrospectively evaluate their experiment and identify areas of improvement, if any. The groups were assessed on three equally weighted criteria that were provided to the students prior to their experiments. The criteria were: (i) design and procedure of experiment; (ii) data collection and analysis (iii) quality of the report presentations.

More so, readings submission of specific topics led to substantial achievements in student knowledge on those topics. It was seen that students were highly involved in the class during and after the topic was taught. There was discussion in the classroom on questions raised by students which covered technical as well as theoretical aspects. The impact of pre-reading on student's knowledge was realized through short quiz. A short quiz comprising of 15 questions was conducted soon after the teaching of the topic reflected significant level of understating any improvement in their level understanding of the topic. Total number of students participated in this activity were 40 out of which 32 students scored 70 (out of 100) or above reflecting the achievement in learning outcome.

From student's performance on several fronts show that self-efficacy, motivation and attitude has a strong positive correlation with subject knowledge achievement which is in agreement with previous studies conducted. Though, we have not included any correlation of self-efficacy, motivation and attitude here. Based on our data and analyses we can see that specific teaching practices can create a positive culture of learning and motivate students towards education which can enhance the overall student quality and performance.

VI. CONCLUSION

The research to seek feasibility and outcome on student driven self-learning attitude in a specific course on product testing was successfully implemented. Upon giving students the autonomy to self-select the laboratory work within the scope of the course revealed individual motivation and self-efficacy. Students were also required to do pre-lecture reading on specific topics that resulted in better understanding of the topics. Additionally, evidence suggest boosting the quality of learning generates positive attitudes, higher levels of confidence and problem solving abilities. Survey data shows statistically significant margin in self-efficacy of students with $p < 0.03$. Whereas, motivation and confidence results in median=5 out of 5 and mean=4.19 (from pre-lab. 3). From this study we identified that students can engage into more in-depth and need-based learning that can contribute to the betterment of the overall quality of both teaching and learning. The depth of learning was monitored via assessment of their work. The outcome of the implementation of the above mentioned strategies in an engineering subject lead not only to motivate self-consciously shaped behaviors of students but also enhanced the overall task performance in terms of knowledge, data analysis and applications. Data collected through a questionnaire helped in evaluating effectiveness of strategies via the students' feedback on if and how the self-learning strategy enhanced both their interest as well their knowledge. Results demonstrate that major transformation in teaching style is not essential though significant enhancement can be made in learning outcomes of the students.

REFERENCES

[1] H. Fabrice and R. Deborah, "Fostering quality teaching in higher education: Policies and practices -An IMHE guide for higher education institutions," *OECD*, 2012.

[2] K. Bain, *What the Best College Teachers Do*, Cambridge, MA: Harvard University Press, 2004.

[3] A. Skelton, "International perspectives on teaching excellence in higher education: Improving knowledge and practice," London: Routledge (Ed.), 2007.

[4] J. Andrews, D. R. Garriso, and K. Magnusson, "The teaching and learning transaction in higher education: A study of excellent professors and their students," *Teaching in Higher Education*, vol. 1, 1996.

[5] R. Pospisil and L. Willcoxson, "Learning through teaching," in *Proc. 6th Annual Teaching Learning Forum*, Murdoch University, February 1997.

[6] J. Fitzpatrick, K. Cronin, and E. Byrne, "Is attending lectures still relevant in engineering education?" *European Journal of Engineering Education*, vol. 36, no. 3, pp. 301-312, 2011.

[7] K. Kougl, "Communicating in the classroom," in *Prospect Heights*, ILL: Waveland Press, 1997.

[8] M. Cavanagh, "Students' experiences of active engagement through cooperative learning activities in lectures," *Active Learning in Higher Education*, vol. 12, no. 1, pp. 23-33, 2011.

[9] J. E. Ormrod. (2010). How Motivation Affects Learning and Behavior. [Online]. Available: http://tech-ology.com/uploads/2/9/4/0/2940083/education.com_-_motivation.pdf

[10] Crawley, F. Edward, J. Malmqvist, S. Östlund, R. D. Brodeur, and K. Edström, "Student learning assessment," in *Rethinking Engineering Education*, Springer International Publishing, 2014, pp. 165-180.

[11] A. Volkov and M. Volko, "Teamwork benefits in tertiary education: Student perceptions that lead to best practice assessment design," *Education and Training*, vol. 57, no. 3, pp. 262-278, 2015.

[12] M. E. Uguroglu, D. P. Schiller, and H. J. Walberg, "A multidimensional motivational instrument," *Psychology in the Schools*, vol. 18, pp. 279–285, 1981.

[13] J. Brophy, *Motivating Students to Learn*, Madison, WI: McGraw Hill, 1998.

[14] P. R. Pintrich and D. H. Schunk, *Motivation in Education: Theory, Research and Applications*, (2nd ed.). Englewood Cliffs, NJ: Merrill Company, 1996.

[15] A. Bandura, "Self-referent thought: A developmental analysis of self-efficacy," in *Social Cognitive Development: Frontiers and*

Possible Futures, J. H. Flavell and L. Ross, Eds., New York: Cambridge University Press, 1981.
[16] A. Bandura, "Self-efficacy mechanism in human agency," *American Psychologist*, vol. 37, pp. 122–147, 1982.
[17] A. Bandura, *Self-Efficacy: The Exercise of Control*, New York: W.H. Freeman, 1997.
[18] F. Pajares, "Self-efficacy beliefs in academic settings," *Review of Educational Research*, vol. 66, pp. 543–578, 1996.
[19] P. C. Blumenfeld, "Classroom learning and motivation. Clarity and expanding goal theory," *Journal of Educational Psychology*, vol. 84, pp. 272–281, 1992.
[20] B. Weiner, "History of motivational research in education," *Journal of Educational Psychology*, vol. 82, no. 4, pp. 616–622, 1990.
[21] A. K. Ditcher, "Effective teaching and learning in higher education with particular reference to the undergraduate education of professional engineers," *International Journal of Engineering Education*, vol. 17, pp. 24-29, 2001.
[22] D. Saltmarsh and S. Saltmarsh, "Has anyone read the reading? Using assessment to promote academic literacies and learning cultures," *Teaching in Higher Education*, vol. 13, pp. 621–632, 2008.
[23] N. A. Mamaril and E. L. Usher "An Examination of students motivation in engineering courses," *IEEE Frontiers in Education*, 2013.
[24] H. Tuan, C. Chin, and S. Shieh, "The development of a questionnaire to measure students motivation towards science learning," *International Journal of Science Education*, vol. 27, pp. 639-654, 2005.
[25] N. V. Bedekar, S. A. Nasab, and W. B. Walter, "Improvement in learning experiences by adopting student centered teaching practices," *American Society for Engineering Education*, 2015.
[26] D. H. Schunk, "Self-efficacy and academic motivation," *Educational Psychologist*, vol. 26, no. 3&4, pp. 207–231, 1991.

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