International Journal of Asian Social Science

Special Issue: International Conference on Teaching and Learning in Education, 2013

journal homepage: http://www.aessweb.com/journal-detail.php?id=5007

A PRELIMINARY STUDY OUTCOME AND ANALYSIS OF TEACHING AND LEARNING PROBLEMS IN ENGINEERING AT UNITEN

Chen Kang Lee

Universiti Tenaga Nasional,Jalan IKRAM-UNITEN, Kajang Selangor, Malaysia

Manjit Singh Sidhu

Universiti Tenaga Nasional,Jalan IKRAM-UNITEN, Kajang Selangor, Malaysia

ABSTRACT

This paper presents a preliminary study on the teaching and learning problems in engineering in mechanics dynamics domain. The motivation for conducting this pilot study is to suggest the improvements in learning mechanics dynamics through smart interactive computer aided learning approach. A questionnaire was distributed to the mechanical engineering students in UNITEN with a sample size of n=127. The data collected was analyzed and the preliminary results revealed that students faced difficulties to comprehend the mechanics dynamics concepts. As such newer technological software may be useful as an additional supplementary tool to aid them in learning.

Keywords: Education, Engineering, Technology, Learning problems.

1. INTRODUCTION

In the era of knowledge driven society, education in general and tertiary education in specific plays a critical and major role in developing the human capitals (knowledge workers) for the nations.In fact, the shift to a new paradigm of education that expects to foster the development of emerging knowledge economy is a great challenge faced by the education practitioners globally, including engineering education. Recently, the paradigm shift in engineering education raised the attention of the engineering communities and is actively discussed in numerous reports (Auguestine, 2005; Froyd et al., 2012; National Science Board, 2007; Prados, 1998; Wince-Smith, 2005). Dobson (2012) reports that the number of enrolments in undergraduate programmes in engineering has grown at more than the national average this century in Australia. As discussed by Duderstadt (2008), one of the characteristics for new paradigms of engineering education is the change of pedagogical style that shift from classroom based pedagogy to active learning approaches that engage problem-solving skills and team building, by which it is more focused on discovery oriented , interactive and collaborative learning experiences. In order to response to the changes in the global environments, the current problems in engineering education need to be identified and solved while higher quality of engineering education should be introduced.

2. OVERVIEW OF ENGINEERING EDUCATION IN UNITEN

University TenagaNasional (UNITEN) is one of the established private higher-learning institutions in Malaysia (Manjit, 2006). For engineering education, UNITEN offered courses in electrical engineering, electrical power engineering, mechanical engineering, computer and communication engineering, and civil engineering. This research focused the study on mechanical engineering specifically on the problems faced by students in mechanics dynamics domain. Mechanics dynamics is a core subject for the degree students in mechanical engineering with the pre-requisite of mechanics statics. At present this subject is conducted through the lecture and tutorial sessions. The assessments include quizzes, assignments, mid-term test and final exam. This subject is important and serves three purposes, by which it enables the students to (i) understand the importance of dynamics in Engineering systems, (ii) the acquisition of sufficient knowledge of the theory of dynamics and to apply them in the analysis of dynamic systems and (iii) apply the knowledge of dynamics in the design of engineering systems.

Till date, the major teaching and learning approach of mechanic dynamics in UNITEN still emphasizes more on instructor-centered, one-way delivery mode and passive students' participations. The teaching tools involved are the used of power-point slides presentation for the theory of mechanics dynamics, and the used of white board to further illustrate on the application of formula in a series of proper working steps to reach the solution of a problem. This is the traditional "chalk and talk" approach that has been used since few decades ago (Mills &Treagust, 2003).According to the previous research studies,the traditional learning (passive classroom teaching) may lead to passive learning, ignore individual differences and needs of the learners, and do not emphasize more on critical thinking, or other higher order thinking skills (Hannum & Briggs, 1982). Furthermore, it could not engage the learners in visualization tasks (Cairncross&Mannion, 1999; Kabouridis, 2010).For those weak learners (in term of learning engineering subjects), they may not actually benefit from the traditional teaching and learning approach, thus require alternative instructional methods to aid in their learning (Manjit et al., 2004).

3. METHODOLOGY

The main objective of this preliminary study was to find out the students' difficulties in learning mechanics dynamics both from the perspective of students and instructors. In this study the survey questionnaire was employed to collect the students' feedback. The data collection took approximately one month from 30th July 2012 to 27th August 2012. Five sections of the students who have taken the mechanics dynamics subject were invited to participate in this study. The questionnaire was prepared and administrated to the students in the hard copy form with the help from two mechanical engineering academic staffs by distributing the questionnaires to the students 15 minutes before the class ended. Short briefing was provided for the students on how to fill in the survey questionnaire. Each of the students took approximately 10 -12 minutes to complete answering the questionnaire

4. FINDINGS AND ANALYSIS

A total of 150 set of questionnaires were distributed to the students and in return, 127 respondents completed the questionnaires which showed the response rate of 84.67%. Basic statistical method (descriptive technique) was used to assess the students' responses. Through Table 1, it can be identified that 49.6% of the students expressed their perception that this is a difficult subject. Meanwhile, 42.5% of the students think that this subject is logical. However, 39.4% of the students would think that this is an interesting subject.

Table- 1. General perception about this subject

Perception	**Frequency (n=127)**	**Percentage (%)**
Difficult	63	49.6
Easy	3	2.4
Fun	27	21.3
Interesting	50	39.4
Boring	14	11
Logical	54	42.5
Of no concern to me	4	3.1

A detailed summary of students' response generally in learning mechanics dynamics is compiled and listed as shown in Table 2. Based on the 127 respondents, it can be clearly identified that more than 60% of the students agreed that the new concepts (e.g. the equation of motion, curvilinear motion, relative motion analysis, kinetic energy and etc) are the most difficult part for this course. Besides that, it was found out that approximately 40% of the students fall in the category of 'often' and 'always' when dealing with the understanding of the material in the textbook. It can also be identified that 47.3% of the students often and always try to do some exercises from the text to reinforce their problem solving techniques. Regarding the problems in understanding the contents due to the static figures shown, 26.8% of the students often faced this problem while 39.4% of the students sometime faced this problem. In general, more than 60% of the students did more or less face the problems on this issue. For the visualization problems, more than 70% of the students at least will face this issue sometimes throughout their study. In contrast, it is a good sign to find out that more than 50% of the students would find the step-by-step approach shown in the sample solutions is useful to aid their understanding. For the level of knowledge for this subject, 55.1% of the students rate their level of knowledge to be moderate.

Table- 2. Summary of students' response generally in learning mechanics dynamics

General Question	**Strongly Disagree**	**Disagree**	**Unsure**	**Agree**	**Strongly Agree**
New concepts are the most difficult part of the course. (e.g. the equation of motion, curvilinear motion, relative motion analysis, kinetic energy and etc.)	1 (0.8%)	16 (12.6%)	27 (21.3%)	66 (52%)	17 (13.4%)
Working with the textbook	**Always**	**Often**	**Sometimes**	**Seldom**	**Never**
I understand the material in the textbook.	6 (4.7%)	45 (35.4%)	50 (39.4%)	22 (17.3%)	4 (3.1%)
I try to do some of the exercises from the text to reinforce my problem-solving techniques.	11 (8.7%)	49 (38.6%)	50 (39.4%)	14 (11%)	3 (2.4%)
I have problems in understanding the contents because the figure(s) shown is/are static (no animations).	10 (7.9%)	34 (26.8%)	50 (39.4%)	24 (18.9%)	9 (7.1%)
I have problems in visualize /visualizing the scenario as described in the text.	14 (11%)	24 (18.9%)	58 (45.7%)	27 (21.3%)	4 (3.1%)
The step-by-step approach shown in the sample solutions was sufficient to aid my understanding.	28 (22%)	37 (29.1%)	51 (40.2%)	8 (6.3%)	3 (2.4%)
Knowledge level	**Very Good**	**Good**	**Moderate**	**Bad**	**Very Bad**
Overall, I think my level of knowledge for this subject is	4 (3.1%)	44 (34.6%)	70 (55.1%)	8 (6.3%)	1 (0.8%)

Problem solving ability is important in the learning process of mechanics dynamics. Table 3 provides a summary regarding the responses of students' problem solving ability in mechanics dynamics. As referred to Table 3, only 35.4% of the students fall in the category of 'always' or 'often' in clearly understand the problem. More than 50% of the students did not always clearly understand the problem that need to be solved. Regarding the ability to clearly identify the given and unknown in problem solving process, approximately 45.6% of the students can often perform while others still facing the problems on this issue. It can be identified that more than 60% of the students' response to have the ability to draw and label the diagram. However, it can also be identified that only 45.6% of the students provide responses that they can often / always think of a plan for the solution. It is interesting to further identify that only approximately 31.5% of the students often /always have the ability to provide alternative ways of solving the problem. Less than 50% of the students can often /always describe the steps that they perform while solving the problem. This is consistent with the finding that less than 50% of the students can often explain the obtained results after the problem solved. Through Table 3, it is interesting to identify that more than 75% of the students often /always preferred to use examples solved in the class as a model for solving other similar problems.

Table- 3. Summary of students' problem solving ability in mechanics dynamics

Problem Solving Ability	Always	Often	Sometimes	Seldom	Never
I clearly understand the problem.	5 (3.9%)	40 (31.5%)	69 (54.3%)	11 (8.7%)	2 (1.6%)
I can clearly identify the given and the unknown.	13 (10.2%)	45 (35.4%)	52 (41%)	17 (13.4%)	0 (0%)
I can draw and label diagram.	20 (15.7%)	62 (48.8%)	30 (23.6%)	15 (11.8%)	0 (0%)
I can think of a plan for the solution.	6 (4.7%)	52 (40.9%)	54 (42.5%)	15 (11.8%)	0 (0%)
I can see alternative ways of solving the problem.	5 (3.9%)	35 (27.6%)	58 (45.7%)	22 (17.3%)	7 (5.5%)
I can describe step by step what I did.	13 (10.2%)	45 (35.4%)	48 (37.8%)	18 (14.2%)	3 (2.4%)
I can explain the obtained results.	7 (5.5%)	50 (39.4%)	51 (40.2%)	17 (13.4%)	2 (1.6%)
I used examples solved in the class as a model for solving problems.	54 (42.5%)	43 (33.9%)	22 (17.3%)	7 (5.5%)	1 (0.8%)

Besides that, feedbacks were collected from three of the mechanical engineering instructors regarding the problems faced by students in mechanics dynamics through the short interviews performed between June to August 2012. The summary of the instructors' feedbacks on problems faced by students was compiled as shown in Table 4. It can be clearly identified that three of the instructors shared the same opinions by which they realized that the students did face the difficulties in visualization especially on the dynamic movement that involved the z-axis. Furthermore, two of the instructors also shared the same views that some of the students did not build up a strong foundation in physics and mathematics. This would lead to the difficulties in understanding of certain concepts in mechanics dynamics. One of the instructors mentioned that some of the students are too focus on how to solve the problems using formula in order to reach the final outcome without having the ability to justify the steps involved or lack the understanding about the logical flow of the solution steps. In addition, one of the instructors further identified that some of the students did not acquire a strong understanding about the importance of engineering mechanics dynamics especially the fundamental principle and knowledge, thus lead to the difficulties faced while moving into the mechanical design subjects.

Table- 4. Instructors' feedbacks on problems faced by students

Instructors	Problems faced by students
1	▪ Difficulties in visualization (need dynamic representation) ▪ Foundation in physics and mathematics not strong ▪ Lack the understanding on the purpose of study (overall picture for engineering profession)
2	▪ Low learning interest ▪ Visualization problems – due to static images and bored of discussing using the textbook. ▪ No interaction involved in the understanding of the application (engineering problems) –static representation of the image ▪ Students are too focus on how to solve the problems using formula & target for the final outcome/results (neglect the fundamental understanding on (i) formula derivation (ii) why the steps come in (lack the ability to justify the

	steps that lead to the final answer / logical flow of the solution steps) (iii) tend to memorise steps (refer to the example & do it similarly). ▪ Not aware / do not understand about the importance of engineering mechanics dynamics– and how to link all these fundamental principles & knowledge for the later application (mechanical design)
3	▪ Foundation of students especially in physics is weak ▪ Visualization problems (dynamic movement that involved x-axis, y-axis and z-axis.)

Meanwhile, the students' response on learning using the courseware was summarized as stated in Table 5. It can be identified that only 58.3% of the students aware or expose to the use of learning courseware in engineering whereas the remaining 41.7% of the students are not aware about the technologies used in learning. There are 44.1% of the students who believe that some contents can be learned faster when using a computer whereas 42.5% of the students are unsure about this. It can be identified that 44% of the students agreed and believed that they will engage in the learning by employing computer simulations while 48% of the students are unsure about this. There are only 49.6% of the students believe that the user interaction performed with the computer simulation on engineering models may enhance the learning process. Furthermore, it is interesting to find out that more than 50% of the students believed that the 2D and 3D animation on engineering model may help to support the visualization process.

Table- 5. Summary of students' response on learning using courseware

Learning courseware					
Aware of / expose to the use of learning courseware	Yes: 74 (58.3%)		No: 53 (41.7%)		
	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
I believe that some contents can be learned faster when using a computer.	2 (1.6%)	15 (11.8%)	54 (42.5%)	39 (30.7%)	17 (13.4%)
I believe I will engage in the learning with the use of /by employing computer simulations.	3 (2.4%)	7 (5.5%)	61 (48%)	44 (34.6%)	12 (9.4%)
I believe that the user interaction performed with the computer simulation on engineering models may enhance the learning process.	2 (1.6%)	7 (5.5%)	55 (43.3%)	52 (40.9%)	11 (8.7%)
I believe that the 2D animation on engineering model may support the visualization process.	3 (2.4%)	8 (6.3%)	50 (39.4%)	52 (40.9%)	14 (11%)
I believe that the 3D animation on engineering model may enhance the visualization process.	2 (1.6%)	3 (2.4%)	49 (38.6%)	50 (39.4%)	23 (18.1%)

5. DISCUSSION

The results of this preliminary study revealed that the difficulties in learning mechanics dynamics are the problems that need to be solved. This is especially referring to the visualization problems (see Table 2) that students faced throughout the process of learning. The findings on the visualization problems faced by students are consistent both from the students' response and the instructors' feedback. The visualization problems may arise due to few potential factors such as the use of text descriptions and the static representation of the figures in order to illustrate the dynamic movement of the mechanism that limit the visualization ability of the students. The use of smart information and communication technologies (ICT) such as the multimedia technologies may aid to enhance the students' visualization ability by using the interactive and animated contents representation in 2-D and 3-D. The detailed descriptions of the various smart ICT software that were developed and on-going research to support engineering education can be found in the literature (Aziz, 2011; Gao et al., 2011; Hsieh et al., 2005;). The futuristic multimedia technologies such as the virtual reality and augmented reality applications in the classroom are still at the initial stage of research and more experiments are to be explored in the current stage to see its feasibility.

Besides that, the research results also indicated that the students do face the difficulties in problem solving especially focus on the ability to justify the steps involved or the lack of understanding about the logical flow of the solution steps as shown in Table 3. The details guidance through the step-by-step approach can be provided in order to aid in the students understanding. This can be achieved through the help from the use of the smart ICT software embedded with the artificial intelligent components to guide the students following the step-by-step approach to the solution of the problem. Interaction with each of the step provided with useful hints and tips to guide the students may aid to enhance the students understanding. In addition, the smart ICT software constructed using multimedia technologies supports the characteristics by which the delivery of information (through multiple media / format), the organisation in which it is delivered and the timing of that delivery can be controlled by the user (Cairnscross&Mannion, 1999). This will give greater learning flexibility for the students especially those slow learners (in engineering learning).

Furthermore, the results of this preliminary study also indicated that there is a huge potential in utilizing the smart ICT to aid in the engineering learning for mechanics dynamics subject. As referred to Table 5, it can be identified that there are still large number of students who are unsure about the potential benefits of smart ICT in learning. Thus, further empirical research is urged to validate the potential of smart ICT in realizing the educational benefits especially in the context of engineering education for a better or revolutionized engineering learning environment.

6. CONCLUSION

Higher education institutions should be aware that it needs to achieve considerable progress as the teaching market grows.This paper presents the preliminary research study on the teaching and learning problems for the engineering in mechanics dynamics domain. The research results indicated that students faced the difficulties in learning mechanics dynamics. The utilization of smart ICT tools to facilitate the teaching and learning of mechanics dynamics are proposed. Further empirical research studies are required in order to explore the potential of smart ICT and its effectiveness in enhancing the quality of teaching and learning in the mechanics dynamics domain.

REFERENCES

Augustine, N. 2005. Rising above the gathering storm: Energizing and employing America for a brighter economic future. Washington, D.C:National Academies Press.

Aziz, E-S. 2011. Teaching and learning enhancement in undergraduate machine dynamics. Computer Applications in Engineering Education, 19(2): 244–255. Doi: 10.1002/cae.20306.

Cairncross, S. and Mannion, M. 1999. How multimedia functions in engineering. Engineering Science & Education Journal, 8(3): 100-107.

Duderstadt, J. J. 2008. Engineering for a changing world – A roadmap to the future of engineering practice, research, and education. Ann Arbor, MI: The University of Michigan.

Dobson, I. 2012. At last count: Engineering undergraduates in 21st century Australia. World Transactions on Engng. and Technol. Educ., 10(4): 253-257.

Froyd, J. E., Wankat, P. C. and Smith, K. A. 2012. Five major shifts in 100 years of engineering education. Proceedings of the IEEE, 100:1344–1360.

Gao, Z., Liu, S., Ji, M.and Liang, L. 2011. Virtual hydraulic experiments in courseware: 2D virtual circuits and 3D virtual equipments. Computer Applications in Engineering Education, 19(2): 315–326. Doi: 10.1002/cae.20313.

Hannum, W. and Briggs, L. 1982. How does instructional system design differ from traditional instruction? Educational Technology, 22(1): 9-14.

Hsieh, S. H., Chen, C. S. and Lu, C. C. 2005. Interactive tutoring components for engineering dynamics. In S.-H.Ou (Ed.), Proceedings of the ICEER-2005 INEER Conference for Engineering Education and Research [CD]. Tainan, Taiwan: International Network for Engineering Education and Research (iNEER).

Kabouridis, G. 2010. An innovative approach to face the first-year mechanical engineering students' conceptual difficulties in engineering design. Proceedings of 1st WIETE Annual Conference on Engineering and Technology Education (pp. 110-113). Retrieved from www.wiete.com.au/conferences/1st_wiete/20-05-Kabouridis.pdf

ManjitSidhu, S., Ramesh, S. and Selvanathan, N. 2004. The multimedia approach in visualizing engineering concept. International Journal of Computing & Information Science, 2(3): 129-136.

ManjitSidhu, S. 2006. Development and applications of interactive multimedia TAPS (Technology Assisted Problem Solving) packages for engineering (Doctoral dissertation). University Malaya, Malaysia.

Mills, J. and Treagust, D. 2003. Engineering education—Is problem-based or project-based learning the answer? Australasian Journal of Engineering Education. Retrieved from http://www.aaee.com.au/journal/2003/mills_treagust03.pdf

National Science Board, 2007. Moving forward to improve engineering education (NSB-07-122). Retrieved from www.nsf.gov/pubs/2007/nsb07122/nsb07122.pdf

Prados, J. W. 1998. Action agenda for systematic engineering education reform: Next steps. Conference on Realizing the New Paradigm for Engineering Education, Engineering Foundation Conference. pp: 1–13.

Wince-smith, D. 2005.Innovate America : Thriving in a world of challenge and change. Global Innovation Ecosystem 2007 Symposium. Pp: 1-12. Retrieved from http://crds.jst.go.jp/GIES/ archive/GIES2007/en/symposium/materials/summary/Summary_DWS.pdf