ICER 2013

The 6th International Conference on Educational Research: Challenging Education for Future Change

ICER2013

13-14 September, 2013

Faculty of Education, Khon Kaen University, Thailand

Khon Kaen University

Faculty of Education

The Hong Kong Institute of Education, China

Thailand Education Dean Council

16 Ed. DEANS

The Consortium of Sixteen Education Dean (Group 16), Thailand

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September 13-14, 2013

Refer to the ICER conference handbook (abstract only)
ISBN: 978-616-223-307-4
Klang Nana Wittaya, Khon Kaen, THAILAND

CIP of ICER conference handbook
National Library of Thailand Cataloging in Publication Data

Faculty of Education Khon Kaen University.
ICER 2013: The 6th International Conference on Educational Research: Challenging Education for Future Change.--: Faculty of Education Khon Kaen University, 2013.
320.
1. Educational Science -- Conference. 2. Education -- Research -- Conference. I. Title.

ISBN: 978-616-223-307-4

Message from the Dean
Faculty of Education Khon Kaen University, THAILAND

Greeting to all participants and welcome to Faculty of Education, Khon Kaen University

The International Conference on Educational Research (ICER) 2013: *Challenging Education for Future Change* is the 6th annual conference to celebrate the 45th anniversary of the establishment of Faculty of Education, Khon Kaen University. The ICER 2013 is jointly organized by the Faculty of Education, Khon Kaen University of Thailand, The Hong Kong Institute of Education of China, Thailand Education Deans Council and the Consortium of Sixteen Education Dean of Thailand (Group 16).

The goals of this conference are to give international educators the opportunity to share ideas and form networks while working together on challenging education for future change. It is anticipated that the exchange of ideas and research findings will contribute greatly to future generations.

During the ICER 2013 event, the APEC-Khon Kaen International Symposium 2013 with its theme "*Innovation of Mathematics Education through Lesson Study - Challenging from Mathematics Education to Emergency Preparedness Education*" is also held at the Faculty of Education starting from September 13 to September 16, 2013. So the two events will share the plenary sessions during the first two days of APEC symposium.

On behalf of the Faculty of Education, Khon Kaen University, I would like to express my gratitude and my sincere appreciation to our co-host institutions, the guest speakers and the organizing committees for their efforts. I also would like to thank all delegations and participants who come from afar to join this event.

I hope the prosperous education will not stop developing as far as the network we form is concerned. The pace of growing should move through the fast changing world as we all expected.

Maitree Inprasitha

(Assistant Professor Maitree Inprasitha, Ph.D.)
Dean, Faculty of Education
Khon Kaen University
THAILAND

Message from Co-host
The Hong Kong Institute of Education (HKIEd)

The Hong Kong Institute of Education is a multidisciplinary education focussed institution with a strong research emphasis. It has a growing international reputation for excellence in preparing globally aware professional educators, providing culturally enriched educational experiences, and producing research of distinction. Central to the Institute's values is a commitment to developing international and regional networks that will facilitate the integration of intercultural and global dimensions into its teaching, learning, and research.

At HKIEd we particularly value collaborative research with international partners. We seek to understand better the contexts that influence people in the Asia Pacific region and to identify ways of improving social outcomes for all. We see international partnerships as important opportunities for enhancing the impact of our research.

HKIEd is proud to join with Khon Kaen University to co-host the 2013 International Conference on Educational Research.

(Professor Allan Walker)
Joseph Lau Chair Professor of International Educational Leadership
Dean, Faculty of Education and Human Development
The Hong Kong Institute of Education
HONG KONG SAR
People's Republic of China

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The Effect of Inquiry-based Learning Environment on Undergraduate Mechanical Technology Students' Achievement in Mechanical Engineering Design Course

Weerayute Sudsomboon[1] *(weerayute_sud@nstru.ac.th)*

Abstract
This study investigated the effects of using an inquiry-based learning environment (IBL) on the undergraduate mechanical technology students' achievements at Faculty of Industrial Technology, Nakhon Si Thammarat Rajabhat University in failure theories of 5592103 mechanical engineering design course. Two groups of undergraduate mechanical technology students in the semester 1/2013 were selected for this study: an experimental group composed of 18 students; and a control group composed of 16 students. The students in the experimental group taught with an IBL, while the students in the control group received lecture-based direct instruction. An achievement test was administered as pre-test and post-test in both groups. The results showed that the *t*-tests did not provide sufficient evidence for a difference in the mean achievement for 3 categories in failure theories were maximum normal stress theory, maximum shear stress theory and distortion energy theory of mechanical elements. Moreover, students in the experimental group showed greater scores toward learning mechanical elements compared to those in the control group whom often showed lack of interest and challenges. Thus, students' comments during lessons and tests were more accurate and advanced in the experimental group as they engage more in the IBL.

Keywords: *Inquiry-based Learning Environment, Engineering Education, Mechanical Engineering Design, Students' Achievement*

Introduction

Students' achievement in Mechanical Engineering Design (MED) is a professional competency of undergraduates. Students' as technologist is prepared to engage in career practice for real-world situations. The MED course has an obligation to promote learning innovation as cognitive development. Therefore, the inquiry-based learning environment (IBL) has selected to be guided for promoting the undergraduate mechanical technology students' achievements at Faculty of Industrial Technology, Nakhon Si Thammarat Rajabhat University in failure theories of 5592103 mechanical engineering design course. As well as, the constructivist pedagogical approaches have emerged in the recent past. The shift of potential alternatives to traditional approach as cognitive development could be established in higher education.

Shigley, Mischke, & Budynas (2008) explained "learn about failure can mean a part has separated into two or more pieces; has become permanently distorted, thus ruining its geometry; has had its reliability downgraded; or has had its function compromised, whatever the reason". The development of logical thinking abilities, spatial intuition about the real-world (Vygotsky, 1978), knowledge needed to study more mechanical engineering areas, and skills in the solving and interpretation of mechanical engineering design solutions. Researcher prepares students' to face professional theory-to-practice competencies, which IBL can promote learning environment in a highly mechanical engineering.

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The theme "students as technovators" come to the fore with its representations of educational scenarios on mechanical engineering design course with inquiry-based learning environment (IBL). With development, teaching methods must be shifted from lecture-based towards student-cantered approaches. The traditional teaching at FIT, NSTRU has not therefore become constructivist pedagogies in a sense that students are provided opportunity to carry out investigations to create their ideas and construct their own knowledge, making inquiries as technologist.

Thus, on exploration of the new learning innovation in technology, instructional activities and learning strategies do not generate IBL where students can create their own inquiries. IBL approaches have more effective in promoting students to acquire engineering process skills. When students' engaging in solving the problems, students can describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and share their ideas with others based on IBL deals. Their assumptions use critical and logical thinking, and consider alternative explanations (Scanlon, Anastopoulou, & Kerawalla, 2012).

In this reason, students actively develop their cognitive domain of engineering by combining science, technology, engineering and mathematics knowledge with reasoning and thinking skills (Jones, Blake, & Petrou, 2012). This study was therefore developed in order to teach students as technovators based on IBL strategies could be conducted and evaluated with the aims of promoting conceptual understanding of failure theories for supporting mechanical engineering design course.

Review of Literature

Theoretical framework

IBL is a natural human activity in which the learner obtains meaning from experience. Traditionally, inquiry has been most readily associated with the sciences, yet it has been employed in many other fields of study as well (Martinello, 1998). According to Beetham and Sharpe (2007), explained "how creative people in the arts and sciences recall their ways of thinking, whether implicit or implied, specific or general, all inquiries are driven by questions, issues, and wonderings". IBL is conceptualized as asks students' relevant questions that adapt from the higher levels of Bloom's Taxonomy, which are comprehension, application and analysis (Bloom, 1956).

Although, these are only different types of possible meta-cognition, when the questions teachers ask are classified, they become even more significant as the teacher moulds the learning environment and expectations. IBL environment involves questions that are interesting and motivating to students. Real life forever poses problems newer and more complex problems. By guiding students through those same scenarios researcher facilitate them to solve problems in a IBL environment.

Conceptual framework

Therefore, questions are at the heart of inquiry. According to Wolf (1987), researcher applied the IBL model are five major types:

1. *Inference question* is conceptualized as students take immediately information (i.e., knowledge acquisition and previous experience). In this study, students searched the research via electronic database, and application, analyze and discuss previous experience as whole as: physic, engineering materials, engineering statics, mechanics of solids, and mechanical engineering design.

2. *Interpretation question* is conceptualized as inference questions demand that students fill in missing mathematic information (i.e., vector representation, linear equation system, matrix, and determinant)
3. *Transfer question* is conceptualized as a student to solve; therefore, transfer questions provoke a kind of breadth of thinking, asking students to take their steps of maximum normal stress theory, maximum shear stress theory and distortion energy theory of mechanical elements.
4. *Hypotheses* are conceptualized as questions about prediction and hypothesis are associated with the sciences, technology, engineering and mathematics. As well as, they can also be employed when solving the problems.
5. *Reflective* is conceptualized as reflective questions and evaluation of the solutions.

There is caution against interpreting steps in the all being necessary or in any necessary rigid order. Additionally, IBL is not as much characterized by a series of steps for learning; it is by situated learning (Lave & Wenger, 1990). This is a new feature describing how learning happens as a function of the achievement, authentic and immediate in which it increases, rather than through decontextualized knowledge representation. The inquiry process is driven by one's own curiosity, wonder, interest, or passion to understand an observation or solve a problem.

Purpose of the Study

The purpose of this study investigated the effects of using an inquiry-based learning environment (IBL) on the undergraduate mechanical technology students' achievements at Faculty of Industrial Technology, Nakhon Si Thammarat Rajabhat University in failure theories of 5592103 mechanical engineering design course compared to traditional direct instruction.

More specifically, the research question that guided the study was as follows: What was the effect of using the IBL model with traditional lectures in failure theories together on the student's achievement? Understanding of maximum normal stress theory, maximum shear stress theory and distortion energy theory of mechanical elements (Shigley, Mischke, & Budynas; 2008) compared to teaching with traditional direct instruction in this study.

Methods

Participants

The participants of this study were 34 undergraduate mechanical technology students' achievements at Faculty of Industrial Technology, Nakhon Si Thammarat Rajabhat University. In doing so, the aim was not only to have equal number of students in groups but also have groups with similar general mechanical engineering design ability. As a result, the experimental group consisted of 18 students. The control group consisted of 16 students.

Instrumentation

The IBL model was employed in the experimental group. The 35-items pre-test and post-test were assessed by an objective test developed by the researcher. The 10-items each 3 categories test which were selected from the Shigley's mechanical engineering design text book (2008) in the failure theories included: maximum normal stress theory, maximum shear stress theory and distortion energy theory as shown in Figure 1. The score ranged 1 point for each right answer, and 0 points for each wrong answer. The content validity was established by five instructors of teaching in mechanical engineering area. The overall reliability of the

pre-test and post-test instrument measured Cronbach alpha reliabilities (α) KR-20 is 0.82. The means, standard deviations, and Cronbach alpha reliabilities KR-20 for the test in the failure theories is shown in Table 1.

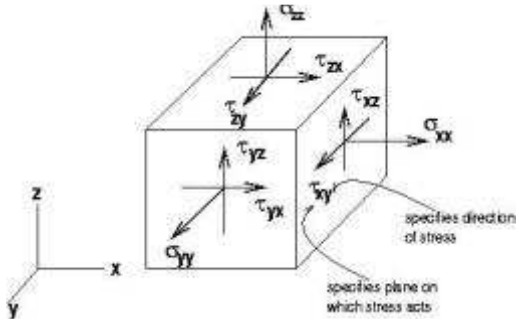

Figure 1 The failure theories on machine elements
http://www.me.umn.edu/courses/old_me_course_pages/me3221-sum/Overviews/FailureTheories

Data collection

The experimental group was set aside controlled by IBL environment for students to reflect on their learning achievement and make entries in their international journals via electronic database (e.g., Sciencedirect, Taylor & Francis, and academic journal area) evaluating individual performance. The control group received traditional lectures throughout the semester on the same content areas. Students had opportunities to ask questions and use reference books and teaching materials, and these were also used by the experimental group.

Pre-test and post-test assessments were made by multiple-choice examinations for both groups based on the solving procedures as shown in Figure 2. Pre-tests were conducted one day before the content offering; both groups completed the test in the failure theories: maximum normal stress theory, maximum shear stress theory and distortion energy theory (Shigley, Mischke, & Budynas, 2008) during a week before the midterm examination in 1/2013.

Data analysis

Data were analyzed by using SPSS, and the level of significance was set at .05 for all tests. The effect of the experiment was tested by *t*-test independent.

Results

What was the effect of using the IBL model with traditional lectures in failure theories together on the student's achievement?

Table 1 Means, standard deviations, and Cronbach alpha reliabilities KR-20 for the test in the failure theories

Variables	Mean	SD	Alpha
Maximum normal stress theory	4.27	0.55	0.92
Maximum shear stress theory	4.04	0.72	0.85
Distortion energy theory	4.16	0.77	0.88

In Table 1, reliabilities were sufficiently high for each of the scales. Data showed that the failure theories: maximum normal stress theory, maximum shear stress theory and distortion energy theory were indicated of the experts, had at high level of the items test.

Table 2 The overall independent *t*-test of pre-test and post-test of the experimental and control groups

Test	Group	N	Mean	SD
Pre-test	Experimental group	18	13.43	3.46
	Control group	16	12.07	4.95
Post-test	Experimental group	18	20.06	2.49
	Control group	16	16.33	3.32

* p <.05

Table 3 The independent *t*-test of pre-test and post-test of the experimental and control groups in 3 categories

Test	Maximum normal stress theory	N	Mean	SD	*t*	*p*
Pre-test	Experimental group	18	4.94	2.87	-1.049	.066
	Control group	16	3.21	3.56		
Post-test	Experimental group	18	8.03	2.49	-1.406	.085
	Control group	16	5.17	3.32		

* p <.05

Test	Maximum shear stress theory	N	Mean	SD	*t*	*p*
Pre-test	Experimental group	18	5.16	4.90	-2.582	.186
	Control group	16	4.83	5.11		
Post-test	Experimental group	18	7.86	5.86	-2.733	.179
	Control group	16	5.59	6.36		

* p <.05

Test	Distortion theory	N	Mean	SD	*t*	*p*
Pre-test	Experimental group	18	6.48	2.20	-2.002	.106
	Control group	16	6.06	2.39		
Post-test	Experimental group	18	7.19	3.14	-2.267	.092
	Control group	16	6.82	3.51		

* p <.05

The *t*-tests did not provide sufficient evidence for a difference in the mean achievement for 3 categories: maximum normal stress theory (p = .066; p = .082), maximum shear stress theory (p = .186; p = .175) and distortion energy theory (p = .106; p = .092), see also Table 3.

Discussion

Both IBL and the traditional lectures scored themselves in a difference value in 3 categories, a finding is similar to those of several studies. This is significant as it suggests students' achievement and/or teaching methods employed in failure theories of 5592103 mechanical engineering design course. IBL environment employed as follow as static failure algorithms in Figure 2, which were comprehension in stresses, application to compute in-plane principal stresses, analysis von Mises theory with Coulomb-Mohr and Modified Mohr and discuss the factor safety for decision making in machine elements. The traditional lectures also employed in IBL.

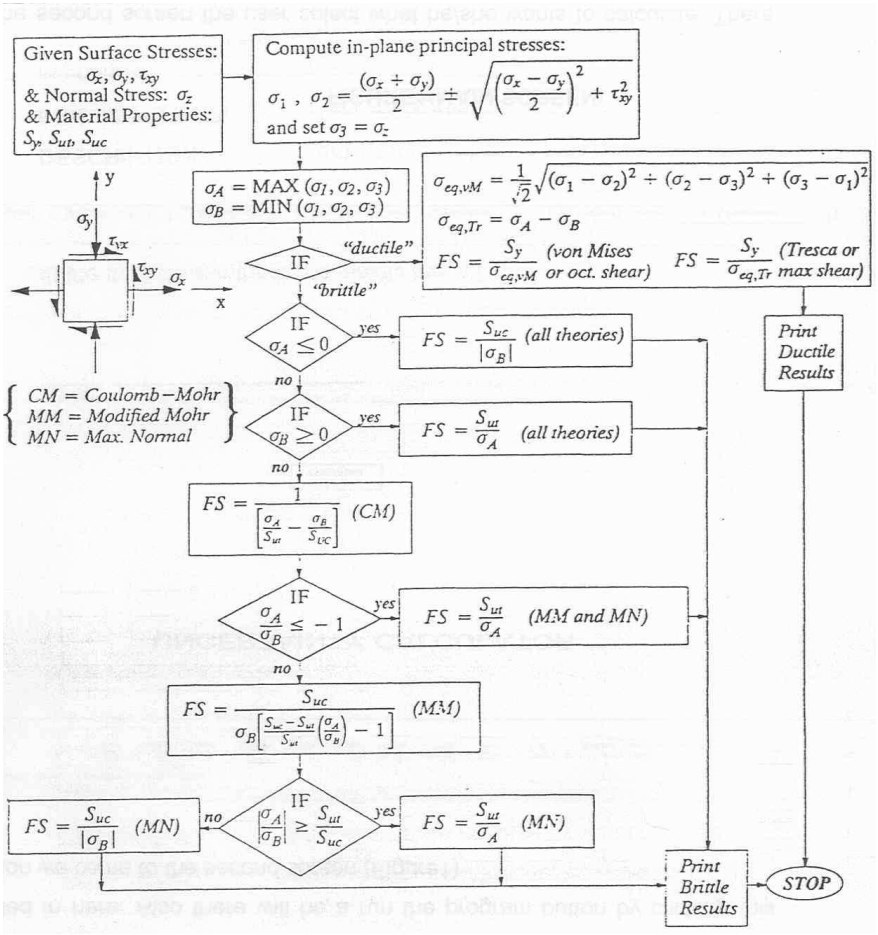

Figure 2 Static failure algorithms
http://www.me.metu.edu.tr/courses/me307/useful_info.htm

The results from Table 2 discussed did not provide sufficient evidence for a difference in the mean achievement. Because of the lack of the knowledge in engineering; for example, physic, engineering materials, engineering statics, mechanics of solids, and mechanical engineering design. Students' disable to link and apply these subjects to solve problem. Furthermore, the assessment of achievement continues to be a key foster in the IBL model literature, and should be studied with the mechanical engineering laboratory subject.

The finding of both group recommended more exposure to valid the learning innovation for computational procedure in mechanical engineering design in five major types of questions: inference questions, interpretation questions, transfer questions, and questions about hypothesis (Keselman, 2003). IBL environment proposed that a combination of IBL and the traditional lectures would foster a better learning opportunities of the achievement required of undergraduates mechanical technology, the traditional lectures focused on real life scenarios and lack opportunities in the self-directed learning from a mechanical engineering design perspective.

As a result, IBL environment noted the self-directed learning was encouraged through individual potentially, integrated information technology, and use of a combination approach to problem solving. The study was encouraged students' problem solving provides the purpose for learning, frames the learning process, and drives all learning.

Conclusion

Students' in IBL gained more achievement and were more promoted for learning than those in the control group. No statistically significant difference was found in 3 categories toward learning in both groups. In addition, this study proposed the skills and abilities of the learning innovation for computational procedure in mechanical engineering design of critical thinking, self-directed learning, and problem-solving through the IBL environment as key in enabling them to meet challenging of maximum normal stress theory, maximum shear stress theory and distortion energy theory of mechanical elements.

A limitation of using a PBL environment is the small number of previous potential subjects who actually study and experience the inference questions demand that students fill in missing information, and then propose that they understand the consequences of information and ideas. There are five major types of questions: inference questions, interpretation questions, transfer questions, and questions about hypothesis is employed the correlation and regression analysis suggest in the future research.

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