การศึกษาผลสัมฤทธิ์การเรียนรู้ด้วยการจัดสภาพแวดล้อมการเรียนรู้แบบสืบค้น สำหรับรายวิชาการออกแบบเครื่องจักรกล 1

วีระยุทธ สุดสมบูรณ์*

บทคัดย่อ

การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อ 1) ศึกษาผลสัมฤทธิ์การเรียนรู้ด้วยการจัดสภาพแวดล้อมการเรียนรู้แบบสืบค้นของนักศึกษาระดับปริญญาตรีสาขาเทคโนโลยีเครื่องกล คณะเทคโนโลยีอุตสาหกรรม มหาวิทยาลัยราชภัฏนครศรีธรรมราช ในหัวข้อทฤษฎีความเสียหาย รายวิชา 5592103 การออกแบบเครื่องจักรกล โดยเปรียบเทียบกับการเรียนรู้แบบปกติ และ 2) เพื่อศึกษาความคิดเห็นของผู้เรียนที่มีต่อการจัดการเรียนรู้ในการทดลองครั้งนี้ กลุ่มตัวอย่างที่ใช้ในการวิจัยครั้งนี้ ประกอบด้วย นักศึกษากลุ่มทดลอง จำนวน 18 คน และนักศึกษากลุ่มควบคุม จำนวน 16 คน ภาคการศึกษาที่ 1/2556 สาขาวิชาเทคโนโลยีเครื่องกล คณะเทคโนโลยีอุตสาหกรรม มหาวิทยาลัยราชภัฏนครศรีธรรมราช การออกแบบการวิจัยเป็นแบบกลุ่มเดียวทำแบบทดสอบก่อนและหลังเรียน โดยให้กลุ่มทดลองทำการเรียนรู้ด้วยการการจัดสภาพแวดล้อมการเรียนรู้แบบสืบค้นและกลุ่มควบคุมเรียนรู้แบบปกติ เครื่องมือที่ใช้ในการวิจัยสำหรับกลุ่มทดลองคือ การให้ผู้เรียนสืบค้นบทความวิจัยที่เกี่ยวข้องกับทฤษฎีความเสียหายจากฐานข้อมูลงานวิจัยอิเล็กทรอนิกส์ชั้นนำ แล้วทำการสรุปประเด็นตามกรอบแนวคิดทางทฤษฎี สำหรับกลุ่มควบคุมให้เรียนตามแบบปกติ เครื่องมือที่ใช้ในการเก็บข้อมูล ได้แก่ แบบทดสอบก่อนเรียนและหลังเรียน และแบบสอบถามความคิดเห็นแบบ 5 ระดับ สถิติที่ใช้ในการเปรียบเทียบ คือ ค่าเฉลี่ย ส่วนเบี่ยงเบนมาตรฐาน และการทดสอบค่าที ผลของการวิจัยพบว่า คะแนนเฉลี่ยของกลุ่มทดลองและกลุ่มควบคุมไม่มีความแตกต่างอย่างมีนัยสำคัญทั้ง 3 ด้าน ของทฤษฎีความเสียหายพบว่า การเรียนรู้โดยเน้นการสร้างองค์ความรู้และการนำเสนอความรู้มีค่าเฉลี่ยสูงสุด นอกเหนือจากนั้นยังพบว่าผู้เรียนในกลุ่มทดลองมีคะแนนเฉลี่ยสูงกว่ากลุ่มควบคุมในทุกด้านของการทดลอง สำหรับความคิดเห็นของผู้เรียนที่มีต่อการจัดสภาพแวดล้อมการเรียนรู้ในการทดลองครั้งนี้อยู่ในระดับสูงสุด และผลจากการวิจัยในครั้งนี้สามารถนำไปประยุกต์ใช้สภาพการเรียนรู้แบบสืบค้นสำหรับผู้เรียนทางเทคโนโลยีอุตสาหกรรม

คำสำคัญ: สภาพแวดล้อมการเรียนรู้แบบสืบค้น วิศวกรรมศึกษา การออกแบบทางวิศวกรรมเครื่องกล ผลสัมฤทธิ์การเรียนรู้

* อาจารย์ หลักสูตรครุศาสตรมหาบัณฑิต สาขาวิชาเทคโนโลยีอุตสาหกรรม คณะเทคโนโลยีอุตสาหกรรม มหาวิทยาลัยราชภัฏ นครศรีธรรมราช
โทร. 0-75377-439, 08-9477-6487 อีเมล: weerayute_sud@nstru.ac.th

Effects of an Inquiry-based Learning Environment on Students' Achievement for Machine Design I Course

Weerayute Sudsomboon*

Abstract

The purposes of this study were: 1) to investigate the effects of using an inquiry-based learning environment on the undergraduate mechanical technology students' achievements at Faculty of Industrial Technology, Nakhon Si Thammarat Rajabhat University in failure theories of 5592103 Machine Design I course compared to traditional lectures; and 2) to survey students' attitudes in this study. The sample was selected for this study: an experimental group composed of 18 students; and a control group composed of 16 students in the semester 1/2013 at the Mechanical Technology Program, Faculty of Industrial Technology, Nakhon Si Thammarat Rajabhat University. The one-group pre-test and post-test was employed in this study. Students in the experimental group taught with an inquiry-based learning environment, while the students in the control group received lecture-based direct instruction. The instrumentation consisted of 35-items pre-test and post-test were assessed by an objective test developed by the researcher. The attitude was collected by a questionnaire by using the five rating scales for both groups. Data were analyzed by means, standard deviation and *t*-test independent. The results showed that the *t*-test did not provide sufficient evidence for a difference for 3 categories in the failure theories learning achievement. The attitude item appeared on the students' were obtained highest scores in cognitive domain and knowledge applications. Moreover, students in the experimental group showed greater scores toward learning in failure theories 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 an inquiry-based learning environment.

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

* Lecturer, Graduate Program in Industrial Technology, Faculty of Industrial Technology, Nakhon Si Thammarat Rajabhat University Tel. 0-75377-439, 08-9477-6487 E-mail: Weerayute_sud@nstru.ac.th

1. Introduction

Students' achievement is believed to be important in the academic mechanical engineering education setting because it is increasingly associated with the career professional technologist for real-world competitive advantage. By examining the previous teaching experience of researcher between cognitive domain and instructional approaches, researcher reviewed the research of Arzarello, Olivero, Paola, and Robutti [1] that stated essential cognitive domain for science, technology and engineering education.

That achieving enhanced sets of the teacher moulds the learning environment and expectations: consequently; comprehension, application and analysis. In the following, Anderson [2], [3] described their approach emphasized the active learning and the pararellels constructivist pedagogies have been efficiently learning approach implemented. The approach is Inquiry-Based Learning environment (IBL) [4], [5]. The IBL environment has selected to be guided for promoting the undergraduate mechanical technology students' achievements at Faculty of Industrial Technology (FIT), Nakhon Si Thammarat Rajabhat University (NSTRU) in the failure theories topic of 5592103 Machine Design I course.

As well as, the IBL environment have emerged in the currently. The shift of potential alternatives to traditional approach as cognitive domain development could be established in higher education. More recently, Shigley, Mischke, & Budynas [6] 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" (p. 211).

The development of logical thinking abilities, spatial intuition about the real-world [7], knowledge needed to study more science, technology, and engineering areas, and skills in the solving and interpretation of mechanical engineering design solutions. Researcher prepares students' to face professional theory-to-practice learning environment, which IBL environment can promote its applications in a highly academic mechanical engineering education.

The theme "students as technovators" come to the fore with its representations of educational scenarios with the IBL environment. 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 learning environment where students can create their own inquiries. The IBL environment has more effective in promoting students to acquire cognitive domain. 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 the IBL deals. Their assumptions use critical and logical thinking, and consider alternative explanations [8].

In this reason, students actively develop their cognitive domain of engineering by combining science, technology, and mathematics knowledge with reasoning and thinking skills [5]. This study was therefore developed in order to teach students as technovators based on the IBL environment could be conducted and evaluated with the aims of promoting conceptual understanding of the failure theories for supporting machine design course.

2. Review of Literature

2.1 Theoretical framework

The 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 [8]. According to Beetham and Sharpe [9], 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". Then, the IBL environment is conceptualized as asks students' relevant questions that adapt from the higher levels of Bloom's Taxonomy, which are comprehension, application and analysis [10].

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 expectations. The 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 the machine design problems.

This 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 we allow them to learn to solve problems in a supported environment with the help of their peers and their instructors [9]. The researcher plays the role as guide or facilitator. Conole [11] addressed educators' uses their expertise to guide the inquiry lesson, and constantly evaluating the progress of the students and the direction the inquiry process is taking.

2.2 Conceptual framework

Therefore, questions are at the heart of inquiry. The IBL environment model in this study proposed a continuing cycle or spiral of inquiry [12], [13] as shown in Figure 1

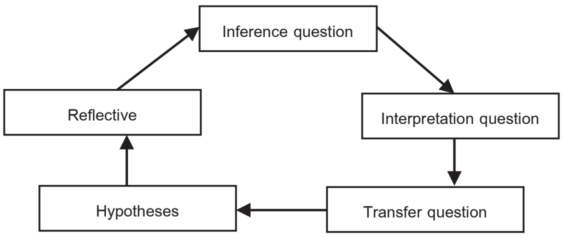

Figure 1 The IBL environment model

The researcher applied the IBL environment 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 conceptualizedas 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 [14].

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.

3. Purposes of the Study

The purposes of this study were: 1) to investigate the effects of using an inquiry-based learning environment on the undergraduate mechanical technology students' achievements at Faculty of Industrial Technology, Nakhon Si Thammarat Rajabhat University in failure theories of 5592103 Machine Design I course compared to traditional direct instruction; and 2) to survey attitudes toward machine design course.

More specifically, the research question that guided the study was as follows: 1) What was the effect of using the IBL environment and traditional lectures in failure theories together on the student's achievement?; 2) How do students attitudes the effect of using the IBL environment with traditional lectures in the failure theories together?

Understanding of maximum normal stress theory, maximum shear stress theory and distortion energy theory of mechanical elements [4] compared to teaching with traditional lectures in this study.

4. Methods

4.1 Sample

The participants of this study were 35 undergraduate mechanical technology students achievement at the Mechanical Technology Program, Faculty of Industrial Technology at Nakhon Si Thammarat Rajabhat University.

In doing so, the aim was not only to have equal number of students in groups, because of students' have failed in the preliminary test. Hence, the actual participants were 34 undergraduate mechanical technology students. As a result, the experimental group consisted of 18 students. The control group consisted of 16 students.

4.2 Procedure

On their prior knowledge of the failure theories, were the maximum normal stress theory, the maximum shear stress theory and the distortion energy theory of mechanical elements. This test was from the Shigley's Mechanical Engineering Design (8^{th} edition) [6] used.

The IBL environment 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 [6] in the failure theories included: maximum normal stress theory, maximum shear stress theory and distortion energy theory as shown in Figure 2.

4.3 Instrumentation

The experimental group was set aside controlled by the IBL environment for students to reflect on their learning achievement and make entries in their international journals via electronic stress theory, maximum shear stress theory and distortion energy theory [4] during a week before the midterm examination in 1/2013.
database (e.g., Sciencedirect, Taylor & Francis, and academic journal area) evaluating individual performance.

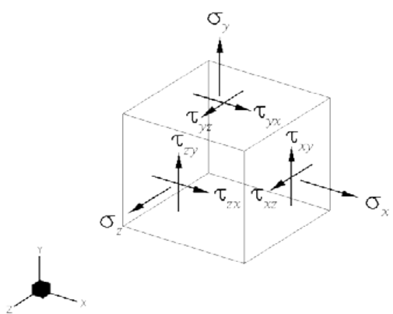

Figure 2 The failure theories on machine elements

The control group received traditional lectures throughout the semester 1/2013 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.

4.4 Data Collection

The 3 categories prior to the start of the study were administered. The item tests were brittle materials (fracture criteria): 1) Maximum normal stress; 2) Brittle Coulomb-Mohr; and 3) Modified Mohr. 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

Two achievement tests were administered. The score ranged 1 point for each right answer, and 0 points for each wrong answer. The content validity was established by five lecturers of teaching in mechanical engineering area from other universities. 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.

The attitude was adapted from Vygotsky [7] and modifying a questionnaire 20 items by using the five rating scales for both groups. The reliability of this attitude, as estimated by Cronbach's alpha, was .94.

4.5 Data Analysis

Data were analyzed by means, standard deviation. Using SPSS for processing and the level of significance was set at .05 for all tests. The effect was tested by *t*-test independent.

5. Results

5.1 What was the effect of using the IBL environment model and 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	18	13.43	3.46
	Control	16	12.07	4.95
Post-test	Experimental	18	20.06	2.49
	Control	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 the maximum normal stress theory

Test	Group	*n*	*Mean*	*SD*	*t*	*p*
Pre-test	Experimental	18	4.94	2.87	-1.049	.066
	Control	16	3.21	3.56		
Post-test	Experimental	18	8.03	2.49	-1.406	.085
	Control	16	5.17	3.32		

* p <.05

Table 4 The independent *t*-test of pre-test and post-test of the experimental and control groups in the maximum shear stress theory

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

* p <.05

Table 5 The independent *t*-test of pre-test and post-test of the experimental and control groups in the distortion theory

Test	Group	N	Mean	SD	*t*	*p*
Pre-test	Experimental	18	6.48	2.20	-2.002	.106
	Control	16	6.06	2.39		
Post-test	Experimental	18	7.19	3.14	-2.267	.092
	Control	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 = .179) and distortion energy theory (p = .106; p = .092), see also Table 3-5.

5.2 How do students attitudes the effect of using the IBL model with traditional lectures in failure theories together?

Table 6 Students' attitudes

Item	*Mean*	*SD*	*Rank*
1. Cognitive domain	4.64	0.44	highest
2. Knowledge Applications	4.83	0.39	highest
3. Problem-solving skills	4.26	0.58	high
4. Learning approach	4.35	0.51	high
Average	4.52	0.48	highest

In Table 6, students' has been provided attitudes on the effect of using the IBL model and traditional lectures in failure theories together was at the highest level.

6. Discussion

Both IBL environment 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 Machine Design I course. Students noted that strength was a property or characteristic of a mechanical element.

In auditioning to solving the strength of machine elements in the IBL environment, students must rearrange the failure resulting from static loading. Researcher has established the step by step to consider the relations between strength and static loading in order to do the design of machine elements. The step by step has the following:

Step 1 Consideration of static strength and stress concentration. Students proposed the knowledge representation to compute plane stress as shown in Figure 2.

Step 2 Students are concerned with the plane stresses σ and shear stresses τ that act on the oblique plane. Afterward summarized all the stress component to zero, the stresses σ and τ are found to be

$$\sigma_1, \sigma_2 = \frac{\left(\sigma_x + \sigma_y\right)}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau^2{}_{xy}}$$

and set $\sigma_3 = \sigma_z$ (1)

In a similar equation the two extreme-value shear stresses are inference and interpretation questions found to be

$$\tau_1, \tau_2 = \pm\sqrt{\frac{\left(\sigma_x - \sigma_y\right)^2}{2} + \tau^2{}_{xy}} \qquad (2)$$

Step 3 Transfer questions are employed by failure theories. Students can be chose the generally accepted theories as follow as:

Ductile materials (Yield criteria)

- Maximum shear stress
- Distortion energy
- Ductile Coulomb-Mohr

Brittle materials (Fracture criteria)

- Maximum normal stress
- Brittle Coulomb-Mohr
- Modified Mohr

Step 4 The hypotheses are generated knowledge construction through their international journals via electronic database (e.g., Sciencedirect, Taylor & Francis, and academic journal area) evaluating individual performance. The distortion-energy theory is also conducted:

- The von Mises theory
- The shear-energy theory
- The octahedral-shear-stress theory

Step 5 Students considered the coordinate transformations the octahedral shear stress is solved by

$$\tau_{oct} = \frac{1}{3}\left[(\sigma_1 \quad \sigma_2)^2 + (\sigma_2 \quad \sigma_3)^2 + (\sigma_3 \quad \sigma_1)^2\right]^{1/2} \qquad (3)$$

The result is reflective.

Students have been computed as comprehension learning 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 design of machine elements.

The results research finding from Table 2 discussed did not provide sufficient evidence for a difference in the mean achievement. First, they had not been searched to find the international journals. To make sure they understand the feedback, they were required to teach their first inquiry the international journals via electronic database (e.g., Sciencedirect, Taylor & Francis, and academic journal area) evaluating individual performance.

Second, the causes of the lack of the engineering knowledge background: for example; physic, engineering drawing, engineering materials, engineering statics and dynamics, and mechanics of solids. 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 environment model literature, and should be studied with the mechanical engineering laboratory subject.

The research 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 [15].

The IBL environment proposed that both combination of the 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 [5].

The attitude item appeared on the post-test only was administered to the both groups. It asks the students who were taught with an IBL environment and the traditional lecturers which they preferred to test. Students' were obtained the highest scores in cognitive domain and knowledge application. Because of the IBL learning environment noted the self-directed learning was encouraged through individual potentially, integrated information technology, and use of a combination approach to problem solving [9]. The study was encouraged students' problem solving provides the purpose for learning, frames the learning process, and drives all learning.

7. Conclusion

Students' in the IBL environment 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 machine design I course.

A limitation of using an IBL 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 question, interpretation question, transfer question, questions about hypothesis, and reflective is employed the correlation and regression analysis suggest in the future research.

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9. References

[1] Arzarello, F., Olivero, F., Paola, D., & Robutti, O. (2002). A cognitive analysis of dragging practices in dynamic geometry environments. *International Reviews on Mathematical Education, 34*(3), 66–72.

[2] Anderson, R. D. & Pratt, H. (1995). *Local Leadership for Science Education Reform*. Dubuque, IA: Kendall/Hunt.

[3] Anderson, R. D. (1999). Inquiry in the everyday world of schools. *Focus: a magazine for classroom innovators (special issue)*, *6*(2).

[4] Jones, A., Blake, C., & Petrou, M. (2012). Inquiry learning in semi-formal contexts. In K. Littleton, E. Scanlon, & M. Sharples (Eds.), Orchestrating inquiry learning. Routledge Keselman, A. (2003). Supporting inquiry learning by promoting normative understanding of multivariable causality. *Journal of Research in Science Teaching, 40*(9), 898–921.

[5] Scanlon, E., Anastopoulou, S., & Kerawalla, L. (2012). Inquiry learning reconsidered: contexts, representations and challenges. In K. Littleton, E. Scanlon, & M. Sharples (Eds.), Orchestrating Inquiry Learning. Routledge.

[6] Shigley, J. S., Mischke, C. R., & Budynas R. G. (2008). *Mechanical Engineering Design*, 8th ed., New York: McGraw-Hill.

[7] Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, Mass.: Harvard University Press.

[8] Martinello, M. L. (1998, Winter). "Learning to question for inquiry". *The Educational Forum*, 62 (2), 164-171. Kappa Delta Pi, International Honor Society in Education.

[9] Beetham, H., & Sharpe, R. (2007). Rethinking pedagogy for a digital age - designing and delivering e-Learning, Routledge: London.

[10] Bloom, B. S. (1956). "Taxonomy of educational objectives: The classification of educational goals". *Handbook 1: Cognitive domain*. New York, NY: David McKay, 1956.

[11] Conole, G. (2008). Capturing practice: the role of mediating artefacts in learning design, in Handbook of Research on Learning Design and Learning Objects: Issues, Applications and Technologies, L. Lockyer, S. Bennett, S. Agostinho, and B Harper (Eds), Information Science Reference.

[12] Bruner, J. (1957), "Going beyond the information given." In I Bruner et al. (eds.), *Contemporary Approaches to Cognition.* Cambridge, Massachusetts: Harvard University Press.

[13] Wolf, D. P. (1987). *The art of questioning. Academic Connections*; p1-7. [Online] Available: http://www.exploratorium.edu/IFI/resources/workshops/artofquestioning.html. Retrieved on November 17, 2012.

[14] Lave, J., & Wenger, E. (1990). *Situated learning: Legitimate peripheral participation.* Cambridge: Cambridge University Press.

[15] Pratt, D., & Ainley, J. (1996). Construction of meanings for geometric construction: two contrasting cases. *International Journal of Computers for Mathematical Learning, 1*(3), 293–322.