A Comparison of the Effectiveness of STEM Learning and Imagineering Learning by Undergraduate Student in Computer Science

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Abstract - This is a quantitative study was to compare the effectiveness of two different ways of learning, STEM learning (STEM: Science Technology Engineering and Mathematics) and Imagineering learning, to study samples of 60 were selected with the cluster-sampling method from the whole population of the fourth Computer Science students at RMUTT who studied in Semester 1 Academic Year 2014 and they took the compulsory course of Multimedia Technology. These samples were divided into two groups, one of 30 students with the STEM learning and the other of 30 students with the Imagineering learning. Each group was expected to have the same level of Multimedia Technology ability since they were in the same field of study. The data were collected from the samples’ responses to: 1) questionnaires (surveying of satisfied and learning attitudes), 2) learning behavior observation, and 3) creativities of portfolio assigned. The statistics used for data analysis in this research consisted of mean, standard deviation, and t-test for the effectiveness with STEM and Imagineering learning techniques.

The summary of this research are students’ satisfaction and attitudes of STEM learning and Imagineering learning were highly satisfied. To difference analysis between Mean effectiveness of STEM learning students’ and Imagineering learning students’ with similar condition and content. The results were found out that STEM learning students’ had higher Mean effectiveness than the Imagineering learning students’ in statistical significance at .05. To analysis learning behavior between STEM and Imagineering learning, we used questionnaires and behavior observation in three issues: participation of students, learning enjoyment, and learning collaboration. This means the STEM learning students had higher overall learning than the Imagineering learning students in significantly different at the rate of .05. The assignment creativities’ of student between STEM and Imagineering learning techniques. These results were found to be statistically significantly different at the rate of .05. This means the Imagineering learning students had higher averaged creativity of portfolio assigned than the STEM learning students.

Keywords - STEM Learning, Imagineering Learning, Computer Science Student(s)

I. INTRODUCTION

In the current, the world has developing rapidly because of technology can relevance data that affect to 21st Century learning and teaching for today’s students and instructors. The important of 21st Century is Learning skill, that focusing to Project-based Curriculum for manage learning has to knowledge, ability and necessary skills. So, instructors had to paving and preparing to manage learning, content knowledge, specific skills, expertise and literacy as well as the other factors that can support the learning. That, corresponding to Rajamangala University of Technology Thanyaburi.
(RMUTT) Development Plan during in 2014 to 2017 has policies as “University of creating a professional (Hands-on) in Science Technology and Innovation” means we focused on producing people to have skilled and specialized in business and industry that response to the country’s development. Therefore, the goal of the development includes a graduate, instructors, staff and management.

Faculty of Science and Technology, RMUTT, dedicates to develop qualifies graduates as University philosophy and National Education Act. Then, the policy improving and developing effective individual course learning activities, focusing on professional Hands-on experiences. To do so, STEM (Science Technology Engineering and Mathematics) learning, has been applied to enhance the better learning skills. The researchers were conducted experiments with Multimedia Technology because in the past, instructors taught according to course description and classroom practices only, not only creating monotonous learning atmosphere, but also difficult to understand and inapplicable to the real world.

Therefore, it is important to compare the effectiveness of STEM learning and Imagineering learning. Both learning techniques apply imagination to stimulate the thinking process and motivation of learning in order to develop intellectual skill. Moreover, the learners can understand the element or multimedia processes and appropriate technologies. Thus, this study is the experimental research with the following objectives:

1) To compare the effectiveness of STEM and Imagineering Learning Techniques
2) To compare students’ satisfaction between STEM and Imagineering Learning Techniques
3) To compare the learners behavior between STEM and Imagineering Learning Techniques
4) To evaluate the leaning output creativity between STEM and Imagineering Learning Techniques

II. LITERATURE REVIEW

A. 21st Century Teaching and Learning

21st Century Teaching and Learning is defined strategic approach to learning by design models and best practices for enhancing the effectiveness of the curriculum. It’s focused on knowledge skills, specialization, learner’s competencies in higher order learning skills and evaluation skills that ability to use new knowledge in a creative way. These are the Partnership for 21st Century has developed a vision for student success in the new global economy (The Partnership for 21st Century Skills, 2009), as shown in Fig. 1.

![Fig 1. A Framework for 21st Century Skills](image)

Fig. 1, this Framework describes the skills, knowledge and expertise students must master to succeed in work and life, students must also learn the essential skills for success in today’s world, such as critical thinking, problem solving, communication and collaboration.
Fig 2. Thailand Quality People in 21st Century

Fig. 2, the elements described above are the critical systems necessary to ensure 21st century readiness for Thai’s students must learn since Kindergarten to University or long life learning. It’s consisting of five domains, 3R’s and 7C’s that produce 21st Century outcomes for today’s students.

B. STEM Learning

STEM education is the Interdisciplinary integration between Science: S, Technology: T, Engineering: E, and Mathematics: M. By using the nature integration of Engineering (in solving problem), Science (in experimenting of solution), and Mathematics (in mathematical calculation), and technological applications that also promote skill development in 21st Century. From the research study (Dejarnette, 2012; Wayne, 2012; Breiner, Harkness, Johnson, & Koehler, 2012), is supporting to develop and teach STEM education in Early Childhood for response to the intelligence. Especially in children to developing cognitive skills in Engineering and using technology such as: iPad and Tablet to developed learning STEM education that the reports shown children in Early Childhood can develop as well (Aronin & Floyd, 2013), thus the success of STEM education is not only caused by a consistent of the course, quality of teachers, evaluation measurement and time spent in teaching, but also to support more research (National Research Council of the National Academies, 2011). Therefore, in the case of Thailand, STEM education should come from the partnership and the stakeholder to develop curriculum in STEM education, research, teacher, and management education to achieve success.

C. Imagineering Learning

Imagineering learning is a combination of the words between “Imagine” and “Engineering” (Dictionaries, 2011) which the prefect combination of learning nature and teaching method form Walt Disney’s synthesis (Wright, 2008), which studied and developed the skill for fill design and convergence product development. So, Imagineering learning processes consist of six perspectives with total 17 steps. The procedural steps are as follows:

Fig 3. The Process of Imagineering Learning

Fig. 3, these were derived from the research of the Breda University of Applied (Breda University of Applied Science, 2012) which was the integration of Imagineering Club (Yates, 2012; Paczuska, 2012), ABC model (Nijs and Peters, 2002) work Imagineering (Langford, 2010) and Imagineering mental
model (Prosperi, 2011). The Imagineering learning is consisting of Imagine, Design, Develop, Present, Improvement, and Evaluate. While the research in Thailand as Jitsupa et al., (2014) to study about “A Comparison of SDLC-Based Learning and Imagineering Learning by Undergraduate Student in Computer with Different Experiences” found that: the overall result of learning by the experienced students and the inexperienced students through SDLC-based learning and Imagineering learning was in a high degree and the computer students showed a statistically significant difference in learning through SDLC-based learning and through Imagineering learning, at the rate of 0.05.

III. METHODOLOGY

A. Scope of Research

This study is to compare the effectiveness between STEM Learning and Imagineering Learning. The scope of research is as follow:

- Sample groups are senior students in major of Computer Science at Rajamangala University of Technology Thanyaburi and registered for Multimedia Technology in Semester 1 Academic Year 2014, divided into 2 groups.
- Defined into two groups: the first group using STEM learning technique in common with normal teaching and the second group using Imagineering learning technique in common with normal teaching.
- Condition and contents are the same by focusing on outcomes of the work, teamwork, communication, and presentation.

B. Process

This is the experiment research which follows the methodology of research cycle (Kemmis & McTaggart, 1982), consists of four steps: Plan (P) Action (A) Observe (O) and Reflect (R) by inside of each step using Deming cycle quality process (contains four steps: Plan (P) Do (D) Check (C) and Action (A)). These are to control and compare the effectiveness between STEM and Imagineering learning techniques. In SETM processes, which stands for Science, Technology, Engineering and Mathematics, in not simply a list of subjects that are to be taught, but more of an education approach to teaching and learning. Although there are several models on implementing a STEM program, we have developed a model based around the Engineering Design Process (EDP). The EDP is five steps are the following: Ask, Imagine, Plan, Create, and Improve. And Imagineering process, the instructors acting as a facilitator and manage Imagineering learning to appropriate with the content in each week (As a conductor). Instructors focus on encouraging creative outputs from students’ imagination and collaboration with others. Learners design and create output by themselves while themselves and able to describe the correct processes by own nature.

Hence, we evaluated questionnaires, learning behavior observation and creativities of portfolio assigned all consists of activities, workshops, lectures, homework, simulations, interview, feedback, present and creating, as shown in Fig. 4.
IV. EXPERIMENTS AND RESULTS

Experiment focuses on four statistical issues, Mean of pre-test, Mean of effectiveness, learning Behavior observation, and Creativities of portfolio assigned, as followings:

A. Data

This is a quantitative study to compare the effectiveness of two different ways of learning, STEM learning (STEM: Science Technology Engineering and Mathematics) and Imagineering learning. The 60 students were selected with the cluster-sampling method (Fraenkel, Wallen and Hyun, 2012). These students enrolled in semester 1 academic year 2014 and registered for course of Multimedia Technology as required by curriculum.

1) The Samples: These samples were divided into two groups as the follows:

- 30 students with the STEM learning.
- 30 students with the Imagineering learning.

Each group was expected to have the same level of Multimedia Technology fundamental knowledge.

2) Tools: The data was collected by:

- Questionnaires (surveying of satisfied and learning attitudes)
- Learning Behavior observation
- Creativities of portfolio assigned

B. Evaluation

This research was analyzed using basic statistics such as: Mean, Standard deviation, and compared the results by t-test.

C. Results

1) Mean of Pre-test: For the difference in analysis, Mean of pre-test between STEM learning students’ (in common with normal teaching), and Imagineering learning students’ (in common with normal teaching), is shown in TABLE I.

<table>
<thead>
<tr>
<th>Learning</th>
<th>n</th>
<th>( \bar{x} )</th>
<th>S.D.</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM</td>
<td>30</td>
<td>24.53</td>
<td>6.35</td>
<td>.279</td>
</tr>
<tr>
<td>Imagineering</td>
<td>30</td>
<td>24.21</td>
<td>11.49</td>
<td></td>
</tr>
</tbody>
</table>

TABLE I demonstrates the results of the Mean of pre-test between STEM learning students’ and Imagineering learning students’. By \( df = 58, \alpha = .05 \) t-test was calculated as .279. This means both group is not significantly different.

2) Mean Effectiveness: For difference analysis between Mean effectiveness of STEM learning students’ and Imagineering learning students’ with similar condition and content. We focused on outcomes of the work, teamwork, communication, and presentation as shown in TABLE II.

<table>
<thead>
<tr>
<th>Learning</th>
<th>n</th>
<th>( \bar{x} )</th>
<th>S.D.</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM</td>
<td>30</td>
<td>35.87</td>
<td>7.50</td>
<td>2.211</td>
</tr>
<tr>
<td>Imagineering</td>
<td>30</td>
<td>32.30</td>
<td>8.30</td>
<td></td>
</tr>
</tbody>
</table>

TABLE II demonstrates the result of the Mean effectiveness between STEM learning and Imagineering learning groups. By \( df = 58, \alpha = .05 \) t-test was calculated as 2.211. This means the STEM learning students’ had higher Mean effectiveness than the Imagineering learning students’ in statistical significance at .05.

3) Learning Behavior Observation: For analysis learning behavior between STEM and Imagineering learning, we used questionnaires and behavior observation in three issues: participation of students, learning enjoyment, and learning collaboration as the follow:

- Issue: The participation of students. As shown in TABLE III.
TABLE III  
LEARNING BEHAVIOR ANALYSIS  
IN PARTICIPATION OF STUDENTS

<table>
<thead>
<tr>
<th>Learning</th>
<th>n</th>
<th>x</th>
<th>S.D.</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM</td>
<td>30</td>
<td>4.231</td>
<td>.336</td>
<td>12.764</td>
</tr>
<tr>
<td>Imagineering</td>
<td>30</td>
<td>3.051</td>
<td>.491</td>
<td></td>
</tr>
</tbody>
</table>

TABLE III demonstrates the results of learning behavior analysis in participation of students between STEM learning students’ and Imagineering learning students’. By $df = 58$, $\alpha = .05$ (equal to 2.002), $t$-test was calculated as 12.764. This means the STEM learning students’ were participated higher than the Imagineering learning students’ in significantly different at the rate of .05.

- **Issue**: The learning enjoyment, as shown in TABLE IV.

TABLE IV  
LEARNING BEHAVIOR ANALYSIS  
IN LEARNING ENJOYMENT FROM TEACHING

<table>
<thead>
<tr>
<th>Learning</th>
<th>n</th>
<th>x</th>
<th>S.D.</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM</td>
<td>30</td>
<td>3.933</td>
<td>.391</td>
<td>16.987</td>
</tr>
<tr>
<td>Imagineering</td>
<td>30</td>
<td>1.879</td>
<td>.567</td>
<td></td>
</tr>
</tbody>
</table>

TABLE IV demonstrates the results of learning behavior analysis had enjoyment between STEM learning and Imagineering learning. By $df = 58$, $\alpha = .05$ (equal to 2.002), $t$-test was calculated as 16.987. This means the STEM learning students’ enjoy more from teaching higher than the Imagineering students in significantly different at the rate of .05.

- **Issue**: Learning collaboration in class. As shown in TABLE V.

TABLE V  
LEARNING BEHAVIOR ANALYSIS  
IN LEARNING COLLABORATION

<table>
<thead>
<tr>
<th>Learning</th>
<th>n</th>
<th>x</th>
<th>S.D.</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM</td>
<td>30</td>
<td>3.121</td>
<td>.373</td>
<td>9.432</td>
</tr>
<tr>
<td>Imagineering</td>
<td>30</td>
<td>2.134</td>
<td>.413</td>
<td></td>
</tr>
</tbody>
</table>

TABLE V demonstrates the results of learning behavior analysis in learning collaboration between STEM learning and Imagineering learning. By $df = 58$, $\alpha = .05$ (equal to 2.002), $t$-test was calculated as 9.432. This means the STEM learning students had higher learning collaboration than the Imagineering learning students in significantly different at the rate of .05.

- **Issue**: Learning collaborations in class. As shown in TABLE V.

- **Issue**: The learning enjoyment, as shown in TABLE IV.

- **Issue**: Learning collaborations in class. As shown in TABLE V.

4) **Creativities of Portfolio Assigned**: The difference analysis of assignments’ creativities of students between STEM learning and Imagineering learning, as shown in TABLE VI.

TABLE VI  
DIFFERENCE ANALYSIS CREATIVE THINKING BETWEEN STEM LEARNING AND IMAGINEERING LEARNING

<table>
<thead>
<tr>
<th>Learning</th>
<th>n</th>
<th>x</th>
<th>S.D.</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM</td>
<td>30</td>
<td>33.30</td>
<td>8.67</td>
<td>1.943</td>
</tr>
<tr>
<td>Imagineering</td>
<td>30</td>
<td>34.87</td>
<td>7.13</td>
<td></td>
</tr>
</tbody>
</table>

TABLE VI demonstrates the results of difference analysis of portfolio creativity assigned between STEM learning and Imagineering learning. By $df = 58$, $\alpha = .05$ (equal to 2.002), $t$-test was calculated as 1.943. These results were found to be statistically significantly different at the rate of .05. This means the Imagineering learning students had higher averaged creativity of portfolio assigned than the STEM learning students.

V. CONCLUSIONS

From this study, the evaluation of the comparison of effectiveness of STEM and Imagineering Learning by Undergraduate Student in Computer Science and registered for Multimedia Technology in Semester 1 Academic Year 2014 amount 2 groups. The results found that the STEM learning students’ had overall higher Mean effectiveness and learning behavior observation than the Imagineering learning students’ in statistical significance at .05. This technique, the learners can understand the element or multimedia processes and appropriate technologies, have more interested to learn, too.

Therefore, instructors should be included STEM learning activities into the lesson because these techniques allow learners using the nature integration of Engineering (in
solving problem), Science (in experimenting of solution), and Mathematics (in mathematical calculation), and technological applications that also to promote skill development in 21st Century. But the problem in this technique, instructors need to have the time and flexibility to prepare activities and develop knowledge, skills, and character. While the Imagineering learning had higher averaged creativity of portfolio assigned than the STEM learning as every process had imagination and creative thinking skill for fill design and convergence product development.

Moreover, teaching in the current, instructors should be consistent with the learning in the 21st century skillset. These skills are often defined as the 4Cs: creativity, collaboration, critical thinking, and communication. As STEM and Imagineering continue to grow in implementation, instructors can fit them together in curriculum and instructional practice. Additionally, these two approaches can capitalize on each other’s strengths and fill each other’s potential gaps. The key in an intentionality or imagination in design that recognizes what might be missing from each approach, developing teaching efficiency, and affecting the performance of the learners as well to stimulate the thinking process and motivation of learning in order to develop intellectual skill.

REFERENCES

(Arranged in the order of citation in the same fashion as the case of Footnotes.)


