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A STEAM Learning with Digital Fabrication Laboratory on Cloud Computing Model to Enhance Creative Product

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Abstract

This research developed a model of steam learning with digital fabrication laboratory on cloud computing model to enhance creative product. The objectives of the study were: 1) To create the model, and 2) To evaluate a model. This research method was two parts. The first part about the design's model had four subs: 1) to study and synthesize the relevant documents in this research such as steam, digital fabrication laboratory, cloud and creative product. 2) to develop a process in the model, 3) to present the process model with experts to get it approved to be able to hold in-depth interviews, and 4) to create the tools for assessing the model. The second part is referred to as model evaluation. The sample group has five experts who consist of Information Technology and Instructional Design. Then, this research uses means and standard deviations to analyze data. The process's model has nine procedures in three components. The experts assed of the model overall found were a good level that the model could help learners in building creativity skills.

Keywords: STEAM, digital fabrication laboratory, cloud computing, creative product

1. Introduction

Nowadays, information and communication technology (ICT) has been developed, especially in the field of internet technologies that facilitates mankind and supports business and industrial operation, and people's routines in everyday life. As mentioned about how internet technologies positively impact people's lives, the Thai government decided to develop a policy of Thailand 4.0 model. This model aims to drive Thailand out of 'middle income trap', and improve country's economy with the contributions of innovation, technology and creativity by focusing on value based economy system which increases value and potential of production and management that are the bases of Thailand's economy, and developing internet network that provides knowledge to users who have opportunities to use this internet technology. This also includes pointing out the advantages of using this form of technology (Office of the National Broadcasting and Telecommunication Commission, 2017).

Steam is a method to manage education including five interdisciplinary: science, technology, engineering, arts, and mathematics. This method focuses on practical knowledge that can be practiced in real life and creating new production processes and products. Steam lesson management is learning management that not only emphasizes on remembering theories, scientific rules, or mathematics but also helps users to understand the proposed theories and lessons by practices. Furthermore, it helps users to improve thinking, questioning, problem solving, information searching and analyzing skills, together with integrating these skills in their routines (The Institute for the Promotion of Teaching Science and Technology, 2014). The steam learning model requires a lab for learning operation, especially 'Digital Fabrication Lab'.

Digital Fabrication Laboratory: Fab Lab is a small lab surrounding by innovative learning passion that encourages students to learn and work at the same time (Fab Lab4Shool, 2016). Fab lab is also a place to create scientific and engineering masterpieces (Sheridan et al., 2014) as the designing of demonstration helps to solve issues and innovate creative masterpieces by the integration of idea and imagination based on technology (Knips et al., 2014; Suvit, 2018). Moreover, Digital Fabrication Lab in today's world brings 'Cloud Computing Technology' to support the operation as an effective tool.

Cloud Computing is an enormous IT evaluation model or internet-based computing model that can store and access user's input on the internet (Gartner, 2008). Cloud computing operates on the evaluating system of 'cloud' which is created on a web browser or application (Mansuri et al., 2014; Zhang et al., 2010). As stated before, it is a beneficial technology on the internet (Singh, 2018), especially for learning and teaching since it supports learning activities. In other words, this technology helps the learner to access the lecturer's stored information or data anywhere and anytime. Thus, it is considered as a medium that strengthens the connection and communication between learners and the lecturer (Wang, 2017).

'Creative Product' is referred to as the product of idea or innovation which can be both solid and non-solid. The product of creative ideas is required to be new, highly stimulated, stable, valuable for creator and society, and able to solve and evaluate issues (Newell et al., 1962).

According to the issues stated above, the researcher decided to create steam learning with digital fabrication laboratory on cloud computing model to enhance creative product to support the lessons of 21st century.

2. Research Objectives

This research aims to create a steam education with digital fabrication laboratory on cloud computing model to enhance creative product, and lead the model to expertise evaluation in order to use this model as a conceptual framework in further studies.

3. Conceptual Framework

This research's conceptual framework consists of three components:

1) 'Steam' is an education approach that supported industrial revolution 4.0 that focused on the increase of knowledge utilization (Nguyen et al., 2020). Steam education model specialized in technology, science, engineering, art, and mathematics that were deeply related to the innovative creation which encouraged learner to design the product (Hadinugrahaningsih, 2017; Roberts, 2015). Hence, steam learner had to study about technological tools and devices, and integrate them with knowledge and creativity to solve problems of product creation (Nguyen et al., 2020).

2) 'Digital fabrication laboratory' is referred to a workshop that supported the 21st century learning and teaching (Smit, 2018). In this study, the researcher had studied both software and hardware, which were related to the digital fabrication laboratory, in order to support the study that encouraged the learner to increase skills towards modern technological tools such as 3D printer, laser cutting and programs that were used to create tangible works which were made from the learner's creativity (The NME ICT initiative of MHRD, 2020). Furthermore, digital fabrication laboratory helped to raise the learner's interest (Togou et al., 2020), and it could be integrated to steam education (Milara et al., 2019).

3) 'Cloud computing' is a highly secured technology and resource pool that allowed both learner and user to share hardware, software, information and storage together at anywhere and anytime (Srinivas et al., 2012: Lakshminarayanan et al., 2013). Moreover, cloud computing could support steam education (Corbi & Burgos, 2017; Kumar& Sharma, 2017; Hyun & Park, 2020) and digital fabrication laboratory (Cornetta et al., 2018; Cornetta et al., 2019; Lorenzo & Lorenzo, 2019).

The researcher had synthesized these 3 components in the study about the model of a steam education with digital fabrication laboratory on cloud computing model, in order to create the research's framework. This type of learning model could satisfy the 21st century teaching and learning which focused on the learner's knowledge and skills utilization as to create the creative product (the American Association of Colleges of Teacher Education and the Partnership for 21st Century Skills, 2010; Boy, 2013) as shown in Figure 1. The model's process and tools could be found in Figure 2 (Hyun & Park, 2020; Cornetta et al., 2019; Lorenzo & Lorenzo, 2019; Cornetta et al., 2018; Wang 2018; Corbi & Burgos, 2017; Kumarm& Sharma, 2017; Nemorin, 2017; Fleischmann et al., 2016; Connor et al., 2015; Wolf et al., 2014; Hirafuji, 2014; Stacey, 2014; Troxler & Zijp, 2013; Blikstein, 2013).

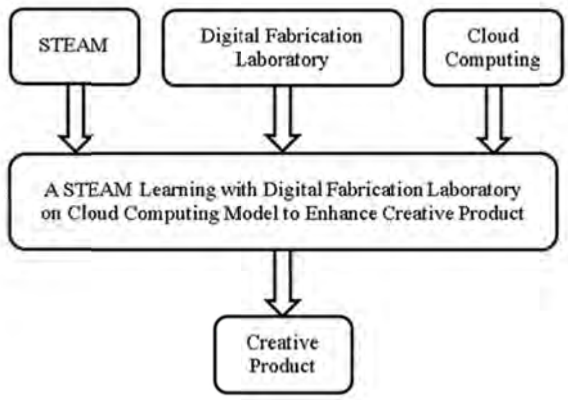

Figure 1. The conceptual framework

4. Scope of the Study

1) Population

The experts' population included information technology and instructional design.

2) Sample

List the experts or individuals who were chosen to be a part of this research must have at least 5 years of experience in the mentioned

3) Variables

- Steam learning with digital fabrication laboratory on cloud computing model to enhance creative product' is the independent variable.
- The dependent variable is the evaluation of this research's model appropriateness.

5. Research Methodology

The research had 2 parts.

1) The first part

The first part was to develop a model, with the process as follows:

a) To study and synthesize steam, digital fabrication laboratory, cloud and creative product from documents and research.

b) To develop a model.

c) To present the process model with experts to get it approved to be able to hold in-depth interviews

d) To create tools for assessing the model.

2) The second part

The study's second part is concerned about the model with the following methods:

a) To present the model to the 5 experts from the fields of Information Technology and Instructional Design.

b) To improve the model according to experts' suggestions.

c) To present the model's diagram and report.

d) To analyze the results of the model evaluation by using mean ($\bar{X}$) and standard deviation (S.D.). The 5-point Likert scale was used on the evaluation form. The scales are classified as very good, good, moderate, less and least.

6. Research Methodology

The results had two parts.

6.1 The First Part

The model is illustrated in Figure 2. This constructed conceptual model has 3 components with 9 procedures as can be seen below (Hyun & Park, 2020; Cornetta et al., 2019; Lorenzo & Lorenzo, 2019; Cornetta et al., 2018; Wang, 2018; Corbi & Burgos, 2017; Kumar & Sharma, 2017; Nemorin, 2017; Fleischmann et al., 2016; Connor et al., 2015; Wolf et al., 2014; Hirafuji, 2014; Stacey, 2014; Troxler & Zijp, 2013; Blikstein, 2013).

Component 1. 'Input' has 2 parts: 1. Digital Fabrication Laboratory and 2. Cloud tools. These components operated by the use of 3D printing, CNC, Laser Cutters, Rhino, Tinkercad, 3D Max, CNC simulator pro, Laser Cut Simulator, Facebook, Line and Thingspeak to operate in the process.

Component 2. 'Process' includes 7 different parts in steam:

1) Problem Identification is a step that a lecturer assigns students to group, brainstorm, and research about problems in order to set the project scope, and present them to their lecturer and classmates. Hence, 'Problem Identification' helps the lecturer to summarize, and approve the presented problems, project topics, and scope of each project.

2) Related Information Search is a step that each group of students has to re-search, analyze, and summarize the knowledge about information technology that is related to their project topics. Then, student groups have to present the researched information to the class.

3) Solution Design is a step that each group of students utilizes the concluded information and knowledge to design their models, and solve problems of different aspects according to their project subjects. In this step, students must concern about resources, restrictions, and conditions of the specified circumstances. Afterwards, student groups have to analyze their model designs, and choose the possible solutions to introduce to the class.

4) Planning and Development is a step that student groups use the approved and presented model designs to plan for the operation procedures by dividing each procedure according to its activity duration, and person in charge. For each procedure, the goal has to be clear, and able to measure the accomplishment. Furthermore, each group of students has to develop models according to the plan that the group has set, and periodically present each procedure to the class by following the process that the group has done.

5) Testing, Evaluation and Design Improvement is a step that each student group tests and evaluates the primarily created models whether they can reach the set goals and objectives. Then, every group of students has to use the results of evaluation to efficiently improve their models and projects.

6) Discussion and Revise is a step that the lecturer lets students suggest, share, and discuss about their models and projects with each other in order to gather more ideas and advices to develop and enhance their works.

7) Presentation is the final step that each group of students presents the summary of project, model and project development, and how their projects solve the previously identified problems.

Component 3. 'Output' is related to the main component which is a creative product that can be developed by activities and procedures from learning.

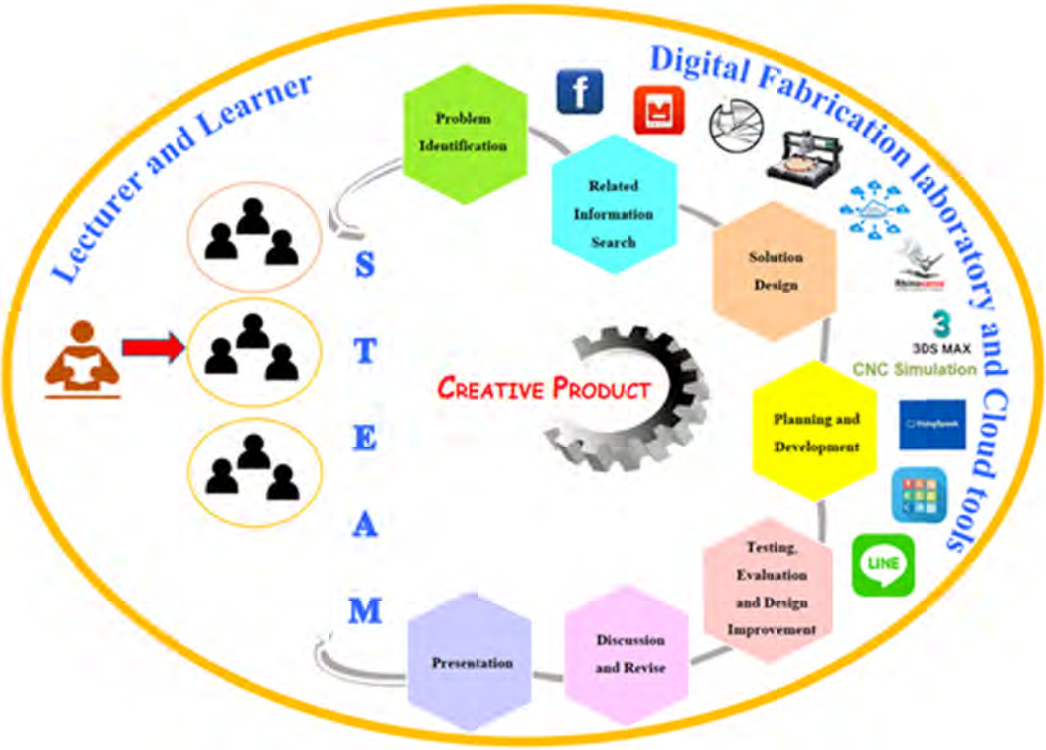

Figure 2. The research model

6.2 The Second Part

The model appropriateness evaluation was done by 5 experts as shown in Table 1. The overall result was ranked as 'good' (mean= 4.53, S.D. = 0.06). The details of top 3 ranked components in the model appropriateness evaluation are as the follows: 'The arrangement of the components' sequences in the model was suitable and easy to understand' was ranked as very good (mean = 4.56, S.D. = 0.38). The theory and research that were based on the synthesis of model were ranked as very good (mean= 4.55, S.D. = 0.46). Finally, the model could develop appropriate creative product methods' was ranked as good (mean = 4.52, S.D. = 0.53).

Table 1. Results of appropriateness evaluation of a model

Evaluation Lists	Results		Appropriateness Level
	$\bar{X}$	S.D.	
1. Theoretical principles, Research used as a basis synthesis for steam learning with digital fabrication laboratory on cloud computing model to enhance creative product.	4.55	0.46	Very Good
2. The components of the model were related to a steam learning with digital fabrication laboratory on cloud computing model to enhance creative product.	4.51	0.49	Good
3. The arrangement of the sequences of components in a model was suitable and easy to understand and clear.	4.56	0.38	Very Good
4. The overall value of the components in a model was complete as it could satisfy the needs, and its function was accurate to the purposes of this research.	4.51	0.53	Good
5. A steam learning with digital fabrication laboratory on cloud computing model could develop suitable creative product methods	4.52	0.53	Good
Summary	4.53	0.06	Good

7. Discussion

The results of the evaluation of a model were related to the study of Oner et al. (2016) which stated that STEAM was effective since the process of STEAM would support product creativity. In addition, it fulfilled the standard of product design development. Another research is written by Georgiev et al. (2017) about ‘digital fabrication laboratory and the study of Sathaporn and Namon (2015) about ‘Cloud Computing’ referred that both cloud computing and the internet are tools that help to create the creative product.

8. Expected Benefits

Acquiring a method to improve the teaching and learning in this model to increase skill in building the creative product of learners.

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