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Mobile and CAD Technology Integration Effects on Designing Process of Malaysian Polytechnic Architecture Student in Producing a Creative Product

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Abstract

The purpose of this research is to examine the effect of integrating the mobile and CAD technology on designing process of Malaysian polytechnic architecture students in producing a creative product. A website is set up based on Caroll's minimal theory, while mobile and CAD technology integration is based on Brown and Campione's technology of learning theory. This study utilized a quasi-experimental method. Final semester students of four (4) polytechnics are chosen as a research sample where sixty (60) students are in the treatment group and another sixty (60) students are in the control group. Final product is evaluated by an expert in architecture field using the validated instrument developed by researcher based on Creative Product Analysis Model (CPAM). The inferential statistics namely T-Test with a significant level p = 0.01 were utilized. Research outcome shows that there is a significant difference between the treatment group product (M=79.1) and control group product (M=70.5). This research contributes to the use of real case in the development of an architectural website, in the use of mobile technology as media information sources, the use of CAD technology integration in designing process and in the construction of validated instrument which is used to evaluate creative architectural products.

Key-word: - real case ; web site ;mobile technology; CAD technology; architectural design process; creative product

1. Introduction

Architectural design is a complex and open process. Design process starts from the abstract stage to solve a design problem until it reaches the design solution in the form of design product. Designing activities is a repetitive problem solving process (Demirkan 1998). Watanabe (1994) describes designing process as a process to fulfil human needs through new idea produced. According to French (1998), architecture design is a response to human special needs which is refuge and comfort. While according to Lawson (1997), architectural design is a process to

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produce a new architectural design product. Lawson (1997) also states that architectural design is a process where an architect produced a space, place and building which has a big amount of effects on the quality of human life. Most architects agreed with Sanders (1996) whom stated that architectural design is a repetitive process where the process scheme can be recognized, valued, repeated, explored and repaired until the best solution is achieved. In the context of this research, architectural design is a systematic process through a few stages in producing a new product that can be valued from physical aspect and providing benefits to human life and environment. Decision making activities in architectural design process happens at sketching stage, schematic design stage and final design stage. This research concentrates on schematic stage of design process which involves sketching and schematic design. As a conclusion, beginning stages of design process involves collecting the information needs in the design process and producing new ideas. Technological development nowadays, has given chances for mobile and CAD technology to be integrated in design process. Mobile technology gives chances for students to have access to the information without time and place limits. Websites referring to real cases provide opportunity to gather quick information for design process purpose. Media variety in design process also can give more choices to designer in creating new ideas. According to Dong & Gibson (1998), CAD technological development in three dimensional drawings, three dimensional digital model and computer simulation can provide new methods for designers to find more solution in schematic design process.

i. Problem statements

Design is a process involves two important activities which are creating design information and creating new ideas to solve the design problems. There are some weaknesses for these two activities. According to Yunus et al. (2006), many of the design layouts that being produced by the students in polytechnic does not show any maturity. Yunus et al. (2006) also said that majority of the design products do not have any concrete design concept. Hamdan (2005), also mentioned that intellectual values for the design ideas not up to level of the diploma student. The design products from the polytechnic students also do not have a strong creativity element. All the problems mentioned above cause by the students design approached. New approaches in teaching architectural design are needed in order to rejuvenate the students in creating creative design product. New strategy is needed to help the student to get the design information anytime and anywhere while new strategy also needed to help students in creating creative ideas during design process. Web site for design information built on real case approach based on mobile devices can be a good approach to help students to obtain focus information at anytime and anywhere. Digital model offered by the CAD technology can be a good approach to help students to create new ideas in a short period of time. Digital model allows the students to create many design ideas during the design process. Therefore this research want to see the quality of design information produced when web site build on real case based on mobile device being integrated in the design process. This research also wants to study what effects it will have on the design product when CAD technology being integrated into the design process.

ii. Research purposes

The purposes of this research are as follow:

a. To identify the interest of the student in finding information need in the design process through web mobile or conventional method
b. To study the effect of integrating mobile technology at the analysis stage in the design process
c. To study the effect of integrating CAD technology at the synthesis stage in the design process
d. To study the effect of integrating CAD technology at the simulation stage in the design process
e. To study the effect of integrating mobile and CAD technology in producing the final product of architectural design

2. Review of literate literature

i. Real case an educational approach

With architecture being a much more complex career, real case study as a lecturing method has starts to be an effective method among architectural lecturers. According to Vijayalakshmi (1997), real architecture cases involve construction and designing process of a completed building. Oren (1990) says that information usage based on real project will helps student to analyse, make comparison and validate important aspects from studied buildings. With the use of real case method, researcher will develop a website which is related to the same buildings type that will be designed by students. Important links from this website will be connected to additional information for students. For this research, the use of real case in the development of the website is expected to make the student information searching ease and focus to the project needs. Focused in searching information is suitable to be used in a website based on a mobile technology with regards to the proven ability of the mobile devices to be used at anytime and any place.

ii. Website based on mobile device

There were different opinions in defining mobile knowledge. Lehner and Nosekabel (2002) describe mobile knowledge as a service that provides electronic information generally and educational content which helps information searching without time and places limits. Vavoula and Sharples (2002) explains that there are three ways where learning can be mobile which is learning is mobile in a space, learning is mobile in different aspect of life and learning is mobile without time and places limits. According to Anna et al. (2003) education based on mobile technology is a learning method using small media, mobile and did not produce inconvenience in every aspect of life. From definition above, a conclusion can be made that education based on mobile technology is an educational approach that are capable of conveying information at every time and places based on student needs. Referring to Chen and Kinshuk (2005), educational service based on mobile technology is a movable learning sources and can be access by students without time and places constraints. In order to make a dynamic mobile technology based learning atmosphere, learning system has to be made ready in providing information without time and places constraints (Chen and Kinshuk 2005). Learning system also has to be designed, where the information provided can be chosen by students according to their needs. Educational system design based on mobile technology has to be dynamic, can be changed easily and can be used at every time and places. As a conclusion, educational system design based on mobile technology has to be adapted by users at every time and situations. According to Bottentuitista et al. (2007), website usage through mobile technology can attracts more students to use the internet. In conclusion, if interactive multimedia website that refers to real case is developed using mobile technology, information searching process will be easier where information can be reached by students without time and places constraints. Through faster information reaching process, students creativity can be generate with sufficient amount of information and it can also fasten the student skills for creating new ideas in design process.

iii. Computer aided design

Computer aided design or CAD technology capability in producing architectural design are gaining importance because there were so many benefits including cost and time reduction in designing process. CAD technology also enables people who involves in architectural design industry to sketch and develop their work on computer screen, it can be saved and printed for future use in making changes and editing. According to Husain (2007), nowadays CAD is recognized as computer aided design not as computer aided drawings anymore. This is because of the facts that CAD technology can actually did more than drawings. A tight relationship has exists between CAD software developer and architect, in order to build a user friendly CAD software for architectural design (Vijayalakshmi 1997). CAD technology also enables the producing of high visual impact digital model and gives freedom to the architect to think about object, space and shape in the same screen. Referring to Salman (2004), rapid development for CAD technology has changed the stages in concept shaping from two dimensional to three dimensional. CAD technology existence in architecture has two primary objectives which are to applied human cognitive design process through the computing smart technology and to become an idea representative media in architectural design process (Koutamanis 2003).

iv. Three dimensional digital model

Three dimensional digital models is another representation media that can be built using CAD technology. According to Wei Dong and Gibson (1998), digital model gives chances for architect to think, pictures, communicate and making assumptions in designing process. At concept development stage, digital model design can be use to analyse overall shape, space planning and to decide space height. In schematic stage, digital model can be used to study the suitable type of construction material, colour and lighting for the designed buildings. At the final stage of schematic, digital model can be used to produce a high visual impact design representation. Digital model with the use of CAD technology can produce a visual impact similar to real environment in construction sites. According to Jiangyin (2003), digital model has the ability to represent photo realistic situation with regards to environment details. As a conclusion, compared to conventional model, digital model give chances for architectural students to study about the designed building component in details, suitable finishing materials for each space designed and lighting condition for building's interior. With the CAD technology capabilities, designing process will be simpler, faster and it will give more chances for student to develop their ideas in designing process.

v. Computer simulation

Simulation is a popular teaching technique amongst educators. According to Micheal (2000), simulation helps student to understand a situation, a process and the replication of real situation activities. Menn (1993) says that 90% of the students learned by doing the activities himself even with the helps of simulation methods. In architectural context, computer simulation brings in the real situation in building design. With the capability of CAD technology nowadays, student can use software such as 3D Studio Viz to observe building detailed effect, lighting and movement in a space through animation just like in a real situation. 3D Studio Viz software capabilities is predicted as it can increase students' visual capabilities towards space. Computer simulation eases students to choose suitable building details, lighting and space arrangement for the designed building. The advantages of computer simulation in designing process is that it can boost designers visual capabilities towards space and helps designers to quickly evaluate the quality of designed space. If computer simulation is integrated in learning design process at polytechnic, it is predicted that students can produce a much more creative space design. There was not much empirical research which can proves that computer simulation can increase student's creativity. However, there are several researchers such as Harkow (1996), Micheal (2000) and Lawson (2007) whom has made an assumption that computer simulation can increase student creativity. Through this paperwork, researcher hopes that it can strengthens previous research outcomes on computer simulation capabilities via three dimensional digital models which can produce a much more creative architectural design product.

3. Research methodology

i. Research design

This research consists of two main activities in the design process which is designs' information development activity and creating new ideas activity. Information searching for design purposes on website based on real case is provided by researcher using mobile device while for creating new ideas activity, CAD technology is used. Through this study, researcher want to see the differences in final product designed using mobile and CAD technology integration with the final product build using conventional method. Researcher also wants to see upon how is the effect of integrating website based on mobile device in the design information development activity. This is a quantitative research to study the effects of mobile and CAD technology in design process to produce architectural creative product. Quasi experimental method is used to study mobile and CAD technology integration effects in design process.

ii. Research samples

Research has been made on final semester students of diploma architecture from four (4) polytechnics in Malaysia. Research duration is for six (6) weeks involving one hundred twenty students (120) students as research samples. In this research, research samples have been asked to design a kindergarten building. Sixty (60) students

from Port Dickson Polytechnic and Merlimau Polytechnic were selected to design with the integration of mobile and CAD technology and they are used as treatment group while the other half of the students are from Ipoh Polytechnic and Kuantan Polytechnic perform the design process using conventional method that they used upon. This group used as control group. This research has been conducted by two lecturers from each polytechnic selected. Design process for treatment group and control group has been conducted simultaneously. Products for every activity from both of the design processes have been evaluated.

iii. Research instruments

To evaluate the product for each activity in the design process four instruments have been developed by the researcher. For information analysis product instrument for analysis activity being developed based on requirements being put by Laseau (2001) and Ching (1979), while for product from synthesis activity instrument being developed based on requirements being put by Laseau (2001) and Koberg & Bagnall (1981) and for product from simulation activity instrument being developed based on requirements being put by Laseau (2001) and Mills (2005). The evaluation instrument for the final product is developed by researcher based on Creative Product Analysis Matrix (CPAM) model (Besemer dan Treffingger 1991). Researcher has been using CPAM model as a guide to evaluate the creative architectural design product. To strengthen the finding of this research at the end of the whole activities, questionnaire being given to get the samples' perceptions upon the design activities that they have gone through. These questionnaires provide information to the researcher upon how frequent the samples involved in each activity during the design process.

iv. Pilot survey and reliability of research instrument

A pilot test was carried out from 27th October 2008 to 8th December 2008 with 30 students from Port Dickson Polytechnic. The reliabilities coefficients of the instrument are shown in Table 1. Data from this pilot test not being used for the final analysis.

Table 1 Reliability Coefficients of Researchs' Instruments

No	Instrument	Reference	Items	Cronbach's Alpha Coefficients
1	Information Analysis Product	Laseau (2001) dan Ching (1979)	20 Items	0.9242
2	Synthesis Product	Laseau (2001) dan Koberg & Bagnalls (1981)	18 Items	0.9201
3	Simulation Product	Laseau (2001) dan Mills (2005)	20 Items	0.9570
4	Final Product Based on CPAM Model	Besemer & Trefingger (1981)	31 Items	0.9577
5	Questionnaire		48 Items	0.9652

4. Findings

The finding for this research being divided into five categories which are identifying students interest in finding design information, inferential data to compare design information created through conventional method compare to integrated method, inferential data to compare design product from synthesis and simulation activity through conventional method compare to integrated method, inferential data to compare final design product through conventional method compare to integrated method and students' perception on the design process.

i. Student interest in finding information

In identifying student interest to find information needed in designing process whether it is via mobile technology based website or via conventional method, research outcomes show in Table 2.

Table 2 Frequency in finding information activity

No	Name of polytechnic	Finding information activities (Frequency)
1	Port Dickson Polytechnic	204
2	Merlimau Polytechnic	188
	Total	392
	Mean	6.53
1	Ipoh Polytechnic	80
2	Kuantan Polytechnic	98
	Total	178
	Mean	2.97

Research outcomes shows that the total number of student searches in treatment group is 392 (M=6.53) and total searches in control group is 178 (M=2.97). This outcome clearly shows that student searching activities increased with website integration related to real case based on mobile technology.

ii. Comparing the product of analysis activity

This outcome comparing the quality of designs' information being created from analysis activity consists of two methods which are design information created through conventional method and design information created through integrated method. Research outcome shows in the Table 3.

Table 3 Finding on comparing design information produced in analysis activity

t-test	n	mean	s.d	t	p
Analysis Activity					
Treatment	60	81.2	5.13	18.369	0.000
Control	60	65.5	4.19		

In analysis stage, inferential data shows that there is a significant difference between the mobile technology integrated data (M=81.2) and conventional method (M=65.5), t (118) = 18.369, significant. The significant different on the product being produced in analysis activity proves that the integration of web site based on mobile technology helps the students to produce a quality product in analysis activity.

iii. Creating new ideas in synthesis activity

In determining student skills at synthesis stage in design process with CAD integration, research has been made to decide whether students using CAD technology integration in synthesis stage has made more idea changes from two dimensional to three dimensional compared to students using conventional method in synthesis stage. The research outcomes of the synthesis activity in the design process show in Table 4.

Table 4 Finding on ideas produced in synthesis activity

No	Name of polytechnic	Conceptual diagram	Early ideas produced	2D to 3D sketches
1	Port Dickson Polytechnic	110	132	126
2	Merlimau Polytechnic	119	111	109
	Total	229	243	235
	Min	3.82	4.05	3.92
1	Ipoh Polytechnic	69	70	61
2	Kuantan Polytechnic	81	80	66
	Total	150	150	127
	Min	2.50	2.50	2.12

Research outcomes show that conceptual diagram produced for treatment group is 229 (M=3.82) while conceptual diagram produced by control group is 150 (M=2.50). Research outcomes also show that sketching changes from 2D to 3D for treatment group is 235 (M=3.92) while total number of sketching changes from 2D to 3D for control group is 127 (M=2.12). It shows that treatment group is actively involved in synthesis activity compared to control group.

iv. Comparing the product of synthesis activity

The inferential finding data for synthesis activity are shown in Table 5. This inferential data will determine whether there is a significant different between the product being produced by treatment group at the synthesis stage compare to the product being produced by control group at the synthesis stage.

Table 5 Finding on comparing product in synthesis activity

t-test	n	mean	s.d	t	p
Synthesis Activity					
Treatment	60	80.6	3.72	17.184	0.000
Control	60	67.1	4.80		

Inferential data shows significant difference between initial idea created in synthesis activity using CAD technology integration (M=80.6) compared to initial idea created in synthesis activity using conventional method (M=67.1), t (118) = 17.184, significant. This proves that the initial ideas being produced from integrated method better than the initial ideas being produced from conventional method.

v. Comparing the product of simulation activity

The inferential finding data for simulation activity are shown in Table 6. This inferential data will determine whether there is a significant different between the product being produced by treatment group at the simulation stage compare to the product being produced by control group at the simulation stage. The creative and quality product being produced at the simulation stage helps the students to produce a quality final design product.

Table 6 Finding on comparing product in simulation activity

t-test	n	mean	s.d	t	p
Simulation Activity					
Treatment	60	80.5	5.46	12.267	0.000
Control	60	66.9	6.68		

Inferential data shows there is a significant difference between final design idea produced in simulation activity using CAD technology integration (M=80.5) compared to final design idea produced in simulation activity using conventional method (M=66.9), t (118) = 12.267, significant. This proves that the design idea that being produced from integrated method is better than the design idea being produced from conventional method.

vi. Comparing the final product

In this research the creativity of the design product being determined based on CPAM model which are unique, practicality and detail. This inferential data will determine whether there is a significant different between the final product being produced by treatment group in the design process compare to the final product being produced by control group in the design process. The inferential finding data for comparing design product between treatment group and control group are shown in Table 7. This finding can prove positive effects on the integration of mobile and CAD technology in the design process for producing creative product.

Table 7 Finding on comparing final product based on CPAM model

t-test	n	mean	s.d	t	p
Unique Aspect					
Treatment	60	78.0	7.07	7.134	0.000
Control	60	68.5	7.63		
Practical Aspect					
Treatment	60	78.0	4.69	6.901	0.000
Control	60	73.1	5.97		
Detailing Aspect					
Treatment	60	81.5	4.57	11.076	0.000
Control	60	71.9	4.85		
Overall Creative Aspect					
Treatment	60	79.1	4.27	10.610	0.000
Control	60	70.5	4.61		

Inferential data shows that there is a significant difference between design process integrated with mobile and CAD technology (M=78.0) compared to conventional method (M=68.5) in producing unique design product, t (118) = 7.134 significant. Inferential data also shows that there is a significant difference between design process integrated with mobile and CAD technology (M=78.0) compared to conventional design process (M=73.1) in producing a practical architectural design, t (118) = 6.901 significant. Inferential data also shows that there is a significant difference between design process integrated with mobile and CAD technology (M=81.5) compared to conventional design process (M=71.9) in producing high details architectural product, t (118) = 11.076, significant. As a conclusion, final product comparison from creativity aspect between treatment and control group show significant differences. Research outcomes also show that there is a significant difference between final product produced through the design process that being integrated with mobile and CAD technology (M=79.1) compared to final product produced using conventional method (M=70.5) from creativity aspect, t (118) = 10.610 significant. Overall, inferential outcomes show that there is a concrete effect on mobile and CAD technology integration in producing a creative architectural design. To strengthen the research finding students' perceptions on activities in design process being shown in Table 8

Table 8 Students' perceptions on activities in design process

No	Design activities	Treatment Mean (sd)	Control Mean (sd)
1	Design information searching	3.99 (0.634)	3.07 (0.680)
2	Analysis	4.00 (0.612)	3.22 (0.628)
3	Synthesis	4.03 (0.717)	3.22 (0.697)
4	Simulation	4.08 (0.627)	3.11(0.656)

The mean for students' perceptions for the integrated design process is higher than the mean for students' perceptions for the conventional design process. Student's perceptions strengthen the inferential findings that the integration of mobile and CAD technology in the design process can help the students to produce the creative products. This research shows on how the integration of web site being built using the real case approach based on the mobile device help the students to get more design information at anytime and any place. The integration of mobile technology in the design process generates students' interests to be more active in searching design information during the design process. More design being gathered by the students makes it easy for the students to design a creative product. The integration of CAD technology makes it easy for the students to change their designs' ideas from two dimensional to three dimensional. CAD technology also allows the students the real situation in their design process. This simulation activity makes it easy for the students to generate ideas in creating their design products to solve the problem being given to them.

5. The products

From this research, the integration of mobile technology and CAD technology help the students to produce quality product of architectural works. The final students' products from the treatment groups had its own identities. The products from the treatment group also show qualities of creative products based on CPAM model. Some samples from the student products are shown in the figures below.

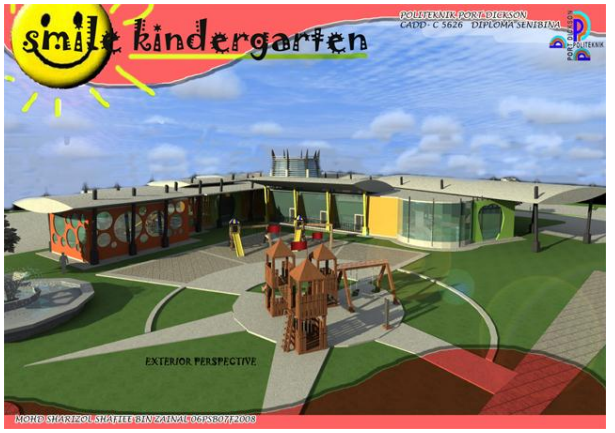

Figure 1 Sample product 1

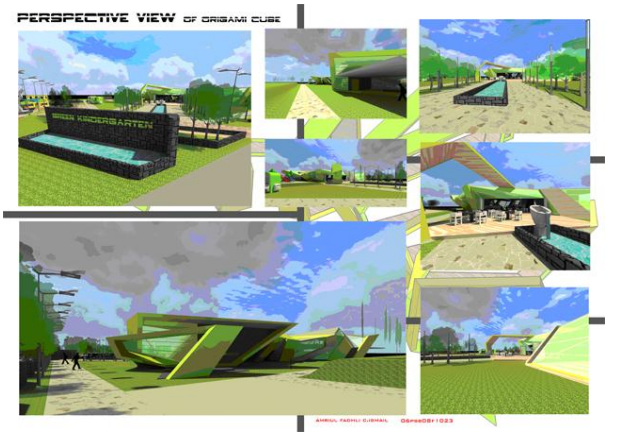

Figure 2 Sample product 2

6. Conclusion and discussion

In this research, positive research results for mobile technology based website shows that learning approach using mobile technology can be a good replacement for computer based learning approach. Students and lecturer can gain benefits from easier and faster access of information sources. When it is easier for the students to get the design information it will create interest to them to involve actively in the searching information activity. Web site being built by a real case approach also will make the students activity to search for design information become focus and easier. As a conclusion the integration of web site built on a real case based on mobile device will make the searching information activity in the design process become focus and occur at anytime and any place. Rapid development in mobile technology has contribute in growth of faster and higher memory mobile equipment, so that these mobile equipment can be used to download data faster than before and it can also save a lot of information in the memory. Mobile technology offers a creative educational approach in providing a unique learning community based on technology for the betterment of future polytechnic. Still, there has to be a lot more qualitative and quantitative research to obtain suitable guidance for mobile technology integration in learning process. In the future, graphic resolution and screen size for mobile equipment is expected to be better build. Furthermore, if internet surfing cost can be cut to a lower price, this mobile technology will definitely be useful for higher education students or out-campus students.

From CAD technology design aspects, it is proven that CAD technology are able to give comfort for student to produce three dimensional digital model and also increases students understanding of space through good visual effect. This is because CAD technology enhances student creativity and it also encourage student to appreciate interior space when student are doing simulation using different details and lighting into the same space. Using three dimensional digital model students involved more in simulation activity using different lighting and material scheme compare to conventional simulation activity. Students understanding toward space are increased with the ability to run a simple simulation into their designed interior space. With the animation, student can look at the space from a different perspective. Student gives good response towards three dimensional digital model usage to produce good quality interior space design. Overall, CAD technology via three dimensional digital models helps student to produce a creative final product design. Three dimensional digital model effects based on the finding from this research can be strengthen with the research done by Mark Von Wodtke (2000) which shows that three dimensional digital model can give good design idea and it also helps designer to validate the space, building shape and details of designed buildings. This research outcomes is also strengthen by Lawson (2007) research outcomes which states

that architect Ian Ritchie has produced a creative gallery space in London Museum with the help of CAD technology integrated design. Lawson (2007) also says that the kindergarten design produced by kindergarten teachers with the help of CAD technology has higher esthetic value than the one produced by an architect using conventional method. From this research, it is concluded that CAD technology are able to help architectural student to produce a much more creative product design. CAD technology, specifically via three dimensional digital models can boost student understandings towards space while they are in designing process through the use of good visual impact model.. Overall, mobile and CAD technology integration in design process is proven to have increase the quality of the final product designed by architectural students which has been achieved in the learning process via design module. As a conclusion this research contributes to the use of real case approach in the development of an architectural website, in the use of mobile technology as media information sources, the use of CAD technology for synthesis and simulation activity in the architectural design process and in the construction of validated instrument which is used to evaluate creative architectural products.

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