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# DEVELOPING AN ASSESSMENT FRAMEWORK: MEASURING DIGITAL LITERACY OF INTERIOR DESIGN STUDENTS IN A DIGITAL DRAWING COURSE

SOMANG YANG

46 Pages

This exploratory study provides a foundation to measure students' level of learning based on education theory for digital technology and meaningful technology theory for digital literacy. There has yet to exist an effective assessment tool that can evaluate students' digital literacy. To provide initial insight into the digital technology integrated course development, Wacom pen-tablet and Autodesk Sketchbook were utilized to create an interior design curriculum for undergraduate college students. The findings of this study shed light on the necessity of assessing new technology for integration into coursework in higher education. There are five themes that an instructor must examine when determining whether to use digital drawing tools in a course: (1) effective learning process, (2) ease of access and execution, (3) transformation of perspective about new technology, (4) technology competency, and (5) impact on the work process and continuous use. The findings of this study are: (1) a framework is needed for the educator to examine the software for proper selection according to the task and goal of the course; (2) an assessment tool is needed to measure student digital literacy; and (3) there are significant factors that influence students' perception of digital literacy based on the definition of digital literacy in this study. This study provides a brief guideline for future study development of assessment tools for digital literacy, which is essential for design professionals in the digital world.

**KEYWORDS:** digital literacy; interior design; digital drawing; assessment tool; technology integration; significant learning

DEVELOPING AN ASSESSMENT FRAMEWORK: MEASURING DIGITAL LITERACY OF  
INTERIOR DESIGN STUDENTS IN A DIGITAL DRAWING COURSE

SOMANG YANG

A Thesis Submitted in Partial  
Fulfillment of the Requirements  
for the Degree of

MASTER OF SCIENCE

Department of Family and Consumer Sciences

ILLINOIS STATE UNIVERSITY

2019

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DEVELOPING AN ASSESSMENT FRAMEWORK: MEASURING DIGITAL LITERACY OF  
INTERIOR DESIGN STUDENTS IN A DIGITAL DRAWING COURSE

SOMANG YANG

COMMITTEE MEMBERS:

Taneshia West Albert, Co-Chair

Connie Dyar, Co-chair

Bill Anderson

Elke Altenburger

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S.Y

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CHAPTER I: DEVELOPING AN ASSESSMENT FRAMEWORK:  
MEASURING DIGITAL LITERACY OF INTERIOR DESIGN  
STUDENTS IN A DIGITAL DRAWING COURSE

**Introduction**

According to the American Society of Training and Documentation, the amount of technology knowledge is doubling every 18 months (Gonzalez, 2004). Due to the rapidly increasing amount of knowledge, capacity to know is more essential than the retained amount of knowledge students previously valued (Gonzalez, 2004). To commit to meeting the needs of twenty-first century society, it is essential to be able to operate effectively in the modern era that is shaped by digital technologies (Amos et al., 2014). Accessibility to computer-aided-drawing-on-screen has increased due to the propagation of cell phones, tablets, and laptop technology, which all recognize the motion of hand or pen use on the screen. The Bring Your Own Device movement is the practice of employees bringing their own technology, which includes mobile phone, tablet, or laptop, into the work environment. This movement has influenced educational settings; New Media Consortium (2016) reported 42% of colleges and universities in the United State implemented the BYOD strategy in 2014. In this current digital age, the most profound challenges and opportunities the education system has faced are the emergence of ubiquitous connectivity, increasing digital technologies, and the power of the internet (Amos et al., 2014). While rapid changes have emerged in technology, digital competence has become crucial. However, university technological resources might be limited or fall behind current industry requirements. Digital literacy is one of the components to determine digital competency, which is affected by adequate technology (Amos et al., 2014).

Computer-aided-drawing (CAD) software and tools are necessary to help students be efficient learners and to improve their drawing skills. Although new drawing software has been developed with diverse functions to be utilized by designers, the frequency of students' exposure to the technology is determined by the interior design program. Council for Interior Design Accreditation (CIDA) professional standards (2018) require that a student's ability to draw be determined by the mean of visual communication and presentation skill. The CIDA requirements request that drawing skill be at competent entry-level standing as demonstrated by students' completed work. The completed student work includes sketches/drawings, exploration of ideas, design refinement, 2- and 3-D basic creative work, manual or digital drawings, perspectives, detailing and working drawings, and student presentations (CIDA, 2018).

Despite various usage of computer-aided-hand-drawing in the field, interior design students are not adequately being exposed to the use of digital drawing tablets and software and basic instruction for how to utilize them effectively or efficiently (Henderson, 2015). In future-focused learning in connected communities (Amos et al., 2014), digital literacy was defined as a fundamental change (more than another set of skills and knowledge to develop) in the way one contributes to a digitally enabled society, which has fundamentally changed as a result of the impact of digital technology. The need for digital literacy also affected the educational system such that teaching and learning were impacted by being able to participate in a digitally-enabled education system (Amos et al., 2014). Amos et al. (2014) stated that digital pedagogy recognizes and responds to the shifts of value in what is associated with efficient learning. To some students, a digital drawing tablet is still perceived as new technology, even though it has been around for several decades, because they have not been exposed to or had a chance to use the

tool. To improve digital literacy, it is essential to develop digital drawing skills to deepen students' level of professionalism and drawing fluency.

The major goal of digital literacy in this study is to develop leadership in the interior design program so students are more digitally aware as well as lead the way with professionals in the design industry. In this digital era, especially with emerging artificial intelligence technology, the job market will have an expectation that professionals have an established competent skill set in technology. A basic understanding of utilizing new technology has been demanded of both professionals and educators for some time.

### **Terms and Definition**

**Technology:** Digital technology that includes software or devices that create a digital image.

**Tool:** The media that conveys ideas or is used for drawing execution. In this study, tool indicates software, device, or any other media that can carry data as an input or output method.

**Traditional Drawing:** The word “traditional” has been used to convey the media for drawing, mostly paper drawing before computation.

**Sketching and Drawing:** Activities of making and developing spatial visualization (Alias, Gray, & Black, 2002). Maizam (2002) defined the nature of sketching as estimating proportions and lengths by the eye, while standardized drawing follows a specific scale. However, in this study, sketching and drawing are used interchangeably to mean a method for spatial visualization of the designer's idea.

**Pen-tablet:** Computer hardware as a replacement for a mouse, imitating a pen shape.

Autodesk Sketchbook: Drawing software that includes functions for sketching and for imitating Adobe Photoshop.

### **Purpose of The Study**

The purpose of this exploratory case study is to discover how a digital drawing course, using digital drawing tablets and software during the drawing process, can improve interior design students' understanding of drawing concepts. This will allow the researcher to examine whether the digital drawing class more efficiently teaches concepts by utilizing diverse digital tools. Moreover, student achievements with digital literacy will help the educator assess the instruction tools and methods to prepare for future design courses.

By measuring the efficiency of the digital drawing tool and how usage of the digital drawing tool and software affects students in their digital literacy, this study will serve as a pilot study or reference for educators' course development. Moreover, this study can be a base for developing a digital technology course model in design academia.

There are several assumptions to begin the study:

*A1: Drawing is one of the fundamental skills required to be a practicing interior designer.*

*A2: Digital drawing exercises is a complementary method for learning hand drawing.*

*A3: Meaningful technology can transform students' learning process (Sadik, 2008).*

The basic hypotheses of this study, based on these assumptions, are:

*H1: There will be a significant difference in perspective toward the new technology before and after the course exercise.*

*H2: There will be a significant relationship between significant learning theory, meaningful digital technology learning, and digital literacy.*

*H3: Digital integrated course design will significantly influence student learning toward digital tools.*

Based on the hypotheses, the next questions emerged from the need to measure the effect of a digital drawing tool and software on the following student outcomes: understanding of complex rendering principles, application of the knowledge, integration of understanding in problem solving, the shift to digital-enabled solutions in the design process, and a lasting change in usage for their future career.

*RQ: Can digital literacy be increased through a computer-aided drawing integrated rendering course more than through the use of traditional tools?*

To answer this question, the following questions are presented:

*RQ 1-1: How can we assess digital literacy or transformation?*

*RQ 1-2: What differences do students have in perception of computer drawing software and computer drawing tools?*

*RQ 1-3: Is pen-tablet meaningful technology?*

*RQ 1-4: What factor of students' perception is related to the level of expectation for future use of the technology?*

### **Significance of The Study**

There is on-going interest in developments in education and technology for higher education, including the need for developing digital literacy and the theoretical perspective of implementing technology within the design course. This study may help teachers by providing them a new pedagogical approach and future-focused integration of technology curriculum that may result in efficient technology education. By providing a clear aspect of using digital

technology within the course, what is efficient or not, and how to develop a drawing course, interior design instructors will gain insight into using drawing technology in their curriculum.

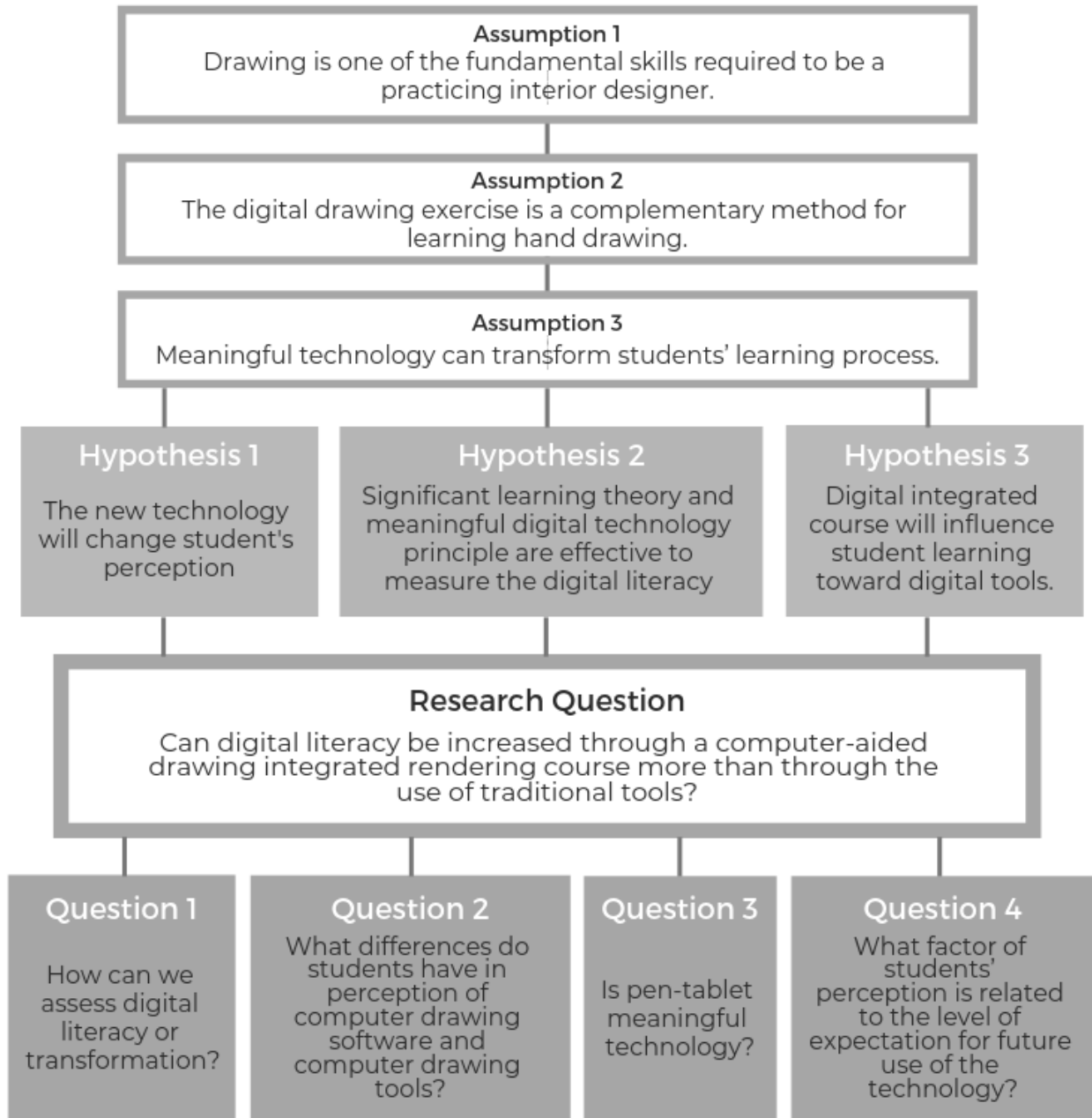


Figure 1. Research Question Development Process



## Methods

The study utilized surveys for data collection: one survey at the beginning of the course and one at the end to assess digital literacy by measuring students' change in perception of their work and tools utilized in the class. Multiple methods of data collection and analysis were employed to enhance validity and reliability of the study. Therefore, a scaling rubric instrument was used to investigate factors that influenced students' perception and to assess level of engagement in learning. In addition, open-ended questions were conducted to determine the accuracy of the survey results.

The sample was recruited from a public university with undergraduate students enrolled in a CIDA-accredited interior design program. The course was offered in the fall semester. Among the 21 students taking the rendering for interior design course for the fall semester, 17 students agreed to take a pre-survey before the start of lessons for the digital drawing class, and 13 students agreed to take a post-survey after they finished the course. The population of this study is representative of interior design students in Illinois who have yet to reach a high level of drawing or visual skill before they attended the interior design program. A large majority (95%) of students in the interior design program are female; male students could not be sampled within this scope of study. Participants were in their fourth academic year and the majority had no or not significant experience in digital drawing software or the digital tool. In some institutions, the interior design program does not require a portfolio for admission, thus most of those students have less experience in sketching or drawing than the population group in interior design programs that require a portfolio for admission and acceptance to the program. This study observes undergraduate university students ages 20 to 21, majoring in interior design, and participating in an advanced-level rendering course.

## **Instrumentation**

Information from a pre-existing “course readiness” survey disseminated by the professor of record as a standing activity to analyze course readiness was analyzed against a short post activity survey given by the researcher.

The pre-test survey consisted of 22 questions asking about prior experience, satisfaction of the tools as an assistant medium, perception of the tool, and comfort in use of the tools. An R.A.T. model was applied to evaluate the level of understanding: future project application (integration), understanding of the drawing principles (understanding), and any changes after digital lesson (transformation). Students completed an identifier form where they provide a unique four-digit numeric/alphabetical code that served as their sole identifier on surveys and student works for this study. Surveys with student identifiers were eliminated from the data set and not included in this study.

The post-test was designed according to the five themes of using digital drawing tools: (1) effective learning process, (2) ease of access and execution, (3) transformation of perspective about new technology, (4) technology competency, and (5) impact on work process and future usage. The survey consisted of 56 questions with four questions asking for a short comment. This survey was taken two months after the course ended. The terms used for the questions followed the verbs in accordance with the hierarchy of level of learning in Bloom’s digital taxonomy (Churches, 2008). Some terms were utilized to support the significant level of learning (Fink, 2013). The terms and aspects of these theories satisfy the definition of digital literacy for this study: the ability to read, interpret, and reproduce data and images using digital devices; the ability to utilize the digital knowledge by application, evaluation, and creation effectively; and the ability to collaborate, share, and communicate using resources in the digital environment. A

revised Bloom's taxonomy (Krathwohl, 2002) categorized the level of learning achieved to cross-check the assessment on students' level of learning and find the meaning of the stage of learning.

### **Technological Instruments**

**Software.** The in-class lesson introduces students to digital drawing tools, software, and concepts, emphasizing understanding of the functions and building fluent digital drawing skills. Previous drawing experience is a prerequisite for this lesson, as this rendering course required an advanced level of drawing that can be optimized for rendering beyond what was needed in the basic drawing course they took as a prerequisite. This course aims to prepare students for entering a professional interior designer career where they will utilize visual presentation skills. Linear perspective, figure/ground relationships, shading techniques, tonal value, visual perception, spatial concepts, and critical thinking skills are all emphasized extensively. During this course, a digital drawing tool, Wacom pen-tablet, is used along with digital drawing software, Autodesk Sketchbook, for a duration of four (4) weeks. The expected student achievement level is adjusted in accordance with the course level. The instruction and lecture were included in the digital rendering section of the curriculum. The course was designed before this study was executed, but the software, Autodesk Sketchbook, was included in the course for this study due to its unique function that includes a perspective guide. "Perspective drawing" is one of the drawing principles students learned as part of their prerequisite mechanical drawing course; however, it was observed, over two years, that the instructor spent one lecture explaining the perspective drawing method even though students already took the perspective drawing lecture, and a number of students still had issues with applying the principle.

Thus, the software was chosen as a replacement for instruction about perspective as a complementary tool to help student understanding.

**Device.** The Wacom pen-tablet was utilized as a replacement tool for the hand-drawing tool. The basic feature of this tool is digitalization of hand movement by tracking the movement and presenting the data on screen, converting movement to a drawing path. As an output of this process for drawing, the screen replaces paper as the outcome with multiple options for brush type and color. The Wacom pen-tablet utilized for this study was Intuos Drawing, which has a separate board and pen as the input media or tracking movement (drawing). When output media is separated from the input media it causes discomfort in the technical qualities of form and line, and the aesthetic qualities of style and line, due to its unfamiliar position for the eye and hand to the monitor to evaluate the output (Tan, Peek, & Chattaraman, 2015). In comparing the efficiency of digital drawing tools by measuring the user perception of quality outcomes, the participants' preference among these tools was mostly due to its familiarity (Tan, Peek, & Chattaraman, 2015). This study concludes that the perception of the tool is linked to affordances and constraints that affect interaction between user and tool. According to Tan et al.'s study, the interface of Intuos tablet, shown below, was the least preferred interface among the comparison group, according to this theory. This course has been utilized the Wacom Intuos tablet due to the limited support from the department.

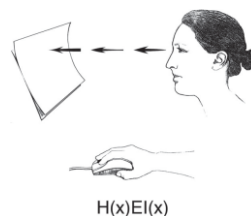


Figure 2. HEI position  $H(x)EI(x)$ . Reprinted from “HEI–LO Model: A Grounded Theory Approach to Assess Digital Drawing Tools”, by L. Tan, P. F. Peek, V. Chattaraman, 2015, *Journal of Interior Design*. Copyrighted by Wiley-Blackwell

**Activity.** One of the activities in the course includes the peer-review critique, which involves providing written feedback to peers about their progress according to 10 elements of concepts they have learned during this rendering course. Students also submit a corrected version of their peer's work based on their review sheet by utilizing functions in Autodesk Sketchbook. The outcome of this activity reflects their learning in two ways: (1) critical thinking skills, which is a higher level of learning process (Krathwohl, 2002); and (2) Bloom's digital taxonomy by digital file transforming, sharing, and duplicating (Churches, 2008).

After the end of the first digital rendering exercise, a narrative rendering activity is introduced that involves half an hour of lecture on the concept of narrative and inspirational art works, which helps students' understanding of narrative in images. Parallel to creating visual design, creating story is one of the ways to improve imagination and creativity.

### **Digital Literacy Framework Assessment Methodology in Theoretical Perspectives**

To assess the students' digital literacy, the R.A.T. framework was utilized and adapted. The R.A.T. framework is a technology educational model and is defined as: (1) replacement, (2) amplification, and (3) transformation (Hughes, 2006). For in-depth analysis of students' learning experience, the themes of significant learning (Fink, 2003) and Bloom's digital taxonomy (Churches, 2008) were utilized to select the digitally meaningful terms and to navigate participants' level of learning.

The R.A.T model is developed to assess technology integration into K-12 classrooms. This model determines the level of effect the technology has and defines its basic role as replacement of the traditional tool. The next role of technology is to amplify the instrument for learning by increasing efficiency or productivity of its use. Transformation means that the technology transforms instruction, student learning, and even the subject itself. The concept of

transformation involves changing the user’s perspective of the technology because they envision new uses of the technology. The R.A.T model defines the curriculum goals as the knowledge to be gained, learned, and applied. Beyond the knowledge students will gain, the experience and learning through the course transform student mental processes toward the use of technology. Reinking (1997) observed that multimedia books changed classrooms, reduced instruction, increased peer interaction and collaboration, and increased students’ role.

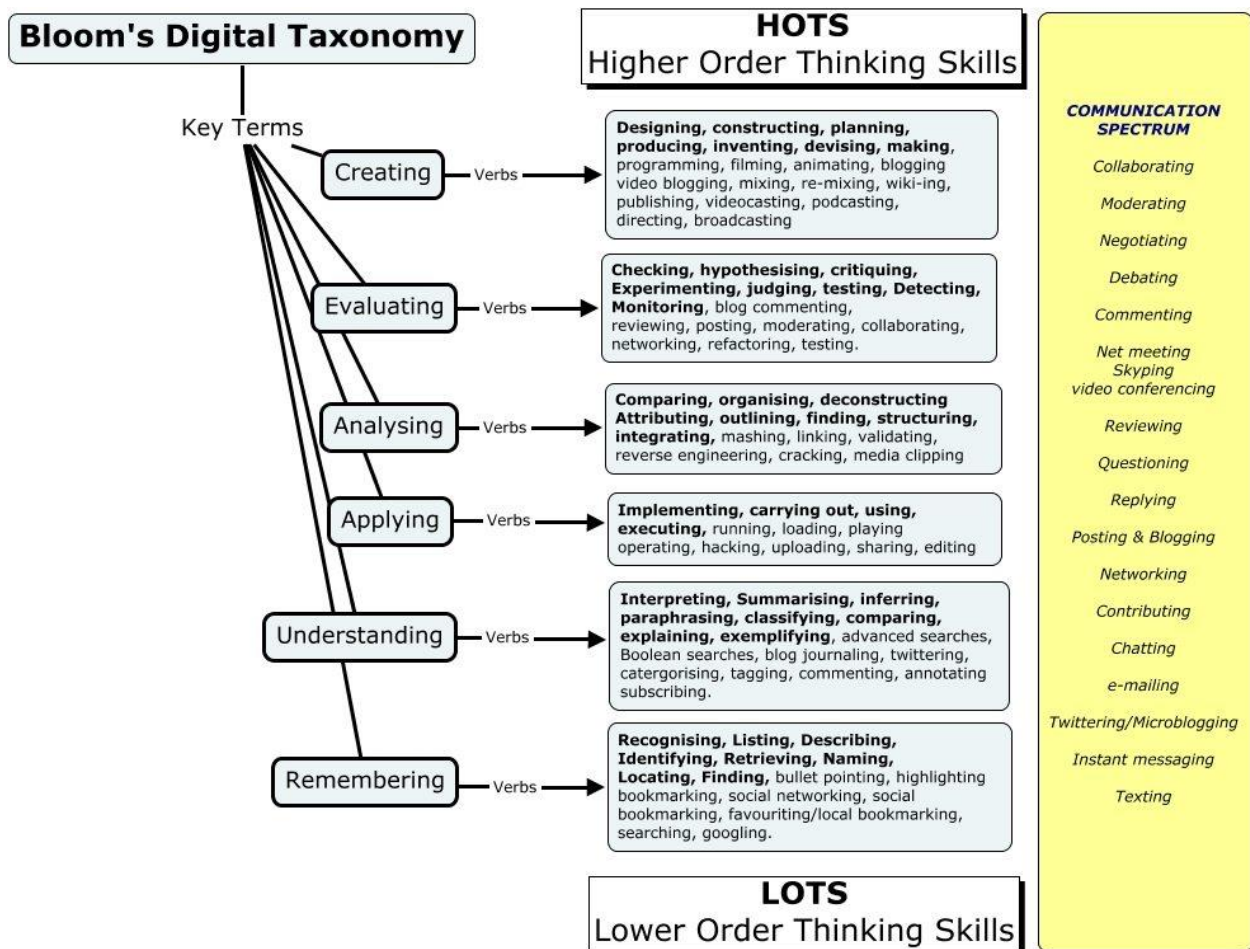


Figure 3. Churches mind map of Bloom’s Digital Taxonomy by Teaching Thought Staff (<https://www.teachthought.com/critical-thinking/ablooms-digital-taxonomy-for-evaluating-digital-tasks/>)

## **Data and Analysis Indicator**

The students produced their rendering assignments in the condition of an ordinary rendering course at the university, in class with their instructor. Two variables during the period of this study are that students were provided new technology—the Wacom pen-tablet device and Autodesk Sketchbook (suggested) software—and a new mixed-method lecture format that provided both formal and informal instruction for both tools.

One-way ANOVA was used as an analyzing tool to see the relationship of mean values of selected factors and variables. Linear regression and ordinal regression model were utilized to crosscheck results.

## **Results of This Study**

To find the results for the hypotheses for this study, the following questions should be answered.

1. Do students reach the level of transformation through the course?
2. Does a digital drawing course change student perception toward digital technology?
3. Can a digital drawing tool change students' perception toward new digital tools?
4. What factors of students' perception affect their digital literacy or transformation?

To answer these questions, Bloom's taxonomy and the R.A.T. model were utilized based on the definition of digital literacy. This study emphasizes the digital taxonomy in Bloom's taxonomy: editing, mixing, converting, organizing, commenting, critiquing, and posting. The R.A.T model was utilized as a navigator to assess the taxonomy within the concept of transformation for the definition of digital literacy.

In this study, meaningful learning reaches beyond the knowledge and experience students gained during the class that increases their potential use of new technological tools. The

emphasized dependent variables among the 53 survey questions in the post-test were: future use of the tools, developing interest and confidence in new tools, and generating need of digital tools. The analysis is seeking the factors that influence students' transformation in their learning process toward new technology.

A one-way between subjects' ANOVA was conducted to compare the effect of confidence in software on interest in the software, and extended interest in new software. There is no significant effect of confidence on interest at the  $p < .05$  level for the three conditions [ $F(1, 11) = 0, p = 1.000$ ], [ $F(1, 11) = 0.006, p = 0.937$ ]. Usefulness of the software for execution is one of the factors that affects interest in using other software (Linear regression;  $p = 0.008$ , Standardized Coefficients  $\beta = 0.700$ ). The participants' feeling of capacity in editing and mixing the digital resources has a positive relationship with the factors that influence expectation to use the software in the future ( $p = 0.009, p < 0.05$  level, Standardized Coefficient  $\beta = 0.700$ ). Usefulness and the function for editing and mixing digital resources are significant factors that define students' self-cognitive transformation. The average mean of students' perception toward the software was positively scored ( $M = 4.45/5, N = 13$ ), which indicates students' satisfaction with the software. All members of the sample group agreed or strongly agreed that they would use the software in future projects. Nine of 13 participants were interested in using new software after they took this course, and four participants of 13 had no interest or a neutral opinion of their interest to use new software. Satisfaction toward overall rendering principles, such as value, tone, hue, and scale, significantly predicts curiosity to know more functions of the software,  $\beta = .700, t(11) = 2.87, p < .01$ . Satisfaction also explained a significant proportion of variance in interest in more function scores,  $R^2 = .238, F(1, 11) = 10.577, p < .01$ .



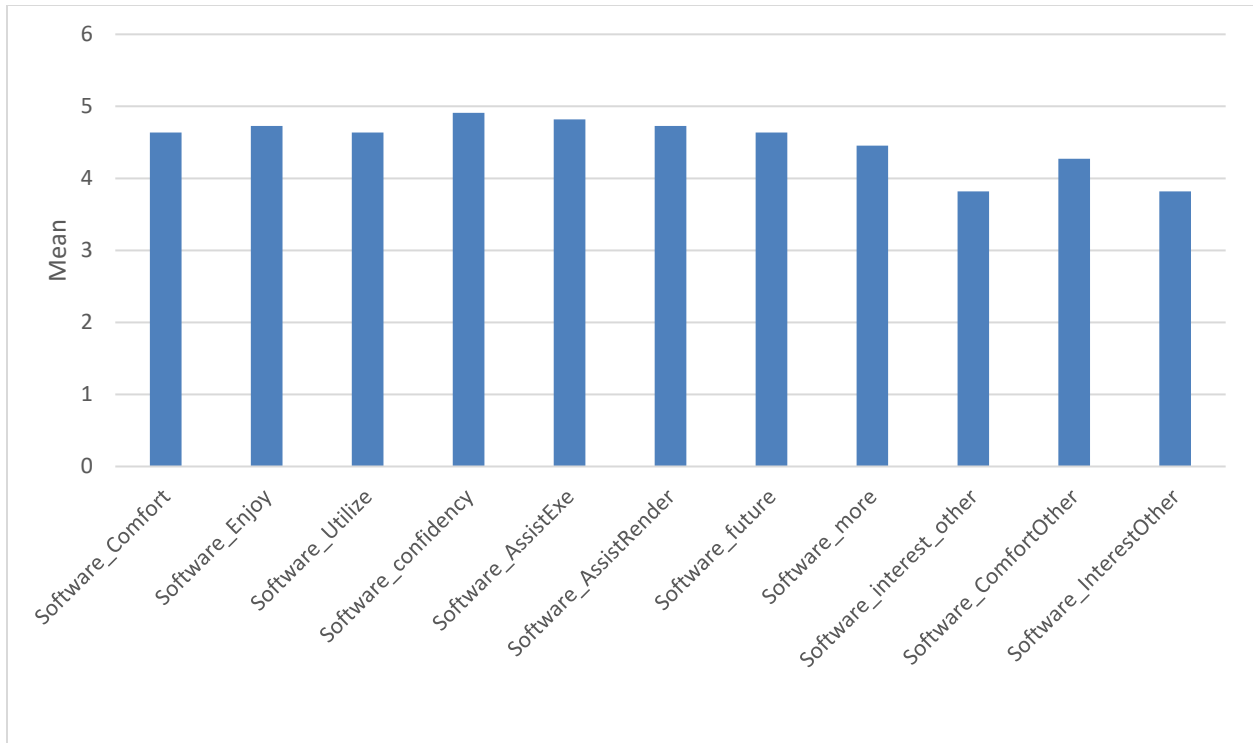


Figure 4. Impact on Students' Perception Toward Software After The Course

Easiness in execution of the device (students feel the tablet is easy to use) affects student perception of the device. According to the survey results, there was a significant difference in: (1) their perception of their ability to edit and mix digital resources for materials, entourages, and their digitalized paper renderings; (2) enjoyment during the use of the tool; (3) perception of the device as an assistant tool for execution; and (4) expectation for future usage of the device. Students' future expectations of the device showed significant relationship in: (1) editing and mixing digital resources, (2) perception in assistant tool for execution, (3) needs of access, and (4) easiness of use. Participants' perception of the tablet as an execution tool and assistant tool for understanding drawing principles do not have a significant relation in  $p < .05$  level. Also, there is no significant difference in the view of the device for its easiness of organizing and editing in  $p < .05$  level. The self-reflective level of confidence when using the tablet significantly

differs in comparison with expected confidence in utilizing the device in the future ( $p = .000, p < .001$  level). Confidence of device predicts comfort in use of new devices in the future ( $F(3, 8) = 33.867, p = .000, p < 0.001$  level), assisted rendering ( $F(3, 7) = 16.642, p = .001, p < 0.01$  level), and efficiency in execution ( $F(3, 8) = 66.667, p = .000, p < 0.001$  level). Comfort using device significantly affects plan for use of device in the future ( $F(4, 7) = 22.225, p = .000, p < 0.001$  level) and confidence ( $F(4, 7) = 19.250, p = .001, p < 0.01$  level). Participants who had the highest confidence in using the tablet for rendering ( $M = 5$ , strongly agree) strongly agreed that they were comfortable in using a new device, and participants who had less confidence in the use of the tablet felt less comfort in the use of a new device in the future. Confidence of the device and future use of the device are significantly impacted by the feeling of comfort toward a new device ( $p = .001, p < 0.01$  level).

According to Bloom's digital taxonomy by Churches (2008), attitude toward the future use of the tool is significantly affected by the digital aspect of the device to edit and mix digital resources, organize images and data, and manipulate and transform. The attitude toward the tablet also changes the feeling of improvement over traditional rendering, confidence in utilizing, and expectation to use the device in the future. However, the attitude of the tablet as an effective execution tool does not show significant difference in interest in other devices and need of access of the tablet. Preference of the tablet as an editing tool rather than traditional rendering tool made a significant change in their level of comfort, enjoyment, utilization, confidence, and expectation for the future use. However, preference of the tool did not make a significant difference in the expected level of comfort toward new devices.

According to the results, answers for the questions are: (1) students reached some level of transformation through the course; (2) the digital drawing course for this study changed student

perception toward digital tools; (3) the digital drawing tool did little to change students' perception toward new digital tools; and (4) influential factors affecting students' perception of the digital literacy or transformation were featured advantage as digital software, confidence, easiness, and featured advantages for execution in use of device.

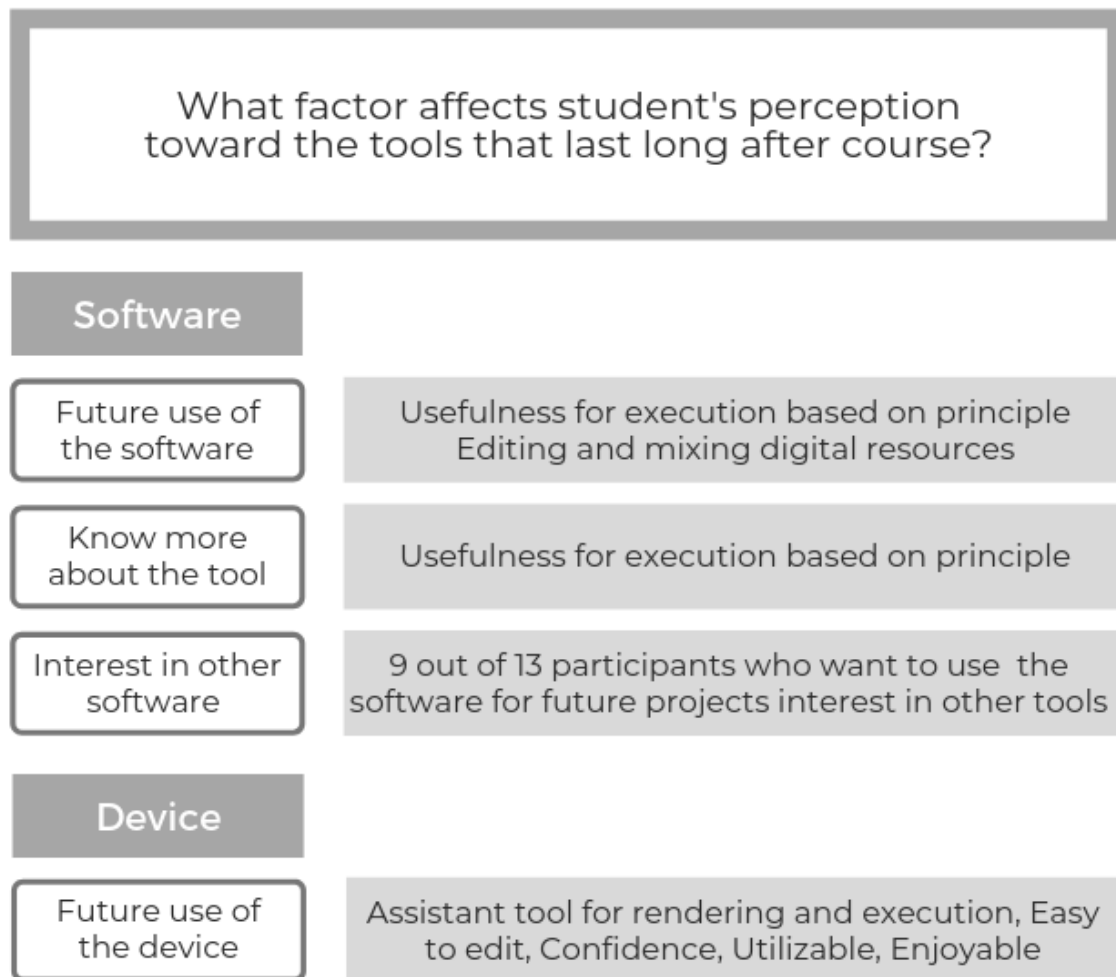


Figure 5. Factors Affecting Students' Perception Toward The Tools After The Course

<b>ANOVA</b>						
		Sum of Squares	df	Mean Square	F	Sig.
Device_Execution	Between Groups	24.726	3	8.242	43.271	0.000
	Within Groups	1.524	8	0.190		
	Total	26.250	11			
Device_principle	Between Groups	22.143	3	7.381	38.750	0.000
	Within Groups	1.524	8	0.190		
	Total	23.667	11			
Device_improvement	Between Groups	18.060	3	6.020	16.856	0.001
	Within Groups	2.857	8	0.357		
	Total	20.917	11			
Device_Edit_Fix	Between Groups	13.393	3	4.464	6.466	0.016
	Within Groups	5.524	8	0.690		
	Total	18.917	11			
Device_Organizing	Between Groups	18.286	3	6.095	20.480	0.000
	Within Groups	2.381	8	0.298		
	Total	20.667	11			
Device_Comfort	Between Groups	18.060	3	6.020	16.856	0.001
	Within Groups	2.857	8	0.357		
	Total	20.917	11			
Device_Enjoy	Between Groups	24.250	3	8.083	24.250	0.000
	Within Groups	2.667	8	0.333		
	Total	26.917	11			
Device_Utilize	Between Groups	13.393	3	4.464	23.438	0.000
	Within Groups	1.524	8	0.190		
	Total	14.917	11			
Device_confidency	Between Groups	14.476	3	4.825	25.333	0.000
	Within Groups	1.524	8	0.190		
	Total	16.000	11			
Device_AssistExe	Between Groups	23.333	3	7.778	23.333	0.000
	Within Groups	2.667	8	0.333		
	Total	26.000	11			
Device_AssistRender	Between Groups	14.052	3	4.684	38.253	0.000
	Within Groups	0.857	7	0.122		
	Total	14.909	10			
Device_Easy_editing	Between Groups	27.000	3	9.000	108.000	0.000
	Within Groups	0.667	8	0.083		
	Total	27.667	11			

Figure 6. Statistical Results; Factors That Affect Future Pen-Tablet Use

## **The Findings of This Study**

The finding of this study is the need for an assessment tool to measure student digital literacy. The meaningful factors that affect student digital literacy are the featured characteristics of the digital technology utilizing digital resources. It is not easy to overlook the advantages of digital tools for a drawing class and the impact they can have on learning. A guide for selection of software and digital device is also needed because there is a vast difference and ability between tools. Also, there are various ways to combine these tools that create different experiences.

Currently, virtual reality is one of the influential technologies used as a presentation method. The emerging technology of artificial intelligence will be ubiquitous within several decades. The speed of emerging technology will be accelerated because the millennials participate in the industries and market with more readiness for the digital format. More people, including professionals and even the customers, will have access and use of software and devices; more tasks that used to be professional work will be transferred to customers. Thus, the role of the professional should be redefined and adjusted. The next professional generation should have digital literacy and be capable of utilizing, customizing, or developing new technology in accordance or in advance of the current stream. Digital literacy is an essential ability as the term “literacy” means especially for design professionals. Design professionals are the leaders of trends and lifestyle. Designers’ creativity and design solutions focus value on the human-centered mind and having insight to human needs in order to create a new environment. In this digital world that consists of millennials, insight of digital technology is an inescapable ability for design professionals.

H1: There will be a significant difference in perspective toward the new technology before and after the course exercise.

H2: There will be a significant relationship between significant learning theory, meaningful digital technology learning, and digital literacy.

H3: Digital integrated course design will significantly influence student learning toward digital tools.

According to the analysis of the results, the hypotheses above were proved to be agreeable hypotheses; however, there are two main limitations. Due to the small sample size, it is hard to think that the sample is representing the population. There is also uncertainty in the accuracy of the assessment tool.

### **Conclusion**

Research shows that several factors influence transforming students' learning for digital literacy. In the use of software, digital optimized function and capacity, such as editing and mixing the digital data and usefulness of execution, are critically influential factors that change expectation and curiosity for future use of the software. In comparing Tan et al.'s (2015) study, one of the other factors that might have affected preferences of the tool is selection of the software. In their study, the researchers utilized Adobe Illustrator, which has a point function that can be edited freely by the action of clicking. In contrast, Autodesk Sketchbook is more optimized for free drawing rather than editing the points. Students' perception of digital drawing might differ by the software they use. For digital drawing research, the interface and main feature of the software must be considered on selection of software. Autodesk Sketchbook is architectural sketch software with its notable feature of a perspective guide function that can replace the perspective drawing principle integrated with image editing and transforming

functions. The reason for selecting this software is that it involves several functions that combine drawing principles with advantages of computer-aided design—utilizing layers, adjusting images by layer, transparency option, easiness to manipulate the digital images by transforming, editing, and mixing—and its interface is based on freehand drawing with a lot of functions that guide the user to correct and adjust the input of hand movement. Moreover, this software is accessible to students and there is a potential to convert the Autodesk Sketchbook project to common 3D modelling software within the same production, such as Autodesk Revit, Autodesk CAD, and Autodesk 3D Max.

The Wacom tablet was chosen because of its financial convenience. The difficulties and unfamiliarity were derived from an unfamiliar hand-to-eye interface (HEI position) that requires hand-eye separated monitor skill (Tan, Peek, & Chattaraman, 2015). Despite the limitation of the device caused by the HEI position, participants answered that rendering with the digital drawing device was easier to edit than rendering with traditional tools ( $M = 3.82$ ). The question asked about the editing process, which exists throughout most of the rendering process. If editing influences most of the rendering process, efficient use and effect of editing can be a significant factor that changes user perception toward the tool. This result indicates that even with limitations coming from an unfamiliar interface of pen-tablet, students perceived the device was effective or useful for rendering. The results lead the author to believe that the improved device could bring a tangible result. If the students used the same interface with a traditional method, the user's perception would be influenced by many other factors that could change the user's perception of other tools. Also, this represents the inevitable effect of digital tool integration.

## **Limitation and Discussion**

Some studies about digital technology integrated courses have been limited by a small sample group (Chu, Hung, Wu, & Liu, 2017; Tan, Peek, & Chattaraman, 2015), and the selection and application of software differs by the instructor. As Tan et al. (2015) pointed out, instructor bias and preference of technique make it hard to collect the sample and the data as one study. The first limitation of small sample size has been noted by many other researches; however, the finding through those studies is that many researchers agree there is a need for digital technology despite students' preferences, and there is an effort to find efficient and meaningful integration. The rationale for the sample size of this study, as an exploratory study to build an assessment framework to determine students' development of digital literacy, is to gain positive insight on how to navigate the next step—what is needed and what is not needed.

There are variables that should be considered when designing a digital integrated course or project. During the digital rendering class, many students were frustrated in the beginning with using the pen-tablet. It seemed hard for them to get used to the tool within 24 hours of course work, while the instructor had been teaching the course for two years. There was a limited budget to support better digital devices that have an identical interface as a traditional drawing, but the traditional way was still less preferable than the pen-tablet, though the choice of software did change (Islamoglu & Degar, 2015; Tan, Peek, & Chattaraman, 2015). The reaction and output of students differs by the software as indicated after students used two software programs for the digital rendering class, as well as indicated by the literature review of other studies about digital drawing. The difference between the two software programs was the existence of a time-saving guide tool that replaces the sensitive hand movement and satisfies the aesthetic outcome (Tan, Peek, & Chattaraman, 2015). Those functions even replace the drawing principles that take



a long time for students to understand and utilize. The content of the lectures changed from being focused on the principles to instruction on how to use the guide function. This change is presented as a role of technology to transform content (Hughes, Thomas, & Scharber, 2006).

The digital pen-tablet cannot replace the paper and pen tool now. However, these hardware and software tools can be utilized and adjusted in accordance with the needs of design students and instructors, as well as the designer as practitioner.

### **Implications for Research and Practice**

The category of instructor's meaning for using digital drawing tools includes five themes: (1) effective learning process, (2) ease of access and execution, (3) transformation of perspective about new technology, (4) technology competency, and (5) impact on work process and future usage. The findings of this study are: (1) a framework is needed to examine software, so the educator can make a proper selection according to the tasks and goals of the course; (2) an assessment tool is needed to measure student digital literacy; and (3) there are significant factors that influence students' perception of digital literacy based on the definition of digital literacy in this study. The small sample size suggests limited validity of this study due to skewed data or other factors not considered; however, this study provides a brief guideline for the next study to develop an assessment tool and to measure digital literacy, which is essential for design professionals in this digital world.

Tan et al. (2015) proposed that even though users' prior experience critically shapes their preference, it might not be reasonable to rely on user perception as an indicator of efficiency. This thought has motivated this study and the examination of the current digital rendering course using a pen-tablet, knowing of difficulties arising from unfamiliarity of the device. There will emerge a variety of VR, AR, or other devices, and adaptation to fast changing technology will be

one of the indicators of a professional's ability. The institutional role for design students is to provide more accessibility to digital technologies to prepare students to be professionals in the digital era. This study is derived from the need to develop digital literacy in interior design students, because the nature of design requires high-end technology from ideation to presentation. However, there has yet to exist an effective assessment tool that can evaluate students' digital literacy. With assessment, educators can objectively measure the effectiveness of their courses for student learning. With an assessment tool, course lessons can be modified to optimize efficiency and effectiveness for digital literacy. The modified technology course and assessment tool based on findings of this study will be used for the next phase of the study. The next step will be to retest with students in multiple universities. The redesigned course and assessment tool will be followed by a redesigned studio space focused on the optimization of digital literacy. This framework can be applied in different areas. The application can be utilized with other population groups in workspaces or other study areas of academia.

## CHAPTER II: EXTENDED LITERATURE REVIEW

### **Introduction**

Literacy is defined as an ability to read and write. However, in the digital age, digital literacy goes beyond the ability to read and write; to be digitally literate reflects the ability to adapt to changes in how to process, deliver, and receive information in today's highly connected world (US Digital Literacy, 2016). Many universities have come up with their own definitions of digital literacy. The University of Illinois (2014) defines digital literacy as

...the ability to use digital technology, communication tools or networks to locate, evaluate, use and create information. The ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers. A person's ability to perform tasks effectively in a digital environment.

Jones-Kavalier (2006) says digital literacy

...represents a person's ability to perform tasks effectively in a digital environment, with "digital" meaning information represented in numeric form and primarily for use by a computer. Literacy includes the ability to read and interpret media (text, sound, images), to reproduce data and images through digital manipulation, and to evaluate and apply new knowledge gained from digital environments.

Thus, in this study, digital literacy basically takes a role as a medium and as a tool to get information and to produce. Beyond the basic literacy level, from an institutional view point, digital literacy is an advanced level of literacy that includes the ability to read, interpret, and reproduce data and images using digital devices, the ability to utilize the digital knowledge by application, evaluation, and creation effectively, and the ability to collaborate, share, and communicate using resources in the digital environment.

## **Need of Drawing Skills for Interior Design Students**

Drawing is one of the essential communication methods for a designer in the design process and collaboration. The Council for Interior Design Accreditation 2018 (CIDA, 2018) set professional standards for the required level of drawing skill. CIDA proposed the professional level of skill for drawing as “communication skill such as matrices for bubble diagrams, sketches and drawings” within the ability to apply “competent entry level skills that must be demonstrated in completed student work.” Even though 3D modeling and software have replaced much of the workload for drawing, it is inevitable that designers develop drawing skills as part of their visual literacy and as a communication method.

Pamela Schenk (2005) investigated students’ attitude toward the role of drawing in higher education in the United Kingdom by conducting decades of examination (p. 2). This comparison study analyzed present studies and found that there was a gap of more than twenty years between industry and education; the respondents in this study were design practitioners in design studios and educators in art and design. The primary study examined the role of drawing in the perspective of design practitioners in the 1980s and the value of drawing courses in higher education (Schenk, 1989). The following study identified the role of drawing along with computer technology in the perception of design educators (Schenk, 1991, 1998). In the primary study, all participants rated the development of drawing ability as “essential” or “important.” In comparison, only two-thirds of educators in the second group agreed that the development of drawing ability is “essential” or “important,” but most of the group agreed that the value of developing drawing ability in education is crucial for design students (Schenk, 2005). The respondents of her study in 2005, who had teaching experience, admitted both the need for

digital software from the early stage of the design process and the ability to quickly draw for ideation, pointing out the limitation of free drawing in digital technology.

Respondents of this study identified that the digital computation technology changed “the range of drawing skills required from those in the pre-computer era.” The change derived from the use of computers had an influence on the curriculum, especially the need for detailed resolution and rendering work using drawing skill (Schenk, 2005). However, the most respondents of Schenk’s study in 2005 believe that students still need the ability to draw as a visualization tool in the early stage of design to build ideas for images and ideation. Students learn to develop and approach their ideas by exploring various design processes, and drawing in ideation is part of the process in a design curriculum.

### **Digital Drawing in Interior Design Field**

Tovey et al. (2003) reviewed the role of sketching and the separate role of computer-aided-design (CAD) with the former as a thinking tool and the latter as a communication tool in the design process. Senyapili and Basa (2006) found a strong connection between creativity and sketching by hand as a technique for the future of design. Robertson and Radcliffe (2009) pointed out that experience with CAD tools can reduce the negative effects CAD tools may have on creative thinking in the early stage of design due to its nature of quick and easy modification.

Demands of digital drawing in current tides of academia needs to be reformed since the use of digital tools is required in academia despite the fact that digital tablets and digital sketch interfaces are widespread and becoming standardized in the profession (Eissen & Steur, 2012; Olofsson & Sjolen, 2007).

## **Need of Hand Drawing**

Hand drawing gives students more “freedom,” which suggests more “solutions” due to its intuitive relationship with the design student (Laisney & Brandt-Pomares, 2015). Laisney and Brandt-Pomares (2015) found that the use of traditional drawing, before the use of 3D modeling CAD tools, allowed students to develop quantitatively more solutions. Even though the participants of Laisney & Brandt-Pomares’ study (2015) consisted of high school students, the result is still valid for university students in the case of limited experience in using CAD tools for drawing.

Hubka (1996) stated the digital design process usually contains four stages: problem formulation, conceptual design, configuration design, and detailed design. Tovey (2003) defined the three functions of sketches: visual representation for communication and recording, visual interpretation for evaluation, and visual thinking for production of creative thoughts using images. With freehand drawing in the visual thinking process, designers reduce the cognitive load, encouraging free flow of thoughts that can generate creative and innovative thinking (Chu, 2017).

Utilizing new tools for learning elevates deeper-learning. The current trend for learning approach in higher education is the deeper-learning approach (Becker et al., 2018). The Pew Research center report suggested five major themes to be prepared as a professional for the digital age of work; one of the major themes was that self-directed learning will become the new credentialing system (Rainie & Anderson, 2017). The NMC Digital Literacy Impact survey took place April through May of 2017, targeting graduates from 82% of four-year universities and 17.5% of two-year colleges (Becker et al., 2018).

## **Use of Pen-Tablet**

Despite the fluency of using a pen to ideate, sketching with a pen requires time-consuming and repetitive work. To employ the digital method tools, a natural pen-like interface is provided, and the output is integrated into the CAD system. Students' preference for a pen was proven in Tan et al.'s (2017) research, which showed a negative reflection toward the Wacom pen-tablet due to the different interface on a different visual monitor and the designer's action-tracking while drawing. One of the differences between Tan et al.'s (2017) HEI-LO project and this study is the selected software for instruction. The CAD software is the variable with the most impact on the user's experience (Tan, Peek, & Chattaraman, 2015). That is the reason Wacom developed another series with a similar interface to a traditional drawing system while replacing paper with a monitor. It is true that users of the Wacom tablet have some discomfort issues with the input interface, but still there are advantages to manipulating digital drawings using a computer. However, educators need to provide more instruction related to the advantages in order to diminish the disadvantages; students need opportunities to explore and discover new functions and advantages with thoughtful lecture and course design.

It is common practice for illustrators, animators, and most drawing-driven practitioners to use a pen-tablet due to its advantages as a digital resource incorporated with software, its use in collaborative work, and improvement in the work process, as well as its easiness of manipulation and ability to explore multiple options by duplicating the file. Drawing-driven practitioners have adopted the digital pen-drawing tool from an older, pre-digital age generation. It is essential for suggesting multiple options to designers so as to find the right fit for their needs. Digital drawing tools and software accomplish this goal. Islamoglu (2015) conducted a study on the location of computer-aided design and hand drawing in design and found that interior designers are able to

offer many suggestions to clients by drawing with a computer so they can include many aspects such as color, material, and texture options, atmosphere effect, lighting options, and even account for estimated cost for each option (Islamoglu & Degar, 2015).

In Senyapili and Basa's research conducted in 2006, most students preferred the computer tools as they were easy to execute and efficient to learn. According to their research, approximately 55% of students regarded computers as the medium of the future due to updated contemporary techniques in the market, time efficiency, and practicality to correct the mistakes. On the other hand, 45% of the students selected hand drawing as the medium of the future (Senyapili & Basa, 2006) due to its nature of requiring relatively less distinctive skill than the computer drawing.

### **Mediating Learning**

Laurillard (2011) discussed that academic learning needs to go beyond the knowledge learned through the class. Individuals create their own learning through the learning process by reconstructing the learning so that it can be extended to a less familiar context (Laurillard, 2005, p. 11). Technology-based resources are not always based on learners' habits and practices (LyonPhilippa, 2011). New instruction might require innovation that leads to the construction of a new pattern of behavior. That is where the innovation is placed; it opens a possibility to expand to a new context. Laurillard's study aimed to show the possibility of technology that impacts students' learning. The limit of Laurillard's project was that the technology used was MP3 or video, which are passive learning resources.

According to the NMC Horizon Report 2018, there has been a trend since 2013 addressing "the interest of assessment and the wide variety of methods and tools that educators use to evaluate, measure, and document academic readiness, learning progress, and skill



acquisition” (Becker et al., 2018). There is a growth in interest focused on deep learning and multiple strategies have been developed in education according to pedagogical theories built on evidence-based teaching strategies. Georgetown University Center on Education and the Workforce reported that between 1991 and 2015, the share of good jobs going to workers without a bachelor’s degree fell from 60% to 45% (Carnevale, Strohl, Cheah, & Ridley, 2017). The report revealed that new good jobs paying an average of \$55,000 per year are going to workers with higher than a high school diploma in skilled-service industries. The trends of needing a specific skill set in the workforce to workers pursuing sufficient salary provided a hint that higher education should next emphasize its value on growing and certifying the graduates' readiness in the workforce.

### **Accessibility**

Senyapili and Basa’s (2006) study indicates that less than half of their participants chose hand-drawing and half chose the CAD tool. Regardless of choice, it is significant that almost half of the group preferred the new technology rather than the traditional tool in the early stage of design (Senyapili & Basa, 2006). If they did not have experience using the new technology, it meant they did not have any other option than to use traditional tools. Interior design programs in higher education might disregard half of the participants who would be willing to use new technology. An individual’s perception of a tool might be based simply by their prior experience. In other words, building a new experience through education can replace the user’s prior experience, and if it was done successfully, this change can transform the user’s insight into new tools.

## **Established Theories for Plan of Study and Assessments**

### **Transforming Digital Student Learning**

Churches (2008) created a digital taxonomy based on Bloom's taxonomy, focused on the cognitive process associated with using technology. For this study to examine the students' outcome, applicable verbs are "uploading, editing, sharing, playing." In the Applying category, "reverse engineering"; in the Analyzing category, "collaborating"; in the Evaluating category, "mixing or blogging"; and in the Creating category to evaluate their level of learning.

### **Significant Learning**

The goal of the digital drawing lesson design is to elevate the student learning outcome to an advanced level of learning. Fink (2003) defined significant learning as lifelong change. Fink defined good courses as ones that challenge students to significant kinds of learning, use an active form of learning. The significant learning is categorized by six themes: (1) foundational knowledge, (2) application, (3) integration, (4) human dimension, (5) caring, and (6) learning how to learn (Fink, 2003). Each category stimulates each aspect, thus, some orientation on each category might lean toward some direction. The significant learning is shaped by the measurement of each category. The significant level of each category will be balanced according to the meaningful instruction and course outcome. For a meaningful technology course, it will be up to the next study to measure the level of significance that a digital technology course has when it enforces the meaning of technology and navigates the course design for design education.

### **Connectivism**

Siemens (2005) developed Connectivism, which emphasizes the value of learning in the process of learning, which is distinguished from other learning theories such as behaviorism,

cognitivism, and constructivism; those theories perceived that learning occurs inside a person. The main features of connectivism are that knowing more is critical to facilitate continual learning, and the information interacts with the related field because it changes the users' decision (Siemens, 2005). By understanding the impact of information technology, the importance of utilizing skill has risen (Siemens, 2005).

Connectivism has grown due to the understanding that being immersed in information transforms users' decisions to utilize certain tools and new information modifies the related field based on the decisions that were made in the past (Siemens, 2005). Principles of connectivism emphasize that (1) learning is a process of connecting information sources; (2) learning, as a complex system, is influenced not only by the individual but also by the environment outside the control of self; (3) nurturing and maintaining connections is needed to facilitate continual learning; (4) maintaining currency of knowledge is committed to learning activity; and (5) capacity to learn is more critical than what is already known. The principal "capacity to know more is more critical than what is currently known" is related to a higher level of learning than a traditional drawing course setting in design education and meta-cognition. In this digital world, information is everywhere, and with the right route and path, the value of learning shifts from what to know to how to get the source. Connectivism addresses the accordance of new tools and learning environment with the model of learning. This theory gives an insight into the skills and tasks needed in this digital era.

### **R.A.T. Model**

The conceptualization of the R.A.T. framework is about technology in education. According to this theory, technology is defined as (1) Replacement, (2) Amplification, and (3) Transformation (Hughes, 2006). To determine if a technology replaces, amplifies, or transforms

students learning, there are three aspects for assessment: instructional methods, student learning process, and curriculum goals. The technology used to replace the hand tool in no way changes current student learning processes, instructional practices, or course goals (replacement).

Replacement is focused on the change within the same instructional goal and students' learning process. Technology as amplification increases efficiency and productivity based on fundamental instructional practices, students' learning process, or content goals (amplification). Technology as transformation involves transforming the instructional method and students' learning process, even the actual subject matter (Hughes, Thomas, & Scharber, 2006). Pea (1985) organized the roles of transformation by noncomputer cognitive technologies in personal intelligence and cognitive change as an amplifier and reorganizer in the mind. When applied to a digital drawing assessment design, students' learning process changes or expands mental work, involvement or expansion of usage of tools. Thus, this change brings new opportunities for different form or learning. This study supports the hypothesis that the level of competency of computer-aided-design/drawing is directly proportional to the development of digital literacy (Hughes, Thomas, & Scharber, 2006). In Reinking's (1997) study about a computer technology-integrated class using multimedia book review activities, Reinking stated that a technological alternative provides an unlimited potential to fuel our conceptions and literacy. Computer technology transformed not only the student learning process but also instructional practices within the language arts curriculum. The major feature of technology as a transformation is that the fundamental goal or nature of instruction, the learning process, and the content are changed, thus, transformed (Hughes, Thomas, & Scharber, 2006).

## **Meaningful Technology Integration and Learning**

Integration is defined by how and why it is used (Sadik, 2008). The ability to utilize technology to obtain information is achieved by meaningful technology integration. This includes being proficient in technology usage in a timely manner, and the ability to analyze and synthesize the information and present it professionally (Harris, 2005). Researchers who have studied meaningful technology integration focus on the educator's role to develop students' ability to create new knowledge, solve problems, and think critically (Griest, 1996; Hoffman, 1997; Richard, 1998).

## **Conclusion**

Through the literature, drawing is a necessary skill for interior designers as a communication skill from ideation through presentation for clients, professionals, and the designers themselves. In this digital era, maintaining a digital format from the beginning of the design process has advantages for fluent workflow. Using a pen-tablet is one of the ways to maintain digital workflow in the design process. There are various types of interface in pen-tablets, and the most preferred type of interface is synchronized screen position and hand position, which is the same interface as traditional drawing. Even though the technology is not new, students perceived it as a new technology because they have not experienced it in their traditional education. This new experience can expand students' perception of the possibility of technology, which impacts their learning. The technology integrated course can transform the student's ability and technological readiness that is required in the interior design field.

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## APPENDIX A: INFORMED CONSENT FORM

### Consent Form

#### Introduction of survey

This research study is being conducted by Somang Yang at Illinois State University- under the supervision of Professor Taneshia West Albert, at Illinois State University-to investigate how a digital integrated instructional course affects interior design students' understanding of drawing techniques and concepts. This research will offer insights concerning how students adopt new technology in the design process. This case study will be conducted with advanced level undergraduate interior design students in the state of Illinois. Participants will complete a short survey regarding their personal experiences and opinion with the digital tablet and software in their learning processes.

#### Procedures

If you choose to take part in this study, you will be asked to complete a short survey with 50 questions. This survey will take approximately 15 minutes.

#### Risks/Discomforts

There is no great stress from the survey during the class hours.

#### Benefits

Your participation will help you to utilize digital drawing tools efficiently in diverse way and you will help us gain useful knowledge about digital course design.

#### Confidentiality

All information provided will remain confidential and will only be reported as group data with no identifying information.

#### Compensation

Your participation will get free snacks as a rewarding for participation.

#### Participation

Participating in this study is voluntary. Your professor will not know if you are participated. No participation will not affect your current standing with Illinois State University. Refusal to participate involves no penalty or loss of benefits. You may discontinue participation at any time without penalty or loss of benefits. You can also skip questions you do not feel like answering.

#### Conflicts of Interest

This study is not funded.

#### Questions about the Research

For questions about this research Somang Yang can be contacted at 773-808-9442 or [syang33@ilstu.edu](mailto:syang33@ilstu.edu).

Please print a copy of this consent form for your records.

I consent to participating in the above study. (Release statement for videotaping or relinquishing confidentiality must be inserted here if applicable.)

Signature: \_\_\_\_\_

If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Research Ethics & Compliance Office at Illinois State University at (309) 438-2529 or via email at [rec@ilstu.edu](mailto:rec@ilstu.edu).

APPENDIX B: POST PROJECT SURVEY

**Post-Project Survey**

**In order to keep this survey anonymous, we will use respondent ID. Please use first two letters of your mother’s first name and the day of your birthday. (If your mother’s name is Jane and your birthday is February 1<sup>st</sup> 2000, your code will be JA01).**

**This way your pre-and post-responses can be matched without using names/identifying information.**

**Respondent ID:**

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**1. Please answer each of the following questions regarding your opinion about Autodesk Sketchbook software by marking the level of agreement that best describes you.**

Thinking back to when you were in FCS 352 fall 2018 rendering class- while you were using the Autodesk sketchbook software, the software helped you to understand:	Strongly disagree	disagree	neutral	agree	Strongly agree
How to render shading of shapes	1	2	3	4	5
How to draw perspective	1	2	3	4	5
How to render materials and textures	1	2	3	4	5
How to render daylighting lighting	1	2	3	4	5
How to render shadows	1	2	3	4	5
the overall rendering principles (ex. Value, tone, hue, scale etc.)	1	2	3	4	5

Thinking back to when you were in FCS 352 fall 2018 rendering class- while you were using the Autodesk sketchbook software:	Strongly disagree	disagree	neutral	agree	Strongly agree
The software was useful to execute my rendering	1	2	3	4	5
The software was useful to apply rendering principles to my assignment	1	2	3	4	5
The software was useful to apply rendering principles to my rendering	1	2	3	4	5

My rendering was improved by using the functions of Autodesk Sketchbook (such as perspective guide, ruler guide, diverse brush options)	1	2	3	4	5
I tried multiple digital resources (such as google images for materials or entourage) for a realistic rendering	1	2	3	4	5
I mixed digital resources (such as google images for materials, images for entourage, my previous project images)	1	2	3	4	5
I was able to edit and mix multiple visual resources (such as google images for materials, images for entourage, my previous project images)	1	2	3	4	5
It was easier to organize images of materials, furniture or objects in my rendering than to organize images on paper	1	2	3	4	5
It was easier to edit digital renderings using Autodesk Sketchbook than to edit renderings on paper	1	2	3	4	5

Thinking back to when you were in FCS 352 fall 2018 rendering class- while you were using the Autodesk sketchbook software:	Strongly disagree	disagree	neutral	agree	Strongly agree
It was easier to critique on the renderings using the computer than to critique on the renderings on the paper.	1	2	3	4	5
It was easier to comment on the renderings using the computer than to comment on the renderings on the paper.	1	2	3	4	5
It was easy to convert digital rendering assignments for submission	1	2	3	4	5
It was easy to convert rendering-on-paper assignments to use in the digital software	1	2	3	4	5

**2. Please answer each of the following questions regarding your usage of Wacom pen-tablet by marking the level of agreement that best describes you.**

Thinking back to when you are in FCS 352 fall 2018 rendering class- while you were using the Autodesk sketchbook software, the software helped you to express your understanding of:	Strongly disagree	disagree	neutral	agree	Strongly agree
shading of shapes	1	2	3	4	5
perspective	1	2	3	4	5
materials and textures	1	2	3	4	5
daylight lighting	1	2	3	4	5
shadows	1	2	3	4	5
the overall rendering principles (ex. Value, tone, hue, scale etc.)	1	2	3	4	5

Thinking back to when you are in FCS 352 fall 2018 rendering class- while you were using the Wacom pen-tablet device:	Strongly disagree	disagree	neutral	agree	Strongly agree
The Wacom pen-tablet device was useful to execute my rendering	1	2	3	4	5
The Wacom pen-tablet device was helpful to apply rendering principles to my assignment	1	2	3	4	5
My rendering was improved by using the Wacom pen-tablet device	1	2	3	4	5

Thinking back to when you were in FCS 352 fall 2018 rendering class- while you were using the Wacom pen-tablet device:	Strongly disagree	disagree	neutral	agree	Strongly agree
I was able to edit and mix multiple visual resources (such as google images for materials, images for entourage, my previous project images) using the Wacom pen-tablet device	1	2	3	4	5
It was easier to organize images of materials, furniture or objects using the Wacom pen-tablet device than to organize images on paper	1	2	3	4	5

It was easier to edit digital renderings using the Wacom pen-tablet device than to edit renderings on paper	1	2	3	4	5
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After you finished the Digital drawing lessons in FCS 352 fall 2018 rendering class:	Strongly disagree	disagree	neutral	agree	Strongly agree
I can give some advice about other's rendering using one or more rendering principles (ex. Value, tone, hue, scale etc.)	1	2	3	4	5
I can critique peer's rendering based on one or more rendering principles (ex. Value, tone, hue, scale etc.)	1	2	3	4	5
I can comment on other renderings based on one or more rendering principles (ex. Value, tone, hue, scale etc.)	1	2	3	4	5
I can explain my rendering based on one or more rendering principles (such as the way I shaded, rendered shadow, size of furniture)	1	2	3	4	5

After you finished the Digital drawing lessons in FCS 352 fall 2018 rendering class:	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I feel comfortable now using Autodesk Sketchbook for rendering	1	2	3	4	5
I feel comfortable now using Wacom pen-tablet for rendering	1	2	3	4	5
I enjoy using Wacom pen-tablet for rendering	1	2	3	4	5
I enjoy using Autodesk Sketchbook for rendering	1	2	3	4	5
I can utilize Autodesk Sketchbook as one of my technical skill	1	2	3	4	5
I can utilize Wacom pen-tablet as one of my technical skill	1	2	3	4	5
I have more confidence in using Wacom pen-tablet for rendering after taking this course	1	2	3	4	5
I have confidence in rendering using Autodesk Sketchbook for rendering after taking this course	1	2	3	4	5

The Wacom pen tablet was helpful overall to execute renderings	1	2	3	4	5
The Autodesk Sketchbook software was helpful overall to execute rendering	1	2	3	4	5
The Wacom pen-tablet device helped me to render easily	1	2	3	4	5
The Autodesk Sketchbook software helped me to render easily	1	2	3	4	5

**3. Please answer each of the following questions regarding your usage of Wacom pen-tablet and Autodesk Sketchbook software by marking the level of agreement that best describes you.**

For my future project,	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I would strongly consider using Autodesk Sketchbook	1	2	3	4	5
I would strongly consider integrating Wacom pen-tablet on one of any other projects	1	2	3	4	5
I would like to explore other tools and functions in Autodesk Sketchbook	1	2	3	4	5
I started to be interested in other drawing or editing software such as Adobe Photoshop after this course to improve my rendering	1	2	3	4	5
I think I can utilize more devices and software in the future	1	2	3	4	5
I feel more comfortable when I think about using new device after taking this course	1	2	3	4	5
I feel more comfortable when I think about using new software after taking this course	1	2	3	4	5
I was interested in other drawing or editing software, such as Adobe Photoshop, to improve my rendering before I decided to take this course	1	2	3	4	5
I wish I could have free access to Wacom pen-tablet for future or other use					

How many tools on the list of Autodesk Sketchbook menu bar and tab can you now utilize?	1-5	5-10	10-15	15-20	20 or more
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**4. What is your perspective based on your experience of digital tool and software overall?**

**5. What were your thoughts when you started use the software and pen-tablet?**

**6. Which tool do you prefer to use for rendering? (Mark appropriate response)**

(        ) pen-on-paper tool    (        ) digital drawing tool (ex. Software and pen-tablet)

(        ) integration of both tools

**And please explain why you have this preference.**

**8. Year in school? (Mark appropriate response)**

(1)	Freshman	(2)	Sophomore	(3)	Junior
(4)	Senior	(5)	Other(        )		

**9. Experience of using pen-tablet before you took FCS352 Rendering for interior design course (Mark appropriate response)**

1) No experience	
2) I have used the device for 1 or less hour	
3) I have used the device more than 1 hour less than 3 hours	
4) I have used the device more than 3 hour less than 10 hours	
5) I have used the pen-tablet before and I don't think I am uncomfortable using it	