COMPARATIVE STUDY OF IMPACTS ON DESIGN THINKING BY USING AUTOCAD AND MANUAL DRAFTING IN THE SCHEMATIC DESIGN STAGE

HETTITHANTHRI U.[1] & MUNASINGHE H.[2]
[1]National School of Business Management, Green University Town, Homagama, Sri Lanka
[2]School of Architectural Studies, George Brown College, Toronto, Ontario , Canada
[1]upeksha@nsbm.lk, [2]hmunasinghe@georgebrown.ca

Abstract
Drafting is a key component in architectural studies. The medium of drafting matters in design thinking. This study was set up to find out if and how drafting media would be effective in stimulating design thinking in the early stages of design ideation. In the architectural learning system, computer aided drafting is not encouraged by lecturers in the early design ideation stage, the reason being that many lecturers believe that computer aided drafting will limit design thinking at this stage. However, drafting is a skill which designers could personalize by adding his/her techniques in order to add aesthetic value to the drawing. This scenario is common in architectural practice. This article aims to find out in what manner the medium of drafting could generate an impact on design thinking of students at the early design stage. For this study, fifty students of an Interior Design degree program were observed, and twenty students were selected based on type of drafting technique: ten students used computer aided drafting and ten students used manual drafting at their schematic design stage. The schematic design stage of the design process has been selected for this study. Qualitative methodology has been adopted in conducting this study and data has been collected through interviews conducted at 2 levels of the process. The collected data has been analysed through a thematic analysis. Furthermore, the results of the project have been analysed parallel to the data gathered from the interviews to measure design thinking capability.

Keywords: Computer aided drafting, manual drafting, design thinking

1. Introduction

Architectural learning is unique from other disciplines and has its own teaching culture. Drawing and drafting possess an inseparable interconnection with the architectural study domain (Yee 2012). Prior to the millennium, architectural drawings and sketches were the best design communication mediums in both practice and learning (Pektas & Erkip 2006). It was an era where architects would add personalized skills to their drawings, thereby creating many trends and styles in drawing which made visual communication more effective and graphical (Donald A Schon 1984). Undoubtedly, drafting has been recognised not only as a significant communication medium, it is indeed a skill-based application in design communication (Senyapili & Basa 2006). Project based learning and studio centric education are the main key components in architectural education (Abdullah et al. 2011). Drawing and drafting are applied in nearly all design stages but the medium selected to express design ideation could be affected on stimulating design thinking specially in the stage of early design ideation.

With the development of advanced computer software, architectural education has faced drastic changes in its inherent learning culture (Alkymakchy 2012). Computer aided drafting became significantly popular among young learners due to many reasons (Al-Qawasmi 2005). Undoubtedly, computer aided drafting tools make the drafting procedure easier and save time, however it is important to research on the manner in which these computer aided tools will affect students' design thinking. It is believed by many lecturers that exposure to computer aided drafting medium at the early design stage will impact students' design thinking negatively. Through this article, we present the results of a comparative study on the impacts of computer aided drafting and manual drafting at the schematic design stage.

1.2. RESEARCH QUESTIONS
This is an observational study conducted to compare the impact of the medium of drafting on the design thinking of students. Research was conducted to find answers for following questions.

- Does the medium of drafting impact design thinking at the early design ideation stage?
- Does computer aided drafting limit students' design thinking?

2. Research Methodology

This is a qualitative research conducted via the study of 20 students in an Interior Design degree program. For this study, students in the first semester of their second year were selected, out of which 20 students were selected for the study based on the medium they were using for the given design projects. Mean age of the selected sample was 21 years while 5 girls and 5 boys have been selected for each drafting medium to maintain gender balance. The reason to select these students for this project specifically is that at this academic level they have been exposed to both mediums for drafting. In the second semester of the first year, learning computer aided drafting has been incorporated into the curriculum as a module, therefore when they approach the first semester of their second year they possess a thorough understanding on the software. A duration of 8 weeks has been allocated towards the design project for the first semester of the second year. The researcher has observed the entire design process as a fly on wall observer (Given 2019). The given project was to provide interior design solutions for a hotel lobby and dining space. Students have completed the initial background study including site and client analysis, and brief finalization within the first week. From the first week to seventh week, students' designs were individually tutored by the module leader and allocated tutors. During this period, students worked in a design studio complete with typical design studio facilities such as space to use drawing boards, model making facilities plus electrical and WIFI facilities in order to use individual laptops and obtain internet access.

The researcher was a silent observer throughout the design process, therefore ethical clearance was obtained to observe the students' learning process and glean the results for this study (Charmaz & Henwood 2019). There were 50 students in this class in total, while for this study 20 students were selected with an equal distribution of 10 out of 20 for both digital and manual drafting medias following an observation of the medium used for designing and communication of their schemes within the first week.

Each student got a tutoring sheet to be filled by all the tutors with their comments on each day of tutoring. In this sheet, tutors had to comment on the students' progress, design thinking, approach and any other matters related to their design. The researcher has used these comment sheets as data for the analysis.

The limitations faced by the researcher is mainly on selecting the sample. It is usually benefited if the researcher could increase the sample size from 20 to at least 50. But due to limited student counts in the class and variations on computer aided drafting skills made the selection challenging. Furthermore, it was difficult to say that all the students who used auto cad were having similar skill levels on handling the digital drafting tool which could limits the application in different ways.

2.1. DATA COLLECTION

Data collection was initially carried out via observation and interviews conducted at two stages of the design process. The researcher used a field diary to record observation notes and a special recording sheet has maintained individually for each student for the purpose of data recording (Cohen, Manion & Morrison 2018). The recording sheet had a distribution of columns for data entry by the researcher under following categories: week, drafting medium, and comments of tutors on progress. In the field diary, the researcher has noted all important facts including activities engaged in during studio sessions. Data collection was carried out throughout the 8 weeks but for the analysis, data obtained from the first 6 weeks has been used since the researcher's primary focus is on finding the impacts of the drafting medium at the schematic design stage. Each week, students got 12 studio hours to develop their design schemes. As per the academic semester calendar, each Monday and Thursday has been allocated with the inclusion of 6 hours per day. The module leader and tutors were available throughout the allocated studio hours to provide design tutoring for students. Each student was equally tutored by the facilitators; students got an opportunity to receive one-on-one tutoring at each studio session, and it was mandatory for students to maintain individual tutoring records with the comments of the tutors. The researcher has access to observe and use those tutoring sheets as research materials.

Interviews were conducted during the 3rd week of the process and again in the 6th week of the process. Students were individually interviewed, and each interview has been recorded by the researcher for the purpose of analysis. The questions were based on discovering reasons for the selected medium and how it has supported them in the generation of novel design ideas and solutions for the given project.

Interviews were taken externally and not within the studio hours allocated for students in order to minimize potential disturbances.

Photographs were taken at random throughout the design process as another recording medium and the learning behaviour of each selected student has been captured for further analysis. Photographs were taken during every studio session and categorised under the name of each student.

2.2. DATA ANALYSIS

In the data analysis, firstly, observation notes have been taken into consideration. For each student, a separate folder has been maintained and the data generated by observation sheets has been categorised according to weekly progress. The data was analysed by a thematic analysis (Tracy 2013). Thematic analysis consists of 3 major steps: coding, categorization and generating themes. Recording sheets generate codes such as use of CAD for layout, use of CAD for elevations and sections, CAD for mind mapping, free hand sketching, drawing perspectives, mind mapping using collages, etc. Those codes also generated categories such as CAD for communication, CAD for drafting, free hand drawings for communication, free hand for drafting. These categories have generated two themes: use of CAD in schematic design, use of manual drafting in schematic design.

Interviews were recorded and transcribed by the researcher for analysis. Questions of the first interview which was conducted at the 3rd week of the program focused on discovering reasons behind the selection of the medium of drafting. The following questions were asked by the researcher and answers were fed in to MAXQDA 11 for analysis.

- Why did you select AutoCAD / manual drafting for your drawings?
- How did it help you in developing your design scheme?
- What are the methods you used in communicating your design to your tutors?
- According to your point of view what are the advantages of the selected drafting medium?
- Does the medium of drafting was helpful in generating novel design ideas?

Students who were engaged in those two mediums were individually interviewed and recorded. Interviews conducted among students used AutoCAD generated codes following codes; faster than manual drafting, easy to reproduce drawings, easy maintenance, less paperwork, easy to put materials, time saving. The above codes categorised in to two main categories, such as easiness and less paperwork which generate the theme as efficient tool. Being confident on the skill, hands on practice, an instant medium to record the imagination, self-satisfaction, visible progress were the codes generated by the initial interview conducted among the students who were using manual drafting. Recording medium, satisfaction and improving skills were the categories generated which lead to a theme called satisfactory tool.

The second interview was conducted at the 6th week and following questions were asked.
- Does your design was well understood by your tutors?
- Were you able to apply possible design solutions for the given problem?
- How the selected drafting medium was supportive in communicating your design?
- Does the selected medium was supportive in managing your time?

Tutor's comments were weekly collected, and those comments were again categorised in to three major themes. Positive comments on design approach, negative comments on design approach, average were the three major themes generated by the comments of the tutors.

2.3. RESULTS

The thematic analysis generated two "major themes" such as "efficient tool and "satisfactory tool". In addition, the researcher has notified many reasons behind the selection of a drafting medium for a given project. Selection of AutoCAD was reasoned out by students due to its and user-friendliness and easy usability. Students were able to easily reproduce drawings, based on their previous work, through the use of AutoCAD.

Students who used AutoCAD brought printed drawings for tutoring. Three out of four tutors commented negatively on the design approach of the students (n=6) in the first week. The table below summarises all comments from the tutors.

Table 1, Summary of the tutors' comments at the schematic design stage

Tutor's Comments	Drafting medium	Number of students
Negative	AutoCAD	6/10
Positive	AutoCAD	2/10
Average	AutoCAD	2/10
Negative	Manual Drafting	2/10
Positive	Manual Drafting	7/10
Average	Manual Drafting	1/10

According to tutors' comments 60% of students received negative comments on their design approach. The reason behind this is that the majority have found difficulties in developing novel design solutions for the given project. The use of AutoCAD leads them to reproduce spaces with typical furniture design templates which were freely available from the software. Surprisingly, 70% of students who got very positive comments from tutors due to new furniture design solutions given, and due to new material applications and non-identical special solutions generated to the given space had used manual drafting techniques.

According to the results generated by the observation, 70% of students used typical furniture templates which are available on AutoCAD and have reused the same furniture for many spaces by copy pasting. This caused the students to complete their drawings much quicker than the students who used manual drafting. In addition, 50% of students failed to give innovative material applications other than typical solutions rendered by AutoCAD. This was significantly contrasted within the manual drafting cluster, where sketches, perspectives and sections were given with new material applications.

Notably, 60% of students who used manual drafting have thought of colour and textural effects of the interior. In comparison, none of the students who used AutoCAD thought of these effects of the interior at the schematic design stage which was depicted as 0%. In terms of attention to detailing, 30% of students who used manual drafting gave thought to joinery and fixing details at the initial design ideation stage while 0% from the students who have used AutoCAD gave thought to these details.

3. Discussion

This article aimed at discovering answers to the research questions depicted in section 1.3. Following the analysis of results, the design thinking ability of the students who used manual drafting were significantly higher than the students who used AutoCAD. In the process of procuring the reasons behind this, many interesting factors were identified. It was proven that the use of AutoCAD is faster than manual drafting which makes editing much easier than manual drafting. After a regular tutoring session, students are required to make changes as per comments made by the tutors; students believe that AutoCAD makes this process easier. It is undoubtedly true that manual drafting is more time consuming than AutoCAD, and that students have to trace or copy the exact existing drawing multiple times in order to make changes which is time consuming. But it was notified that during the manual drafting process, students tend to experiment with novel design solutions compared to the others, which allows the creation of rough sketches (as a result of sudden imaginations) as a recording medium. This process is helpful in stimulating design thinking of students in the early design ideation stage (Cross 2011).

Significantly poor design abilities were seen in the students who used AutoCAD while students who used manual drafting produced quality drawings which had more value than a mere printout. In terms of quality, they have tediously thought out and visually displayed the 3D appearance of the designed space by using perspectives which was significantly less visible among students who used AutoCAD. Drawings produced by AutoCAD were rich in intricate details such as tilling, wood finishes and functional specifications, but they were weak in expressing the holistic image of the designed space to the tutor as majority had not thought of using details beyond plans, sections and elevations.

3.1. CONCLUDING REMARKS
It was evident that the use of AutoCAD has made the process easier and faster, but it was significant that the digital medium has generated a lower stimulant on the design thinking of students. Manual drafting

has generated more sensible design solutions than AutoCAD. Therefore, the use of manual drafting can be recognised as a medium which could stimulate design thinking ability particularly at the schematic design stage, whereas AutoCAD could work as a supportive tool in detailing the scheme when students are in the final design development stage, which would require more time and techniques.

Importance of conducting this type of researches is to understand the impacts of computer aided drafting on design thinking. With the rapid development, those tools are getting updated and changing its functions to cater the complicated needs of the design society. This research will be an eye opener on how the medium could be affected in novel design solutions which could be usually generated in design ideation stage. If the digital tool could be modified in a way to cater or empower novel design solutions, the impact could be lesser. However, through this article researcher has taken an initial step on observing the design thinking process of students and how the other factors could make an impact on it.

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