International Journal in Management and Social Science
Volume 11 Issue 09, September 2023 ISSN: 2321-1784 Impact Factor: 7.088
Journal Homepage: http://ijmr.net.in, Email: irjmss@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal

THE IMPACT OF COMPUTER-AIDED DESIGN (CAD) ON THE MANUAL DRAFTING SKILLS OF UNDERGRADUATE DRAFTING STUDENTS AT THE COLLEGE OF INDUSTRIAL TECHNOLOGY

Rodelyn T. Vertudazo,[1] Marites M. Cumbe,[2] Lourdes S. Esplana,[3] Nhorlyn Rose S. Esplana,[4] Citadel B. Punzal,[5] Medel E. Aloroy,[6] Patrick Neil M. Santiago[7]
College of Industrial Technology, Nueva Ecija University of Science and Technology, Cabanatuan City, Nueva Ecija, Philippines

Abstract

Drafting students frequently find themselves in a dualistic bind, limited by barriers deriving from previous and present civilizations' different approaches to architectural evolution as well as their innate ideals and means of expression. The College of Industrial Technology's drafting courses for undergraduate students include a crucial requirement that they be performed manually. However, it has been noticed that students have a greater propensity for technological advancements because of their "age" (revolutionary influence). In this inquiry, the researchers look at how manual drafting skills among undergraduate students are affected by computer-aided design (CAD). The College of Industrial Technology was specifically chosen for this investigation. Data were obtained using structured questionnaires that were given to second- through fourth-year students during the 2019–2023 academic year. To analyze the data, descriptive statistics were used. According to the findings, 86.8% of students strongly agreed, and 8.7% agreed that using CAD is preferable to manual drafting. The total proportion in agreement (95.5%) shows a clear preference for CAD among students over manual drafting. This study supports the idea that manual drafting should be taught to undergraduate drafting students alongside CAD as a core skill and should be combined with thorough digital drafting for standardized output and potential future benefits.

Keywords: *Information Communication Technology, Computer-Aided Design, Manual drafting skill, Undergraduate Drafting Students*

I. Introduction

Computer-Aided Design (CAD) software has been alive and available to designers (Architects) in practical useful form for over half a century (Botchway, Abanyie, & Afram, 2015). CAD transformed from being an aesthetic simulation application available to mainframe computers and used exclusively by professionals working on special projects to being accessible to any interested individual using a Personal Computer (PC). CAD plays a very important role in the practice and teaching of Drafting in this era of young people who have grown up using computers and adapting to the evolving digital technologies without finding it a complexity (digital natives). Generally, CAD software is not only utilized within the sphere of Drafting but it is also implored in engineering and construction industries to present technical drawings for

various functions. Bernstein (2020) posits that "CAD enables the development, modification, and optimization of the design process". Such a hypothesis can provide a new approach for designers to hunt out more solutions in schematic design processes.

Architectural design like any other form of design involves designing. Abowardah and Manal (2016) describe the design as a process formed through three main phases: Knowledge, Developing Tools equivalent to "Codex Rules" and "Invention". Unlike other systems, with CAD, any design process or product could be depicted in graphical form with comprehensive details and accuracy using lines (straight, curved, or polygonal), layers, three-dimensional (3D) shapes, and objects (The pro-3D Studio, 2019). Later, the time of faster computers and 3D modeling emerged and took CAD to the subsequent level of photorealism. Recent technological advancements allow CAD technology to be used in higher knowledge during the design process and not only for producing drawings (Ng, Goh, & Eze, 2011). More than a decade ago, Computer Aided Architectural Design (CAAD) was introduced to the College of Industrial Technology as a course to be studied (Botchway et al 2015). Within the Nueva Ecija University of Science and Technology undergraduate program, the curriculum has been fashioned to restrict students from using CAD in the first and second years of their academic study (College of Industrial Technology, 2019). They are taught the premise of manual drafting skills at the first-year level, within the respective courses DT 212 Basic Autocad and DT 221 Advance Autocad, and different kinds of conventional design courses (College of Industrial Technology, 2019). The students are expected to initiate the acquired manual skills in the design evolution process. Moreover, within the third year and fourth year of their academic study in undergraduate Drafting Technology, students encourage themselves to use both the elegant computer-aided drafting method (due to the particular incontrovertible fact that they had been taught some way to manipulate CAD) and traditional manual drafting method for presentation since they regard and presume that their AutoCAD project (design brief) becomes more complex as they progress.

Many questions recently are still being raised about the effect of CAD on the students' manual graphics skills and students' skill development. However, architectural design students in most faculties of Drafting in Nigeria are faced with the policy of using manual drafting in undergraduate classes for their design projects. The selection of using digital or CAD media to express their graphics style and present their works is not welcomed by the prevailing curriculum. Nevertheless, it is often detected that students employ CAD while camouflaging the presentations to reflect manual drawings in an exceedingly shot to obey the 'laws'. Cespedes (2008) identified these students as belonging to a bunch called digital natives. Those born with the knowledge of all the digital media available find it easy to use, live with and learn by it. These students are fascinated with the benefits which include better accuracy; speed of drawing; easy corrections and editing; versatility; robust creative options; and availability of instant components within the digital object libraries (Davi, 2020). It is becoming increasingly difficult

to stop students from flouting their skills in CAD. This might continue until convergence between the perspectives of the policymakers, teachers, and students is reached.

From the foregoing, it is deduced that the choice for review of the Nigerian architectural education curriculum is to adopt the digital drafting method because the foremost method of AutoCAD presentation at the undergraduate level is apt. This clarion call is timely and spontaneous to the realities of the growing trends in Information Communication Technology (ICT) of the digital native age and in line with the expectations of practitioners of the profession. Aderonmu et al (2015) support the agitation of future professionals who are itching to not be left behind within the education trend of the digital age while Cespedes (2008) agrees that it is a normal place to work out these peculiar restrictions in schools of Drafting. Alagbe, et al (2014) advocates that style and drawing as skills and techniques will abide with the support of the available digital technologies. This research in essence examines the effect of computer-aided design programs on manual drafting methods in the training of Drafting students in the College of Industrial Technology. Nueva Ecija University of Science and Technology was selected for this study. At Nueva Ecija University of Science and Technology, the curriculum embraces the teaching and learning of CAD applications (College of Industrial Technology, 2019).

Furthermore, the process of developing students' creative and drafting skills manually in Drafting Technology is often classified as one of the most crucial goals of Drafting education (Dare-Abel, 2016). According to Alagbe (2014), not every Drafting student possesses the same quality of graphics skill using the traditional (manual) drafting method that is to say that students' graphics quality vary based on individual ability or experience. The method and media for achieving the goal of good graphics, usually present unique challenges and opportunities during the student's developmental process. Through observation in recent years a good number of undergraduate students in the College of Industrial Technology, Nueva Ecija University of Science and Technology, use CAD for their laboratory exercises over the manual drafting method later on, camouflaging it to appear as if it were drawn manually by aiding it with pencil or the point pen. Despite the availability of various drawing materials and equipment which could enhance the student’s skill towards manual drafting, a great percentage of undergraduate students prove to use CAD over traditional (manual) drafting in their studio works and design. It is for this reason that the study investigates the effect of CAD on Drafting undergraduate students' manual drafting skills.

Finally, this study aims to investigate the effect of CAD on the manual drafting skills of undergraduate students of Bachelor of Industrial Technology major in Drafting at the Nueva Ecija University of Science and Technology. The researchers seeks to investige the following: Are the facilities provided for drafting students in the university, sufficient to aid manual drafting? What benefit does manual drafting as compared to CAD offer Drafting students in their

long-term careers? Are the students equipped with the necessary tools used for manual drafting? Do students have a preference for CAD over manual drafting?

II. Literature Review

Computer-Aided Design (CAD) is a design and drafting tool that has been in existence for a long period as an innovation for designers using drafting tables and drawing instruments. The interface for the use of cad software is usually a personal computer (PC), mouse or trackball, or pen and tablet. It was explained by Andia (2002), that the use of CAD emerged in the mid-1970 and mid-1980s owing to the widespread of personal computers (PC) and commercial-scaled CAD that came into existence. However, not until the early 1990s that the use of CAD attained full recognition and became a rudiment in the curriculum of architectural education. Also, in the early 1990s CAD proficiency became a prerequisite for the acquisition of employment by graduates. The ratio of computers per student surged from 1:50 to 1:10 in the1990s (Lawson, 2002). Contemporarily, with the advent of advancement, students can afford individual computers as the ratio is now on a vehement rise. CAD applications have developed sporadically in recent times and thus facilitated their use in the design process rather than drafting.

A. Types of Computer-Aided Design Programmes

Various types of CAD software have been developed for use across a range of applications and industries (Bryden, 2014). Computer-Aided Design (CAD) is either in two-dimensional (2D) or three-dimensional (3D) formats and is used to design curvatures and figures or curves, surfaces, and solids in two-dimensional (2D) space or three-dimensional (3D) space. CAD can be separated into three different types: 2D drafting systems like AutoCAD LT (also known as AutoCAD Light); 3D solid feature modelers like Chief Architect, ArchiCAD, VrayCAD, SolidWorks, Inventor, Revit, AutoCAD, Civil 3D, MicroStation, Creo, CATIA, and Siemens NX. Visualization, as explained by Pilkaite (2010), is a contemporary design tool that aids the representation of different types of infrastructure. However, visualization became an important 3D object for presentation and advertising purposes. With visualizations, objects are simulated with the exactness of how they will look in real life without the need for expensive external resources.

Figure 1: Typical 2D drawing Electrical Installation is done with AutoCAD 2010 interface.

Figure 2: Typical 3D drawing was done using Revit software.

B. Computer-Aided Designs (CAD) in Drafting

CAD is not without its limitations as far as design production is concerned. For a CAD user/designer, the need to learn other programming skills will help beat these limitations when they arise. CAD has had a radical impact on the teaching, learning, and practice of design (Brown, 2009). Detailed conceptual designs of 2D, 3D, reports, analysis, and geometric manipulations can be done faster. CAD helps to solve complex design problems. According to Koutamanis (2003), CAD technology's existence in Drafting has two primary objectives which are to be applied in the human cognitive design process; through the computing smart technology and to become an ideal representative media in the architectural design process.

C. Computer-Aided Designs on Architectural Education

Schools of Drafting have over the years provided the shell for experimenting with various architectural ideologies and conceptions. Hence, according to Salama and Wilkinson (2007), the advancements in digital technology and design have grotesque bearings on the approaches of architectural education in recent times. Information technology, just like in every discipline, is revolutionizing the practice and technique of teaching Drafting. Moreover, there were argumentative responses by Reffat (2007) that the use of CAD in architectural drawing is robbing the traditional method of hand drafting and craft modeling of its value in design thinking and flow of thought. Brown (2009), also opined that the influx of CAD into architectural education has overridden the traditional methods of drafting by emasculating the advantages of the relationships which should exist between student-to-student and student-to-instructor, which is a canonical interaction in architectural education.

Lawson (2005) claimed that CAD does not improve designing to anywhere near the extent of the opposed publicity of CAD vendors that claim CAD improves designing or how we were meant to believe. As regards the negative impacts of the use of CAD software, Lawson (2005) claimed that "before computers, the student architect had to learn to draw to design and also to see and record. Lawson (2005) added that "it was, of course, possible that very poor Drafting could be presented so beautifully that one was deceived… We are in danger of creating a generation of young architects who are highly skilled with computer software and yet have little visual sensibility". Robertson and Radcliffe (2009), also claim that the most vital aspect of design education is the student-to-student or face-to-face social interaction which CAD has taken away.

D. Architectural Education in the Age of Globalization

Globalization's objectives according to Ameri (2008), entail overcoming geographic divides and boundaries. He underpins that the world is a global village and everyone is compelled to interact fluently and learn from people beyond their borders. Ameri(2008)argued further that the

closeness brought about by globalization is both real and virtual with the latter being arguably the more compelling of the two. He concluded by saying that globalization in contemporary times is deeply connected to the information age. In recent times, globalization seems clearer as countries and continents are taking advantage of the opportunities of Information Communication Technology (Hermann, Pentek, & Otto, 2016).

The concept of globalization and internationalization is however not new to higher education institutions across the globe. Van Damme(2001)noted that while internationalization is not new to universities and higher education policies, the forces and tensions understood by the umbrella concept of 'globalization' constitutes a radically new environment for institutions of higher learning and policymakers to function. Furthermore, the changes to which higher education all over the globe are increasingly exposed, are complex and varied, even contradictory, and the comprehensive concept of globalization is far from clear and well-defined. Nevertheless, the concept of globalization indicates that the various changes are somehow interrelated and create new forms of Interdependencies between actors, institutions, and states.

A view supported by Chukwunonso and Oguike(2013), opined that higher education has approached a level at which ICT plays a vital role in nearly all phases of the educational process. They observed further that while there has been an ICT revolution in institutions of higher learning, there is a lack of policies to facilitate harnessing its educational uses, coupled with high acquisition and running costs. They suggested the development of policies by educational institutions to address fundamental and relevant use of ICT and application issues in learning programs. It is on this premise that this paper evaluated the Effect of CAD on Drafting Undergraduate students' Manual Drafting Skills in architectural education in a digital age taking the perspectives of Nueva Ecija University of Science and Technology Architectural students, with a bid to develop a digital usage policy for the university at the undergraduate levels.

III. Methodology

This segment states the various methods used in research and the sampling techniques used in determining the sample size for the research. How data was collected and analyzed is also discussed in this section. The main objectives of this research will be achieved through quantitative methods

A. Locale of the study

The study was conducted in the College of Industrial Technology, at the Nueva Ecija University of Science and Technology. Nueva Ecija University of Science and Technology is located at General Tinio Street Campus, Quezon District, Cabanatuan City.

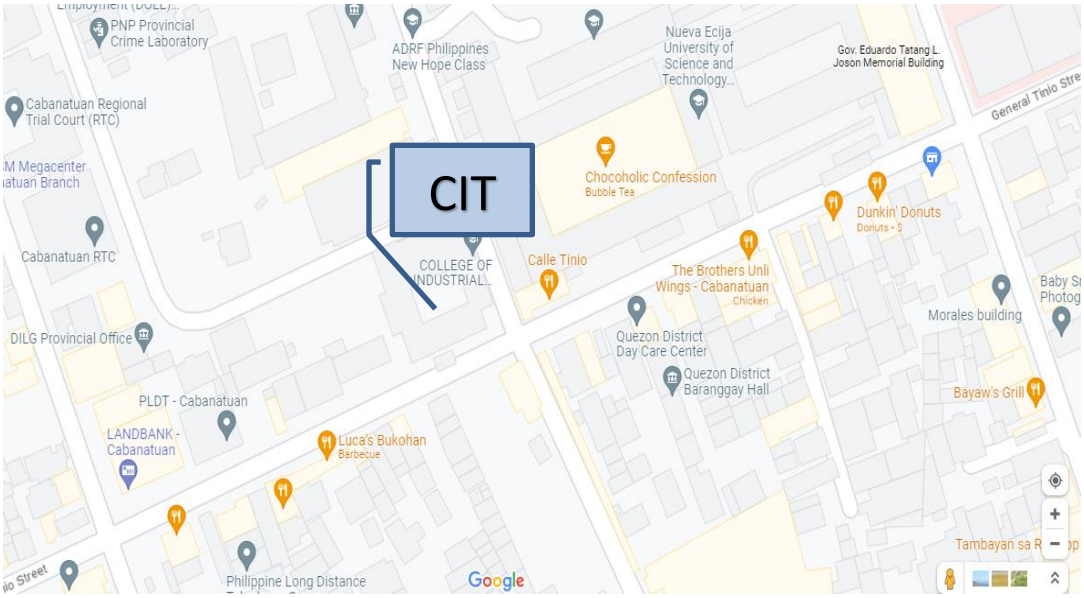

Figure 3. Locale of the Study. Source: Google (2023)

B. The population of the Study

The population of the study was recorded as 34 students, comprising various students from different academic levels of undergraduate study in the College of Industrial Technology, Nueva Ecija University of Science and Technology in the Second Semester, Academic Year 2022-2023

C. Sample Size and Sampling Technique

Given the population size, the undergraduate Drafting students' population of the Second Semester, Academic Year 2022-2023 was taken as the sample size, giving a total of 34 students and data could be collected from all the respondents.

D. Data Collection Method

Data for this study was collected from the respondents through the use of a questionnaire. Questionnaires were administered to the entire student population of 34 respondents, and field surveys through responses to questions in the questionnaire served as the main source of primary data for this study.

E. Data Analysis

Various analytical tools such as pie charts, and tables, were used in analyzing data for this study. Data collected were analyzed using frequencies and percentages. These frequencies and percentages enabled the researcher to represent true data characteristics and findings with a great deal of accuracy. Interpretation and analysis of data were also used to describe items in tables and charts used for this study.

F. Limitation

Since this study is a quantitative research, validation of data characteristics and variables described may be limited to some extent as other statistical tools such as arithmetic mean, variance, standard deviation, and the central limit theorem were not applied to further prove the accuracy of findings in this study. The researcher only used quantitative statistical tools such as frequencies and percentages to describe data characteristics and findings.

G. Data Presentation, Analysis, and Interpretation

The presentation, analysis, and interpretation of data gathered in the course of the study are contained in this part. The data are based on the number of copies of questionnaires completed and returned by the respondents. The data are presented in tables, and pie charts.

Relevant Data of Respondents Table 1: Gender of Respondents.

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	FREQUENCY	PERCENTAGE	VALID	CUMULA
Male	24	70.589	70.589%	70.589
Female	10	29.411	29.411%	100.00
TOTAL	34	100.00	100.00%	

Table 1 shows the gender distribution of the respondent used for this study.24 respondents which represent 70.589% of the population are males.10 respondents which represent 29.411% of the population are females. A total of 34 questionnaires were returned out of 40 served to the study population which represents 85%.

Table 2: Age Group of Respondent

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	FREQUENCY	PERCENTAGE	VALID PERCENT	CUMULATIVE PERCENT
below 20	19	55.882%	55.882%	55.882%
21 – 30	15	44.118%	44.118%	100.00%
TOTAL	**34**	**100.00%**	**100.00%**	

Table 2 shows the age group of the respondent used for this study.19 respondents which represent 55.882% of the population are below 20 years and 15 respondents which represent 44.118% of the population are below 21-30 years.

Table 3: Academic Level of Respondent

	FREQUENCY	PERCENTAGE	VALID PERCENT	CUMULATIVE PERCENT
2nd	14	41.176%	41.176%	41.176%
3rd Year	15	44.117%	44.117%	44.117%
4th Year	5	14.705%	14.705%	100.00%
TOTAL	**34**	**100%**	**100%**	

Table 3 shows the Academic Level of the respondent used for this study.14 respondents which represent 41.176% of the population are in the First Year; 15 respondents which represent; 44.117% of the population are in the Second Year and 5 respondents which represent 14.705% of the population are the in Fourth Year.

Figure 4 shows pie charts presenting various respondents' views on the research questions.

Question: Facilities provided in the Laboratory is Sufficient to Aid Manual Drafting.

As shown below in figure 4, 71% of the respondents strongly agreed to the fact that facilities provided are sufficient to aid manual drafting.11% of the respondents agreed, 2% of the respondents were uncertain about the fact, while 7% of the respondents disagreed and 9 %strongly disagreed.

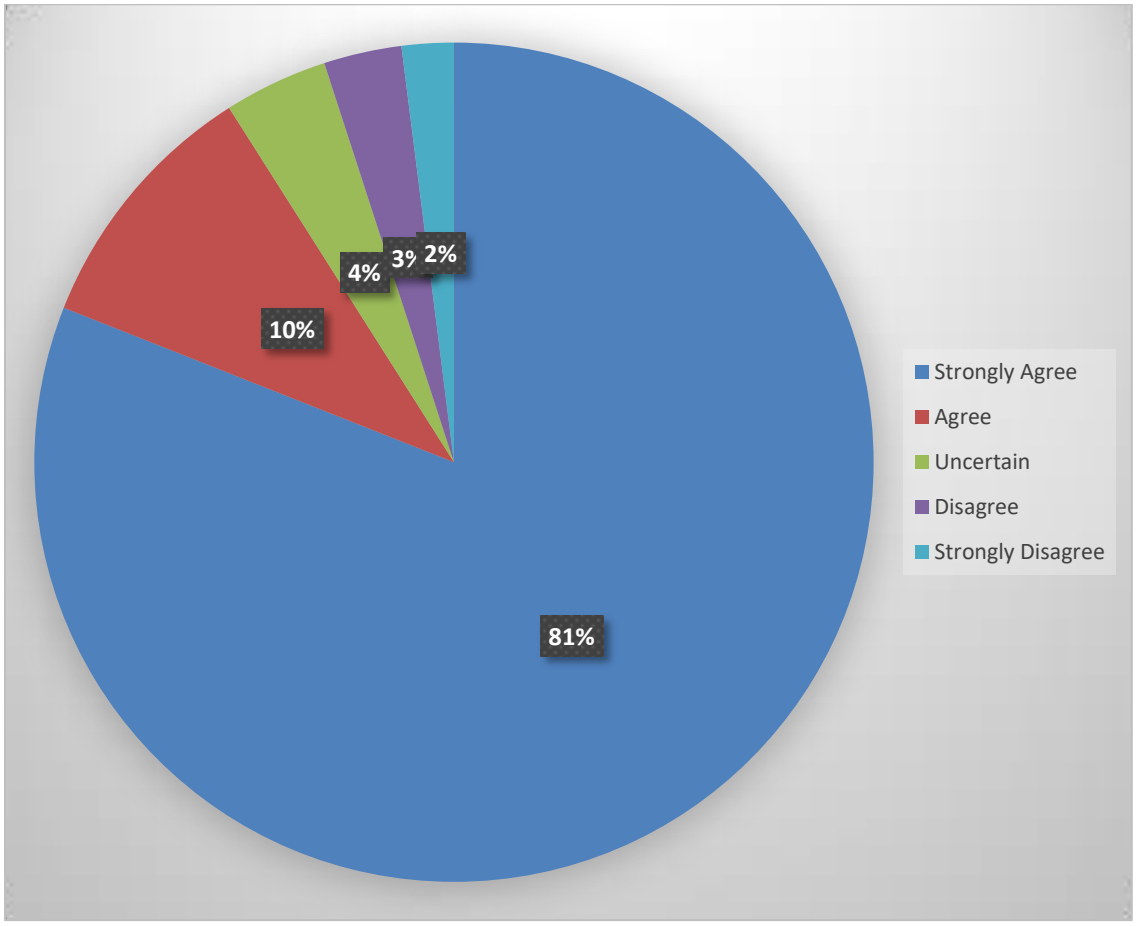

Figure 4: Responses to questions about facilities provided to aid manual drafting

Figure 5. Responses to questions about the manual drafting benefits over CAD on a long-term career.

Question: Students are equipped with the necessary tools for manual drafting.

As shown in Fig. 6 majority (81%) of the respondents strongly agreed with the fact that students are equipped with the necessary tools for manual drafting. 10% of the respondents agreed, and 4% of the respondents are uncertain. However, 3% of the respondents disagreed while 2% strongly disagreed with the fact.

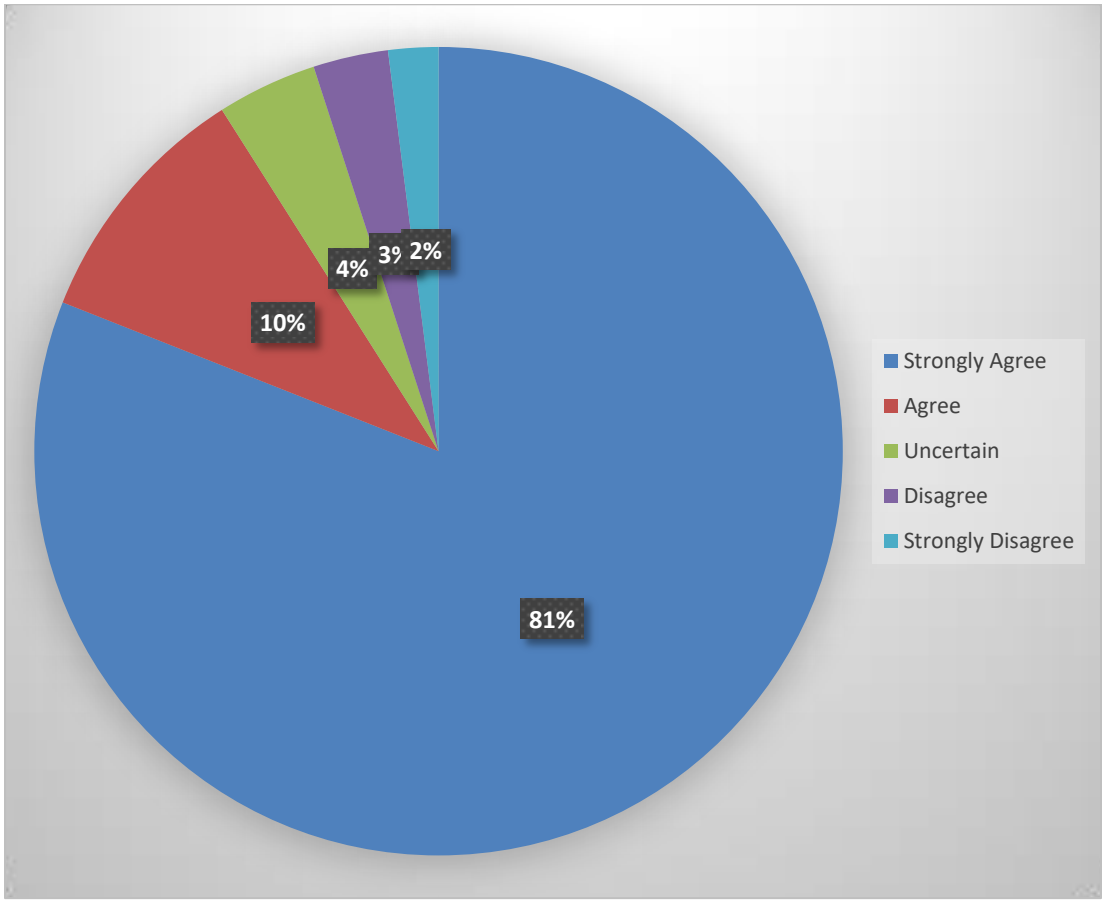

Figure 5. Responses to questions about Students are equipped with the necessary tools for manual drafting.

Owing to the empirical data garnered from the questionnaire, it was revealed that the majority of the respondents (students), use Computer Aided Design (CAD) to enhance their AutoCAD projects, as it is known to be faster, compliant with practice-based skill requirements, of higher quality and has better presentation outlook. Summarily CAD provides students with various ways to efficiently execute a design project with options to manipulate options, analyze and visualize their design proposals. This agrees with Cespedes (2008), that it is often detected that students employ CAD while camouflaging the presentations to reflect manual drawings in an attempt to obey the 'laws'. However, for the indifferences and referencing to manual methods of designing in some of the data retrieved from the interviews, it can be deduced that such respondents are either compelled to use this software due to the technology era we are in or were trained in Architectural schools as at the period before the innovations of Computer-Aided Design (CAD) and technology evolution.

IV. Conclusion

As proven by the respondents, the use Computer-Aided Design (CAD) has overriding advantages over the Manual drafting design construct. Such merits include an improved level of productivity, improved design quality, lower design development costs, and enormous time efficiency to meet up deadlines, etc. Generally, Computer-Aided Design (CAD) is a mere tool that assists the drafting procedure. It has no place in the thinking process and has very little influence on the initial stages of design. It is only a physical tangible tool that transforms the abstraction of the user into reality on the paperless board just like the old traditional methodology of drafting does too. Therefore, there is no vehement reason to seek an opposing ground to the continuity of the use of Computer-Aided Design (CAD) in architectural practice and education in this era of technological ease and advancements. As much as the contemporary world is compelled to form conformism with the dictate of technological advancements, the place of traditional history as the kernel of progress should be fervently protected. History is the connecting bridge that provides synthesis between the past and the "to come". The practice of drawing is central to the design development in Drafting.

Finally, *this study supports the idea that manual drafting should be taught to undergraduate drafting students alongside CAD as a core skill and should be combined with thorough digital drafting for standardized output and potential future benefits.*

V. Recommendations

This study posits that the successful fusion of Manual Drafting and the technological use of Computer-Aided Design (CAD) will produce excellent amalgam products as finished designs. Thus, in Architectural training as well as practices, there should be a balance in the use of Manual methods as well as Computer-Aided Design (CAD) as a complete architect that has mastered various techniques to proffer design solutions.

Therefore, without forgetting the subject at hand, as a recommendation, the contemporary Drafting practice should use the traditional way of sketching before drafting as the canon of the design process. Furthermore, the architectural school's instructors should encourage the students to imbibe the practices of traditional sketching as the basics of the design process.

The departments of Drafting in the various institutions should look critically into the integration of CAD into the architectural AutoCAD at the undergraduate level as this would enhance the quality of graduates produced from these institutions. It will also discourage the students from engaging in unapproved methods to complete their AutoCAD work. It is also recommended that the professional bodies (NIA and ARCON) should actively support the various institutions in

their plight to improve architectural education curricula to meet the challenging needs of a technologically driven built environment.

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