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CAD Inspiration for Design Students on the Geometric Modification of Letters

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Abstract: This study explores geometric modifications in letter design to encourage originality among elementary design students. It emphasizes viewing Computer-Aided Design (CAD) as a tool for boosting students' inspiration and familiarity with innovative letterforms. The study equips students with skills to create original designs and navigate copyright issues related to the use of typeface for their project. To achieve its objectives, the study targets: identifying challenges faced by design students, illustrating geometric modifications, developing procedures to encourage creativity, and evaluating the effectiveness of these procedures. An exploratory method is employed, involving focus groups with ten participants each, utilizing CAD for geometric modifications of existing and original design, and applying the semantic differential scale (SDS)/Likertscale to assess perceptions and efficacy of the suggested procedures. Both descriptive (mean, standard deviation, bar charts) and inferential statistics (chi-square, independent sample t-test, one-way ANOVA) are used in the analysis. The findings highlight gender issue, challenges related to inadequate access to technology and demonstrate CAD's effectiveness in enhancing geometric modification processes. The study emphasizes the significance of understanding anatomy and design principles, particularly in original designs created from scratch, underscoring CAD's role in reinforcing these principles. The outcome shows that students can independently create display and decorative letters for various applications without relying entirely on already existing one for originality purpose. Suggested procedures, including drafting design briefs, seeking mentorship, and integrating CAD with manual techniques, are found to enhance creativity and originality. Thus, it is likely that the suggested procedure has significant effect on the student's creative letter design especially when the elementary design students are flexible and not when they are unyielding. The combination of CAD and manual techniques notably improves students' intuition and creativity in letter design, with the overall positive impact on their creative output.

Keywords: CAD, Copyright, CorelDraw, Computer font, Creativity, Design Students, Geometric Modification, Graphic Design, Letter design, Originality, Typeface

Introduction

In regions where the digital gap persists, access to type design programs is often limited. The assumption that hand-drawn letters are the simplest form of type design would seem advantageous in such areas, but unfortunately, this is not the case (Corel, 2024). The main issue lies in the scarcity of digital resources, which are either inaccessible or prohibitively expensive. In more developed communities where the digital gap is minimal or nonexistent, individuals can readily access technology for creating typefaces directly on computers. However, this advantage is often absent in regions still grappling with the digital divide. Instead of criticize the government for inadequate digital resources to help students in this type of situation, this study addresses an

infinitesimal aspect of these challenges by exploring geometric modifications in letter design to encourage originality. In this study, students are given the freedom to employ any techniques they prefer for their creative exercises to avoid factors that may limit their creativity and interest. However, computer applications such as CorelDraw are utilized by the author as instructional tools to demonstrate modifications in letter design. It is believed that this process may inspire students and increase their interest while familiarizing them with letterforms.

A lack of widespread information results in many individuals being unaware of free programs available for creating typefaces. While some regions possess a basic understanding of intellectual property, comprehensive knowledge is often deficient. It is notable that educational institutions that include copyright and originality in their curriculum frequently fail to effectively convey these concepts. Additionally, the ease with which text and images can be duplicated using computer applications diminishes the incentive for originality, causing students to rely on existing resources rather than creating their own, ultimately leading to a lack of personal identity in their work. To address these challenges, this study considers geometric modifications in letter design to foster originality. Navigating copyright issues related to typefaces and fonts remains problematic for many (Althubiani, 2023). The terms "typeface" and "font" often cause confusion, complicating the process of seeking permission to use these intellectual properties. Although typeface designs themselves are not protected, the software enabling the use of fonts—including font files (e.g., TrueType or OpenType) and rendering code—is subject to copyright protection (Althubiani, 2023). However, some fonts are released under open-source licenses, permitting free use, modification, and distribution. Designers can also modify type after converting it to outlines (ETalks.23927486htvk, 2022). Building on this foundation, this study presents an exploratory prototype on Computer-Aided Design (CAD) inspiration for undergraduate students, with a focus on geometric modifications in letter design to promote originality

The rationale behind this study is to encourage students to view Computer-Aided Design (CAD) as a tool akin to their sketchpad and pencil, fostering confidence in their intuition and reducing reliance on copyrighted materials. CAD can be inspiring due to the various ways it can be used to imagine design beyond what the mind has initially conceived. Though it might seem playful; sometimes, this inspiration may make design to eventually drift from initial sketches when considered better or more innovative than initial mindset. Through this means a student is expected to see other different interesting ways of doing their design works. This is referred to as CAD inspiration in this study. As design students, CAD should inspire them to explore various possibilities of unique letter design, especially when integrating sketches with CAD for experimentation or modification of letterforms. Historically, books were handwritten by scribes around the fifteenth century, emphasizing the relevance of hand lettering as the foundation for typeface design. Understanding this historical context and engaging with CAD software can enhance students' familiarity with letterforms and nurture their creativity while upholding copyright and licensing principles.

Ultimately, this study advocates for a comprehensive approach to type and letter design, recognizing them as forms of visual communication with distinct purposes. By equipping elementary design students with the skills to create original designs and navigate copyright issues, this approach prepares them for careers in type design while respecting the rich tradition of hand lettering for communication. In type design, students may initially lack ideas, thus it's necessary to study established existing letterforms or typefaces to generate new ideas. Knowledge of letter anatomy should enable students to create various prototypes based on different strokes, terminals, serifs, bowls, counters, and other features. Thus, this study presents an exploratory and prototype study on Computer-

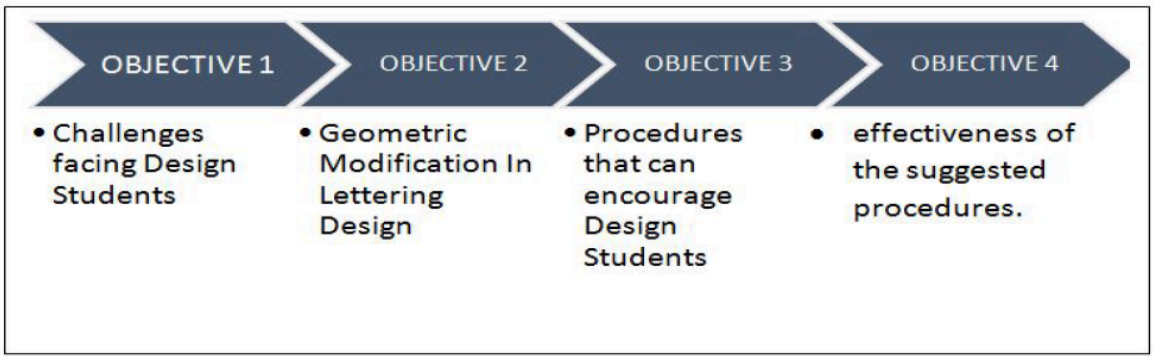

Figure 1: *Integrated diagram for the study*

Aided Design (CAD) inspiration for undergraduate students on geometric modification in letter design for originality purposes, outlining four specific objectives as briefly shown in Figure 1.

Aim and Objectives

The aim of this study is to explore CAD inspiration for design students on the geometric modification of letters for originality purposes.

The specific objectives are to:

I. investigate challenges facing students in letter design or typographic design works in relation to the limited digital resources;
II. illustrate geometric modification in letter design;
III. suggest procedures that can encourage apathetic students to becoming motivated or inspired to seek originality in design project particularly in letter design; and
IV. assess the efficacy of the suggested procedures in fostering originality among students in their design project particularly in letter design.

Literature Review

The study of letters as symbols representing speech sounds is integral to the evolution of human communication, marking a significant milestone in civilization's quest for effective interaction (Sari and Prada, 2020). Despite the prominence of images and digital advancements in printing, written words remain the cornerstone of information dissemination. Proficiency in lettering is indispensable for those involved in crafting communications for both traditional and digital mediums (Willen and Strals, 2009). Prior to 1450, all letters were painstakingly handwritten, until Johannes Gutenberg's invention of the printing press revolutionized the dissemination of written material, ushering in a diverse array of typefaces that are still in use today (Mills and Weldon, 1987; Chapman, 2020).

According to Cheng (2006), hand-drawn letters can be scanned and traced to create digital character outlines, or they can be sketched directly on a digital screen or sketchpad. In some schools, sketching typefaces on a computer is now common, while in other schools, particularly in third-world countries, this practice is less known or affordable due to the lack of digital resources (Boss, 2018). While digitization has brought about significant advancements, it is crucial for scholarly attention to remain focused on this area. A minority of design schools possess the necessary digital resources, which are often inaccessible or prohibitively expensive. If digital utilities such as Adobe Streamline, Pyrus ScanFrost, or DTL TraceMaster are used in developed countries while many schools in underdeveloped or developing countries cannot afford them, a barrier in design education emerges. This barrier prevents the widespread dissemination of knowledge. Consequently,

students in regions where the digital divide persists may not be familiar with specialized font software like FontLab, Fontographer, Robofont, or DTL FontMaster. In such situations, these students lack the opportunity to fully learn and utilize this software. "Today, however, most of those working with typography have little education in type, including, with few exceptions, most designers (although some of the better design schools are beginning to address this important subject). The unfortunate result of this situation has been the proliferation of poor typography" (Strizver, 2006; p.25). According to (Strizver, 2006), these led to the democratization of type design but contributed to the quality of these typefaces ranging from very high end to extremely poor, leaving the daunting task of deciphering “which was which” to the end user. Even, some designers find some of the software like DTL interface difficult to learn (Cheng, 2006).

Previous literature, including works by Eramudugolla and Samarawickrama (2023), Bojan and Uroš (2012), Chapman (2020), Willen and Strals (2009), Mohsen and Sayegh (2018), Fleischmann (2011), Oluyemi et al. (2022), Cheng (2006), Turgut (2014), and Mills and Weldon (1987), has touched upon various aspects of type and letter design. Elias et al., (2023) consider safety, functionality, usability, pleasurable experience, and individuation as users' need when considering typographic properties and accessibility, legibility, readability, personality, and customization as properties of typography. For instance in terms of typographic properties, open aperture helps readability because they are less confused with letter "O" (Cheng, 2020). Sharma et al., (2023) in their study, create an intent- driven system to provide contextual font recommendations to users to aid creative design. Wang et al., (2015) used deep font system for font recognition as well as produce a font similarity measure for font selection and suggestion. However, there is a notable gap in literature concerning the enlightenment of students through CAD-inspired geometric modifications of letters. Design students should continually explore various typefaces to build upon existing knowledge. For instance, Eramudugolla and Samarawickrama (2023) proposed a draft typeface for Sri Lankan Directional Informative Sign Boards, addressing the dearth of literature on Sinhala script or Sinhala typography. Similarly, Prasad, Mishra, and Prasad (2018) suggested a simplified standard method for constructing uppercase letters to alleviate confusion among engineering students and professionals. They noted that software packages like AUTOCAD could aid in constructing Gothic letters. Bojan and Uroš (2012), in their study on font hinting techniques for high-quality font display, emphasized the importance of understanding letter anatomy and the fundamentals of digital typography for well-designed fonts. Hinting is the last stage for the production of professional font by equalizing the design elements to appropriate number of pixels (Cheng, 2006). It can also ensure consistent alignment of the design elements.

Figure 2, extracted from the research conducted by Bojan and Uroš (2012), illustrates the intricate arrangement of nodes along the line segments of specific letters, highlighting notable similarities and differences. This aspect serves as a fundamental underpinning for

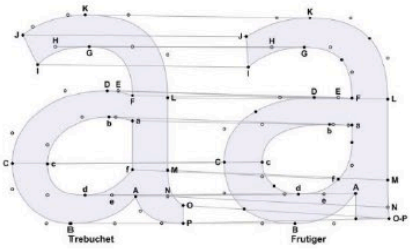

Figure 2: *Nodes on letters to understand both automated and manual techniques. (Bojan & Uroš, 2012)*

comprehending advanced research in both automated and manual techniques. Consequently, this study extends upon this foundational knowledge by introducing CAD inspiration for design students, particularly in the realm of geometric letter modification. It is worthy of note that present study is not about font modification but letter modification; thus, it deals with only the letter design. It is anticipated that this approach will provide students with a framework to focus their projects on letter modification, which is crucial for thriving in an industry marked by fierce competition (Sari and Prada, 2020). Notably, advancements in digital typography technology now enable individuals nostalgic for handmade arts/design products to seamlessly integrate both hand lettering and computer fonts (Turgut, 2014). According to Adkins (2013), best ideas start with pencil and paper when designing font by using CorelDraw. This prior author explored designing font with CorelDraw by first hand sketching the basic shapes that represent the American Captain font before scanning the image of the paperwork into the computer. The author attests that tweaking, adjusting, and testing of the letterform is exactly the kind of challenge that CorelDRAW is designed to handle. Eventually, the design can be exported from CorelDRAW as files that can be seamlessly imported into font editor. Present study is different from the prior authors because it fails to design font but only plays creatively with the letterforms for the purpose of boosting students' inspiration and familiarity with innovative letterforms. In other words, present study can also be considered as a creative process based on the declaration of Walia, (2019) that "creative process may or may not be successful in implementing ideas that solve problems, but attempts by potential creators may certainly bring these problems to the forefront for others to solve". Thus, present study presents an exploration of CAD inspiration for undergraduate students in the aspect of geometric modification in letter design for originality purposes. This can also provide avenue for the knowledge garnered in this study to be explored further by subsequent study.

Methodology

Research Method for Objective 1: Investigating challenges faced by students in letter design or related typographic work.

To address the first objective, a partially structured focus group discussion is employed. The interviews are conducted in four phases: planning, participant recruitment from undergraduate graphic design students, conducting interviews, data collection, and interpretation of obtained data.

Planning Phase: The aim is to explore the hurdles encountered by undergraduate students in letter design or related typographic work. For this purpose, third-year graphic design undergraduates are deemed suitable participants. An announcement soliciting voluntary participation in a letter design task is made to a class comprising 30 students. To ensure anonymity, the specific identity of the school and students remains undisclosed, as per the agreement with the participants and the institution.

Next, the investigation's questions and the focus group's principles (agenda, timing, location, audio recording) are presented to the participating students. The undergraduates opt to partake in the survey voluntarily to contribute their opinions and experiences. Two research assistants facilitate the interviews: one conducts the interview, while the other listens. The interviews are recorded using mobile phones and conducted in a distraction-free environment, typically an unoccupied design studio, to allow participants to focus uninterrupted on the academic process. On average, each interview lasts for 30 minutes.

Sample Description: Twenty out of the 30 students volunteer to participate in the study. Two focus group sessions are conducted within the anonymous design school premises. The participants' ages range from 18 to 22 years old. Table 1 provides further details regarding the sample composition.

Table 1: *Demographic data of participants*

Focus Group (FG)	Educational Qualification	Level	Number of Participants	Participants by Gender	
				Male	Female
FG1	Undergraduates	300 Level	10	7	3
FG2	Undergraduates	300 Level	10	5	5
Total			**20**	**12**	**8**

The execution and topics of the focus group interviews are carefully designed to facilitate open and descriptive discussions among participants. The questions are straightforward, avoiding simple yes or no answers, and encouraging participants to provide detailed responses. Participants are given the opportunity to express their opinions, experiences, and disagreements without interruption. The questions allow multiple responses, fostering a rich exchange of ideas. The interviews focus on various aspects related to letter design, including participants' motivations for participating in the study, their understanding of typographic design and letter design, prior experiences in these areas, knowledge of typography rules and guidelines, technical proficiency, technological barriers, and issues related to creativity, originality, copyright, and ethics. These topics are carefully selected to provide insights into the challenges and considerations involved in letter design.

Research Method for the second objective:
For objective 2, which involves geometric modification in letter design, it is essential to clarify that this study does not delve into the creation of new typefaces but rather focuses on experimenting with existing ones. The purpose is to increase students' familiarity with letterforms and prepare them for future careers in type design. To avoid legal issues related to copyright, the study utilizes letterform from open-source freeware fonts that permit non-commercial modification and adheres to 'fair use' permissions of the letterforms for educational purposes. Notably, this study uses only the outlines of the letterform for the modification and not the font files. CorelDraw is chosen as the software for the study due to its popularity and accessibility among students. While it may not be the industry standard for type design, it serves the educational purpose effectively. The term 'CAD' in this context refers to the use of computer application software to assist in the design process. CorelDraw, known for its simplicity and efficiency, is considered suitable for this purpose. Overall, the methodology ensures a systematic approach to investigating challenges and exploring geometric modifications in letter design while adhering to ethical and legal considerations.

In this study, geometric modification in letter design will encompass the utilization of both curved and straight lines within the letterforms. For letters originally composed of curved lines, a transformation will occur to integrate straight lines, ultimately resulting in octagonal letterforms. Conversely, for letterforms lacking curves, the introduction of additional angles and sides will occur. This method mirrors convenient sampling, ensuring a seamless experiment within the CAD software interface. Various techniques will be employed to modify the geometry of the letters, such as altering, removing, or adding nodes to different segments of the letters. The comprehension of letter anatomy, exemplified in the diagram within Figure 3, will serve as a crucial reference point throughout the process of geometric modification.

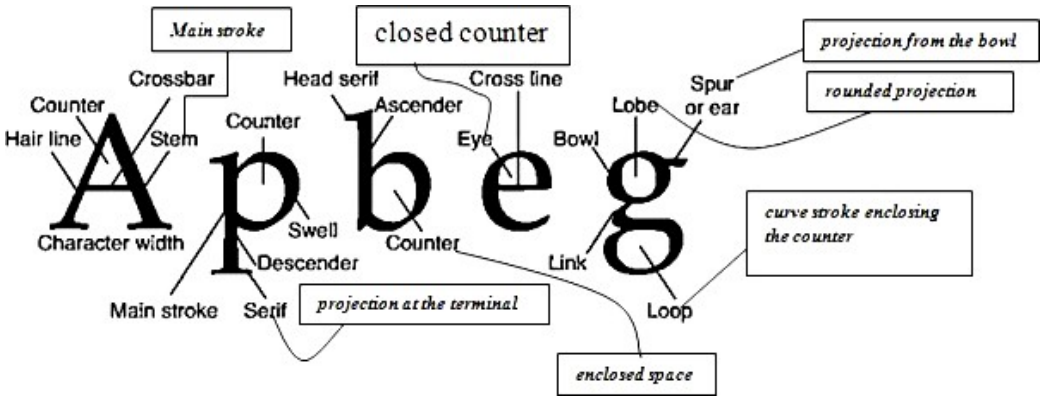

Figure 3: *Some considerable parts (anatomy) of letters during geometric modification*

Figure 4: *Uppercase and lowercase Geometr415 Blk BT in LibreCAD as well as beveled letter in CorelDraw*

By adeptly combining curved and straight lines and strategically adjusting the nodes within the letterforms, the study endeavors to showcase how geometric modifications can elevate the creation of new forms in letter designs. Display letters that can be used for headlines, outdoor advertising design and decoration are used (see Figure 4). Likewise, they are san serif letters of which one of them is an outline of the letterform from a beveled font and others are uppercase and lowercase geometric sans serif. The counter, crossbar, aperture, stem and eye can be modified by adding or removing the nodes, shapes and strokes. The lines, nodes, angles, and other parts shown in Figure 5 can be made editable through the use of CAD. 'Agency FB' designed by David Berlow for Font Bureau would have been used in the exercise but it is a commercial and copyrighted design that cannot be changed by others. The other option is to abide by the ‘fair use’ permission since it is an educational project.

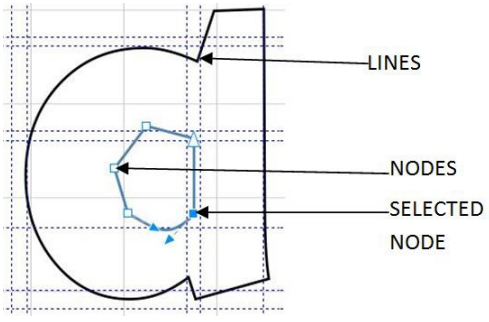

Figure 5: *Nodes of the editable outline*

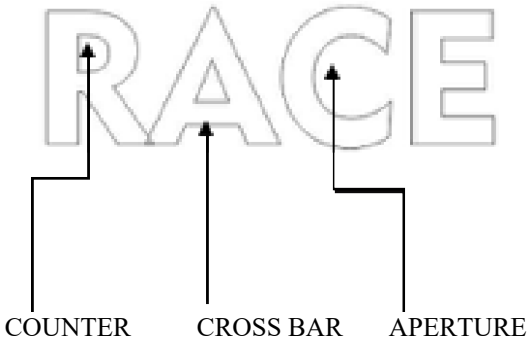

Figure 6: *Parts of letters to be modified in the already existing typeface (non-commercial modification/fair* use)

It is worthy of note that other software such as Microsoft Office Word, Adobe illustrator CS 6, Adobe Photoshop CS 6, Adobe Photoshop CS 5, and LibreCAD 7.5 are also examined to find suitable typeface for the exercise. The outcome results to using open-source freeware typeface that permit non-commercial modification (see Figure 6).

For instance, all fonts in LibreCAD are freely available without any compulsory permission from the inventor while for typefaces in CorelDraw, permission is sought from Bitstream Inc These typefaces allow further use in logo design and poster design to mention a few. On the safer side, present study is perfectly under fair use because it is strictly for educational purpose and not related to usage outside the designers' specification (Aufderheide et al., 2011; Althubiani, 2023; LibreOffice 2018; ETalks.23927486htvk, 2022; Corel, 2024: Netaniel, 2011; LibreCAD, 2018).

During the process of letter modification within the CAD interface, geometric modification of letters through the use of existing typeface and modification independent of existing typeface are compared by the use of the rating scale of 5 to 1(representing 'most significant' (5) to 'not significant' (1) in Table 2). Table 2 outlines the semantic differential scale (SDS) employed to gauge perceptions of inspiration during the design process. SDS is a measurement process for rating based on a series of bipolar adjectives scales separated by a fixed number of intervals (Yusoff et al., 2013). Eventually, this generates data in terms of mean score of the significance of the inspiring variables towards achieving graphic appeal of the modified new form. For instance, situation whereby the modification fails to reveal possibilities of salient modification scores 1 (not significant) while when there is very fantastic salient modification scores 5 (most significant).

Table 2: *SDS for the significance of the CAD inspiration for the letter modification*

Rating Scale	*Level to which the variables are significant*
1	Not Significant (NS)
2	Least Significant (LS)
3	Somehow Significant(SS)
4	Significant (S)
5	Most significant (MS)

The scoring is done simultaneously during the creative process. Specifically, bar chart, descriptive statistics and independent sample T-test are used for the analysis of CAD inspiration for the letter modification. To do this IBM SPSS (Statistical Package for the Social Sciences) Statistics 23 version is used. This software helps in the calculation of the descriptive statistics and independent sample T-test as well as generation of bar chart. T-test is used for comparing mean of two groups (i.e. comparing the typical occurrence of the variables between only two groups). Thus, an independent sample T-test is carried out for the two groups; namely, the category reliant on existing typefaces and the category independent of existing typefaces.

In this study, descriptive statistics includes mean (M) and standard deviation (SD) (see appendix A/B) as generated by using IBM SPSS statistics 23. The aforementioned analysis is necessary so as to show how the inspiration takes place during the modification process. Thus, showcasing the crucial role of CAD inspiration during the modification process. M represents the most typical occurrence of variables relating to CAD inspiration during the letter modification process. SD is the spread of the data in terms of proximity to the most typical occurrence. Low SD shows that the data are clustered tightly around the mean while high SD shows that the data are more spread out. Thus, low SD are more reliable and consistent compare to high SD when considering most typical occurrence of the data in this case.

Research Method for Objective 3: procedures that can encourage apathetic students to becoming motivated or inspired to seek originality in design project particularly in letter design

The methodology for Objective 3 is descriptive-based and incorporates intuition, literature review, and observation. Although this study focuses on design students in regions lacking adequate digital resources, it assumes a strong interest in CAD despite the digital deficiency. For instance, in such regions, a student might more truthfully attribute their failure in a design course to the lack of sketches rather than the absence of a personal computer. The point is that in these regions, sketching and manual design production should take precedence over CAD due to limited digital resources. Therefore, this study views CAD as a source of inspiration rather than a tool for the final production of designs. Just as inspiration can be drawn from nature, experiences, or the works of other students or designers, experimenting with CAD can also spark creativity. This is one of the rationales behind this study.

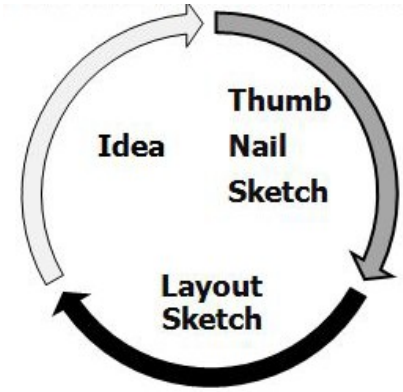

Figure 7: *Cycle of generating idea for a design project*

Brown (2009) observed that students seem to have lost fundamental skills because they prioritize CAD over actual academic training. Sketching, for example, is a crucial skill that students should develop as it allows for the quick presentation of conceptual prototypes. This can help students generate multiple ideas swiftly, fostering originality and creativity. According to Brown (2009), the knowledge students gain from their education should guide the appropriate use of technology. This means academic activities should take precedence over the heightened focus on CAD. Brown (2009) argues that students are becoming detached from their fundamental skills, their approach to design, and their understanding of how technology should be used in their training. Ryan (2008) consider sketching as a very important procedure that help in creating ideas towards originality. In figure 7, thumbnail sketch follows after idea and they are small roughly drawn visuals created in rapid succession (Ryan, 2008). This means idea generation and sketching are very important in a design project; especially, when seeking originality and creativity. Through thumbnail, the students will embark on the journey of turning the abstract vision into a working representation of their final idea (Brown, 2009). *According to Linus Pauling, "the best way to get a good idea, is to get a lot of ideas"* (Kelley, 2002, p. 55).

This will be a conceptual way of visualizing their idea through the cycle in Figure 7. Thus, a student might need to create many sketches to generate new ideas. Hand lettering is an interesting aspect of graphic design just like basic drawings (such as still life, landscape, and figure drawing to mention a few) are intriguing aspect of fine arts. The ability to communicate ideas through simple sketching was, and still is, a vital tool for designers (Brown, 2009). Thus, this study builds on this body of knowledge and other methods earlier stated to achieve the third objective.

Research Method for Objective 4: The efficacy of the suggested procedures.

Students are giving the freedom of using whatever tool, procedure or experiment that please them for their creative exercise and to transform letterform to any form they like. This is done to avoid interference with the possible outcome of the intervention and to see if students will work accordingly or otherwise.

Table 3: *Some of the criteria to be considered in relation to suggested procedures*

Criteria	Description
Interest	The level of interest of the student
Understanding	The level of understanding of the student
Motivation	The level of Motivation of the student :how curious /dedicated or attentive are they?
Appropriateness	The level of appropriateness of the design outcome
Originality	The level of originality, novelty or uniqueness
Instruction Interpretation	Minimized Communication barrier/bridge between the student and instructor
Intuition	Level of independence and Self expression
Flexibility	The ability to easily adopt and manipulate new idea without difficulty

Also, to avoid interference with their preference or interest. However, they are limited to English language. Accordingly, the students' interest, understanding, motivation, appropriateness, originality, feedback interpretation of instruction, intuition, and flexibility are analyzed in relation to the suggested procedures (see Table 3) by using Likert scale for rating the criteria.

As a result of the suggested procedure expected to encourage apathetic students in design, it is hoped that the level of interest of the students can be rated on the scale of 5 to 1 (see Table 4 and appendix A/B for more clarity). In Table 4, VID =1, stands for very indifferent; ID = 2 stands for indifferent; N = 3, stands for neutral; I= 4, stands for interesting; and VI = 5, stands for very interesting. The corresponding values are used for rating the level of interest of the students as they go through the suggested procedures. .NU =1, stands for not understandable; AU = 2 stands for indifferent; N = 3, stands for neutral; I = 4, stands for interesting; and VI = 5, stands for very interesting. The corresponding values are used for rating the level of understanding of the students as they go through the suggested procedures.

In table 4, VLM =1, stands for very low motivation; LM = 2 stands for low motivation; MW = 3, stands for moderate motivation; HM = 4, stands for high motivation; and VHM = 5, stands for very high motivation. The corresponding values are used for rating the level of understanding of the students as they go through the suggested procedures. For instruction interpretation, flexibility, and intuition, VL =1, stands for very low; L = 2 stands for low; M = 3, stands for moderate; H= 4, stands for high; and VH = 5, stands for very high. For rating the level of originality, novelty or uniqueness as well as the level of appropriateness of the design outcome, NS =1, stands for not significant; LS = 2 stands for least significant; SS = 3, stands for somehow significant; S = 4, stands for significant; and MS = 5, stands for most significant (see appendix A/B).

Also, method/tools used, rate of CAD usage, fundamental design principles, and number of sketches are analyzed. Some of the aforementioned parameters are analyzed by using bar chart and frequency table. Chi- square tests also used for originality of paperwork produced in relation to how the participants used CAD. One way ANOVA (analysis of variance) and independent sample T-test are also used. "One-way" as used for ANOVA means that it specifically about the suggested procedures (i.e. only most typical of its effective occurrence will be compared). ANOVA is a statistical technique that is used to check the effectiveness of the suggested procedures by comparing the means of the different procedures based on how the students used them. Based on how the students freely adhered without been compelled, ANOVA can be used to prove or disprove if the suggested procedures are effective or not. The reason is because it not

Table 4: *Likert scale for some of the criteria to be considered in relation to suggested procedures*

Scale	*Interest*	*Understanding*	*Motivation*	*Intuition*	*Flexibility*	*Originality*	*Appropriateness*
1	VID	NU	VLM	VL	VL	NS	NS
2	ID	AU	LM	L	L	LS	LS
3	N	N	MM	M	M	SS	SS
4	I	U	HM	H	H	S	S
5	VI	VU	VHM	VH	VH	MS	MS

easy to just conclude by mere observation or comparison; thus, one way ANOVA is considered suitable for this analysis. Normally, there is null hypothesis and alternate hypothesis when using T-test or ANOVA. The null hypothesis can be considered as follows:

(i) there is no difference among the means of the suggested procedures. This means there is no difference in the most typical occurrence of the suggested procedures.
(ii) the suggested procedure is not effective
(iii) variability between groups is not larger than variability within each group.

The mean of the "between groups" divided by the "within group" is equal to the F-value. The probability value is the p-value. It is the number describing how likely that the occurrence is under null hypothesis or not. F- value greater than p-value, is significant .i.e. effective. In such situation, the evidence is strong to reject the null hypothesis in favour of the alternate hypothesis (.i.e. the suggested procedure is effective). When the null hypothesis is "the suggested procedure is not effective", then p-value is less than/or equal to α (.i.e. 0.05).

Result and Discussion

Result for objective 1: Challenges facing students in letter design or typographic design work

Group Interview Findings

Twenty (20) out of thirty (30) actually volunteered to participant in this study. Three (3) out of twenty (20) participants decided to participate because they hope to benefit from the study. The remaining 17 participants are silent and give no response. "*As a person having ADHD, lettering is an interesting aspect of graphic design that captures my attention and helps me to concentrate*" (male, no.15). ADHD is attention deficit/hyperactivity disorder. (This seems similar to prior study that examine font size and type in relation to enhancing the attention span of children living with ADHD (Phalke et al., 2023)). "*I think I will learn something new*" (female, no.10). "*Every topic in graphics is important to me; so, I want to know any aspect of graphic design*" (male, no.20). The observation is that few students see the need for adequate attention to this aspect of art and design. Analysis of the interview shows that none of the participants have challenges of understanding the meaning of letter design or typographic design works. All of them consider typography to be related to text seen on the digital screens like phones and computer as well as the textbooks. "*I think typographic design work and letter design are the same because both can be used for logo design*" (male, no.1). "*I think typography and lettering should be considered as one*" (male, no.6). Majority of them think that only typography should be taught in the University because lettering is elementary. "*I think hand can be easily used for lettering since it is just drawing of letters but it will be very tedious to use hand for type design*" (female, no.12). "*I think letter design is more related to display category of letters while typography is more relevant to the textbooks, mobile phone and computer*" (male, no.18). "*Typography is not the same as lettering; 'lettering is different from calligraphy even though both are considered as one because of the use of hand*" (female, no.20).

All the participants have done the design and art of lettering in their previous works; But, only fifty percentages (50%) of the students have done design works related to typography. "*I have done courses in lettering and typography; in lettering, we drew letters while, we used computer for logo design, typing, book design, advertising design, and publicity design*" (female, no.12). "*I did letter construction in primary school, secondary school and university*" (female, no.20). Majority do not know the rules and guidelines in typography. They do not mention any anatomy of letters or terms such as kerning, leading and other terms in typography. "*I don't know any typographic rules and guidelines*"(male, no.15). Majority of them have not attempted the use of CAD for letter modification and many of them use mobile phones for their typographic design work. "*I don't know how to use computer application for letter design but I have used CorelDraw for my other designs such as advertising design and others*" (female. no.12). "*For logo design, I used the computer fonts*" (male, no.2). "*Most logo designs I did were*

directly from mobile app such as Canva and I never like to draw logo with hand" (male, no.5). Many of them do not like to sketch their idea but prefer to use computer for their designs. Majority experienced technical limitation in terms of electrical poor supply, lack of computer and other accessories. *"...for example, I decided to use mobile phone for graphic design because, I don't have a computer*" (male, no.5). "*we know that there are a lot to learn from the internet but we face a lot of limitation concerning internet connectivity* (female, no.4)" "*It is very painful that we don't have access to computer programs that can help us in our design works*" (female. no.9). "*We cannot buy computer application programs from the internet because they are very expensive* " (female, no12) "*...Our instructors use old version of computer programs such as CorelDraw and other common programs such Adobe Photoshop* (male, no.19)" "*both students and instructors are affected by technological barriers* (male, no.7)" "*we have access to some trial version of latest computer programs and freeware are not common*"(male, no.8). "*I don't like using hand for design and I like to do my designs with computer* " (female, no.14).

Result for Objective 2: Geometric modification in letter design

a. Abiding by Fair Use of Existing Typeface for the Geometric Modification:

The outlines of the letters are set to hairline and broken apart so that individual letters can be modified (see Figure 8a). The removal of nodes have enabled some curve lines and planes to have been eliminated. The use of grid lines help in checking the proportion of the section of the letters (see Figure 8a and 8b). This also aid the alignment of the design elements, as well as the proportionate and appropriate adding of nodes to the lines at the eye, aperture, stem, counter and other parts, so as to create more angles when moved or repositioned.

In Figure 8a, some of the straight and perpendicular lines to the angles have been transformed to diagonal lines. The 90 degree angular edges and sides of some of the stem and other strokes have been modified to polygonal sides. In letter 'R', first perpendicular lines are not modified except at the counter. The perpendicular lines and 90 degree at the corners within the aperture of letter 'C' is also modified but that of letter 'E' remains perpendicular. (see Figure 8a). At the stem of letter 'E', the point

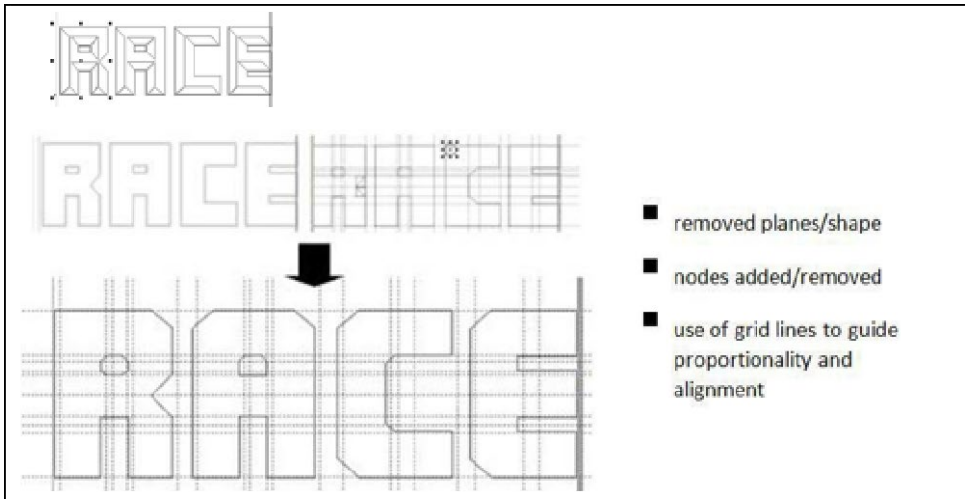

Figure 8a: *Broken apart artistic text and geometric modification of some perpendicular angles as well as lines to derive octagonal letterform*

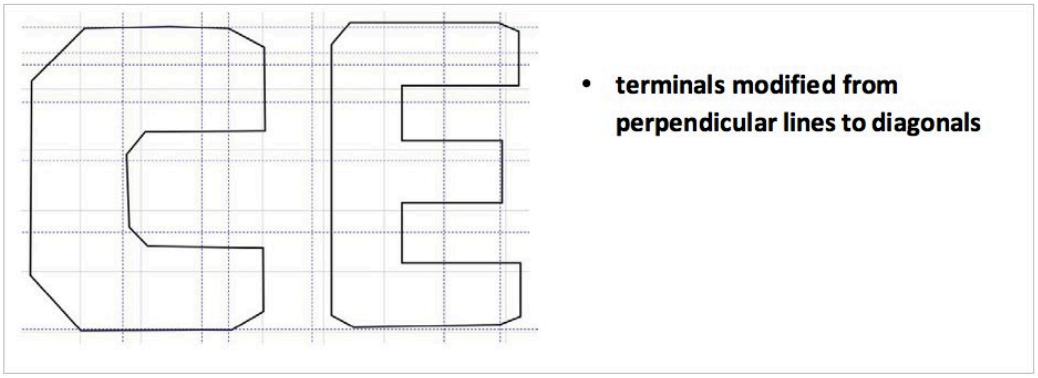

Figure 8b: *Geometric modification of perpendicular lines at the terminal of the letters*

where the lines suppose to intersect at 90 degree is modified to diagonal lines. This illustrates geometric modification of straight strokes in the letters to diagonal lines of the octagonal letterform. The terminals of the letters can be further transformed from perpendicular corners to diagonal by adding nodes and repositioning or moving them (see Figure 8b). The typeface in figure 8a is different from figure 9a. While beveled, angular and quadrilateral letters are modified in Figure 8a, figure 9a consist of triangles (e.g. letter 'A') and circular letterform (letter 'C'). This necessitate kerning while transforming circular letterform to octagonal because negative space will increase after changing the bowl of the circular letterform (.i.e. letter C) to a stem (see Figure 9a and 9b). Even, the triangular letterform when modified to quadrilateral or octagonal will require letter spacing because of the tight closeness that will exist as a result of the extension of the added nodes to the line segment (see Figure 9b).

In the process of modifying a particular letter , different letterform emerges (for example, in the case of the letter 'A' before the last arrow in Figure 9b). This kind of situation can be inspiring and further possible appearance or structures can be done. Thus, in the process of letter modification one can be inspired and a particular idea can be further explored or improved. Having derived the uppercase, the next illustration involves the geometric modification of a lowercase. For the lowercase in Figure 10a and Figure 9b, the edges of the letters consist of straight stroke of the stem (letters 'a' and 'r) and the curve lines (at the bowl, counter and aperture). The letters are

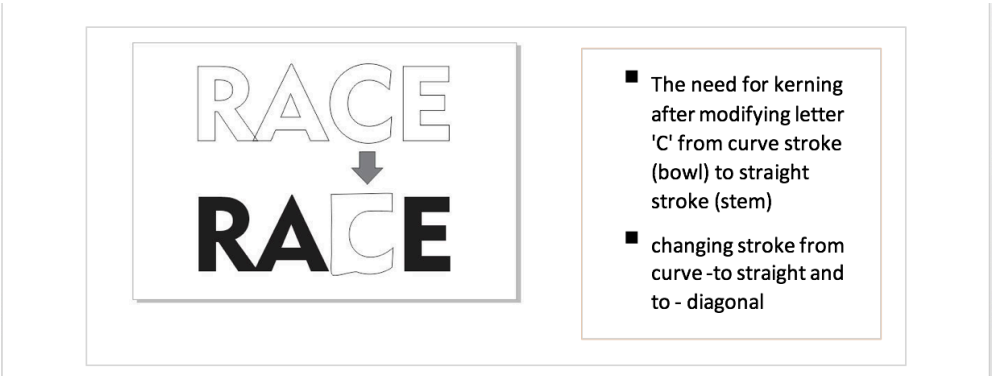

Figure 9a: *Geometric modification of curve lines in circular letterform (letter 'C')*

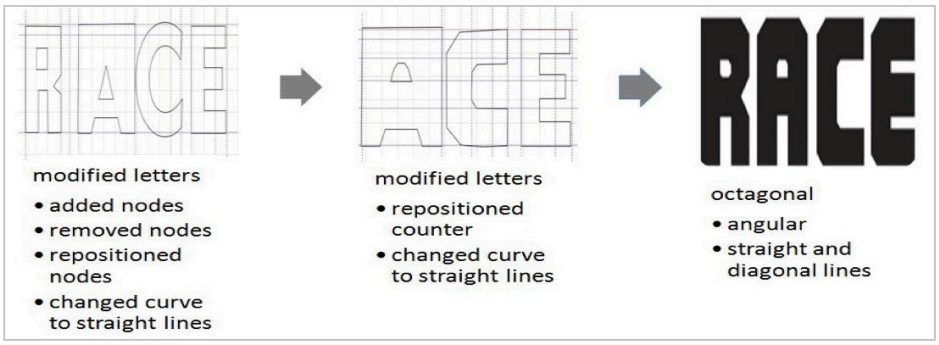

Figure 9b: *Geometric modification of triangular, curve and perpendicular lines to derive octagonal letterform*

broken apart and grid lines are also included so that each curve corner can be modified to angular corner. Each letter is converted by increasing the nodes of the editable line segments in the curve. This enables the inclusion of more angles and to enables the curve segments of the letters to be converted to straight lines. The cell of the gridlines also guide the proportion of the letters. The extension of line segment closes the letter spaces, thus; there is need for kerning as a result of the extension (see Figure 9b).

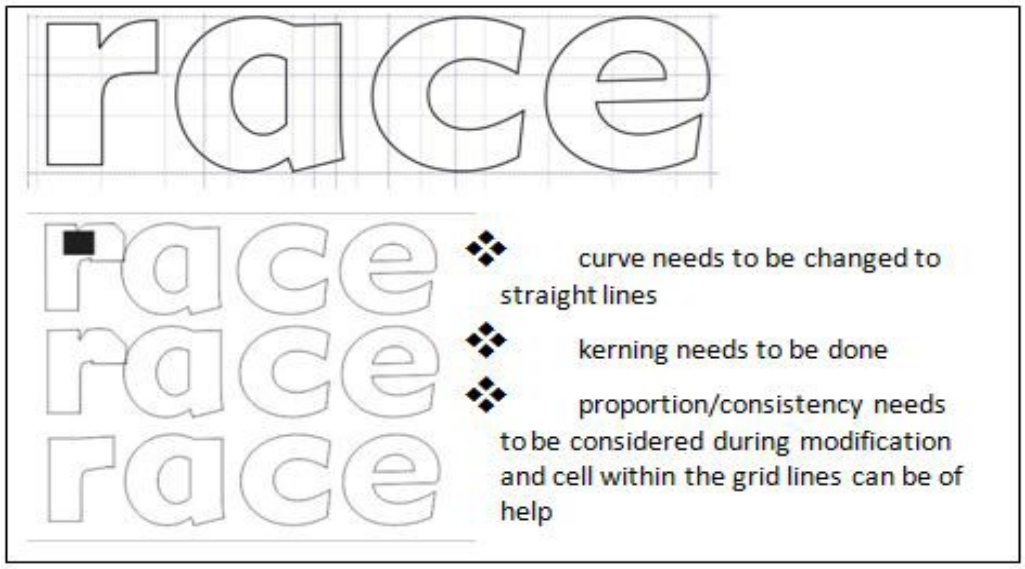

Figure 10a: *Geometric modification of curve lines in lowercase to derive octagonal letterform*

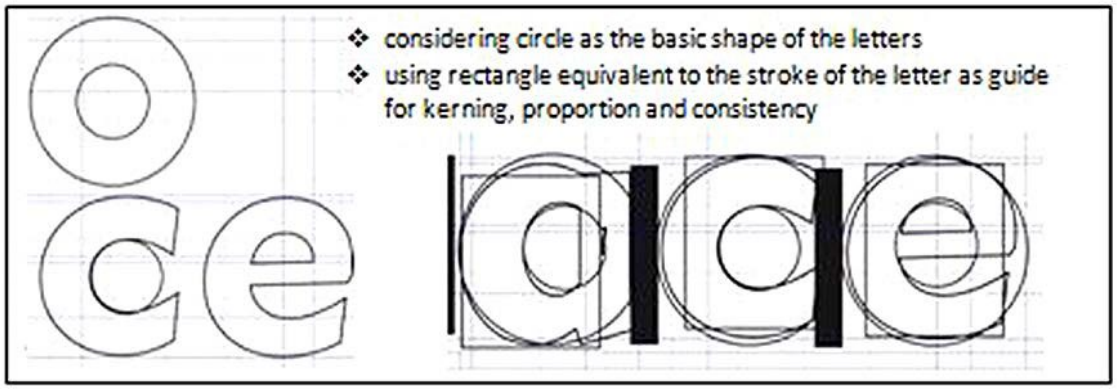

Figure 10b: *Curve lines and the circular letterform of the lowercase*

The lowercase letter 'a' in Figure 10a is a single story. To transform the single story letter 'a' to a double story will require addition of nodes, extension, reposition and moving of the line segment (see Figure 11a). The curve corners are also transformed to diagonals to form octagonal. Thus, the counter, aperture, strokes, stem, and flat foot or tail of the lowercase letter have been the parts of the letters that are modified. It can be observed that the original letter 'a' in figure 10a is single story and does not have a flat foot or prominent tail but through geometric modification it is now modified (see Figure 11a). This also differentiate the modified letter from the original letter (see Figure 10a, 11a and 11b).

b. Geometric Modification in Letter design without depending on Copyrighted Typeface:

With the use of grid lines and cells of 3 by 5, a rectangle of size 0.494" X 1.26" is used as the stem of the letters in CorelDraw so as to design octagonal letter without infringing the copyright of any established typeface.

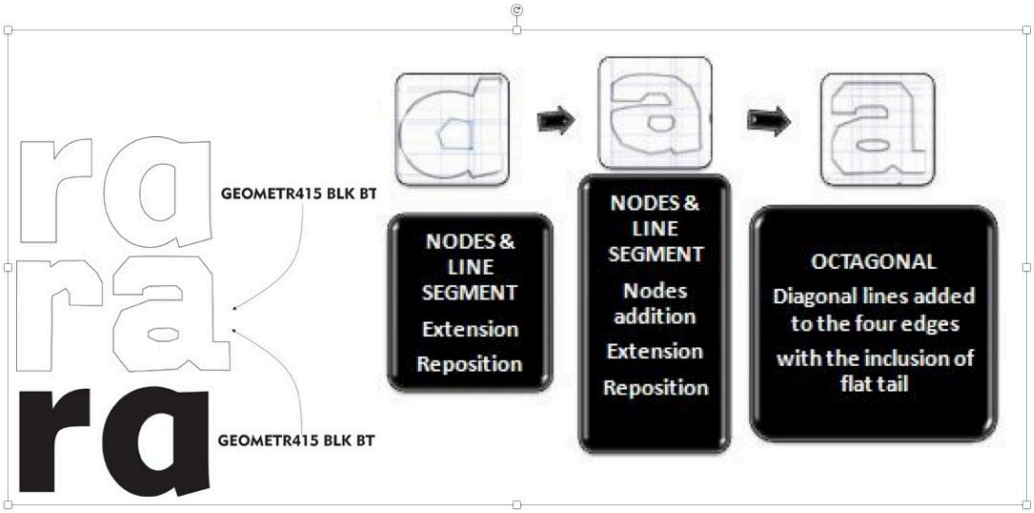

Figure 11a: *Transforming of curve lines in a single story letter 'a' to double story 'a'*

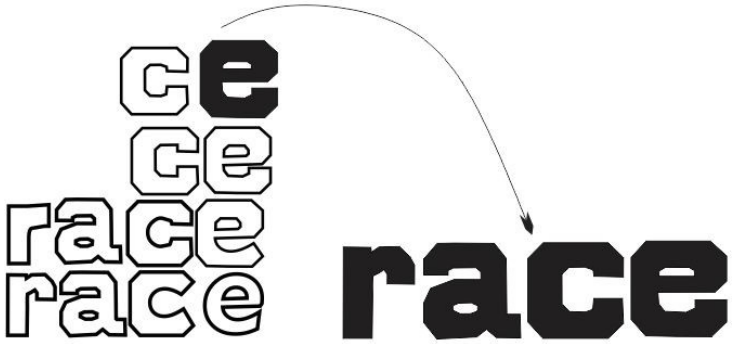

Figure 11b: *Geometric modification of curve lines and edges to diagonal to form octagonal letters*

Although, typeface designs themselves are not eligible for copyright protection. This means that the artistic concepts and shapes of letters in a typeface are generally not protected by copyright law in most jurisdictions (Althubiani, 2023). This rectangle is adjusted to fit 3 by 5 cells at the height and width of each letters. respectively. To obtain a letterform, two or more rectangular shapes (.i.e. stems) are combined by welding (see Figure 12). Display and decorative letters for outdoor spaces and editorial or publication design can be independently created without the use of licensed typefaces by following the process illustrated in Figures 12, 13a and 13b. This digital method of constructing letters involves several key steps. After the combination of necessary shapes, it is welding follows. Then, nodes are repositioned or moved to achieve the desired shape for the letter. Additionally, more nodes can be added, letter spacing adjusted, and shapes incorporated (see Figure 13a). For example, the aperture of the lowercase letter 'c' is deliberately made rectangular, showcasing the freedom afforded by not relying on existing typefaces. This reflects flexibility while not relying on the modification of existing typeface. To enhance the visibility of the tail in the lowercase letter 'a', additional nodes are incorporated and repositioned (see Figure 13 a). Grid lines are also used to ensure consistency and proportion. Similarly, the lowercase letter

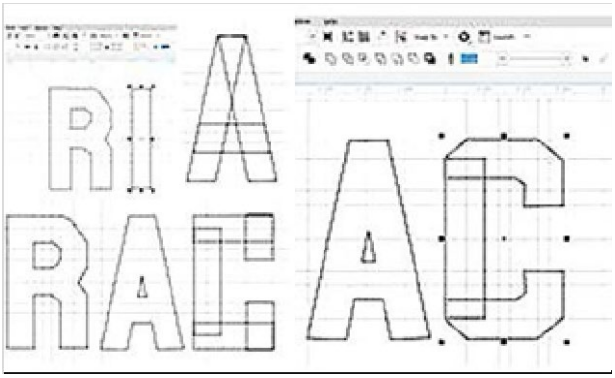

Figure 12: *Geometric modification of rectangular shape to derive octagonal letterform*

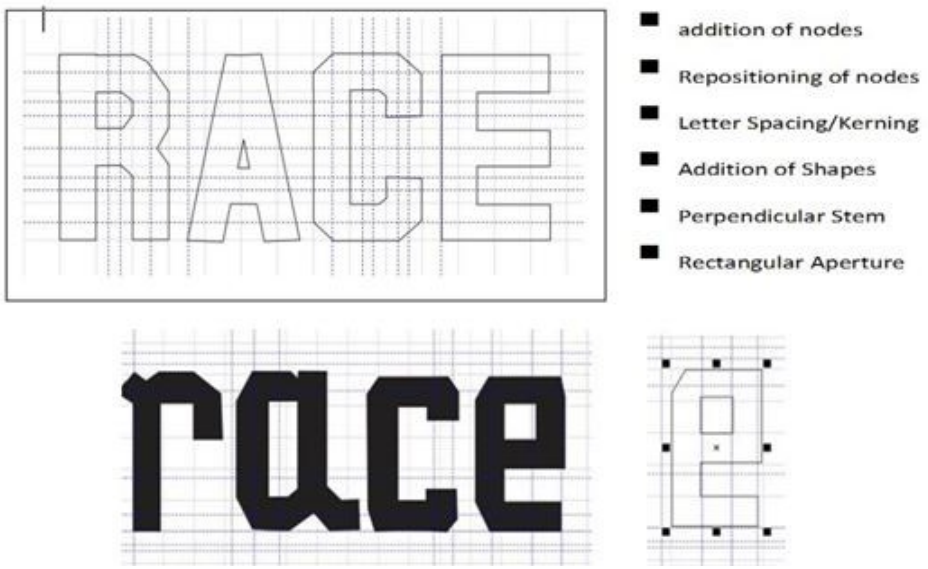

Figure 13a: *Geometric Modification of rectangular shape to derive octagonal letterform for both lowercase and uppercase*

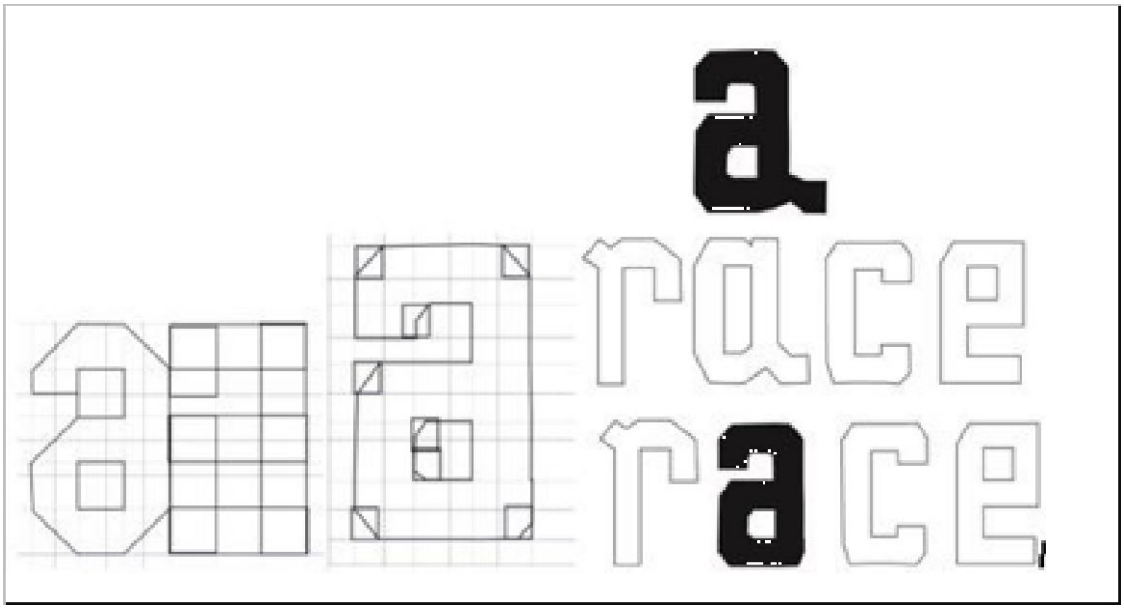

Figure 13b: *Geometric modification of rectangular shape to derive double story lowercase letter 'a' for octagonal letterform*

'e' is transformed from a rectangular appearance by adding and repositioning nodes, modifying the perpendicular lines into diagonal lines, resulting in an octagonal form (see Figure 13a).

Making the lowercase 'a' to be a double story letter also require combination of rectangles, welding and modification of angles and perpendicular lines as seen in Figure 13b. Some rectangles are arranged to form the basic structure of the letter. This involves precise alignment and positioning to ensure the correct proportions and overall shape. Welding these shapes together is the next step, which fuses the rectangles into a cohesive form.

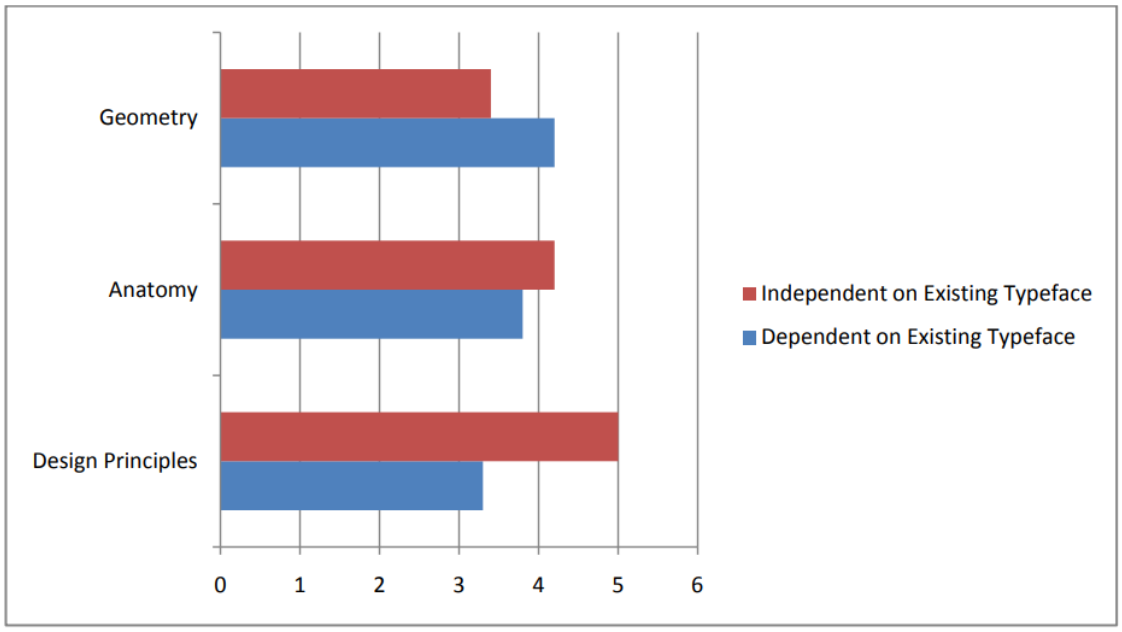

Figure 14: *geometric modification of letters in relation to the level of CAD inspiration*

After welding the shapes together, some points where lines intersect at 90 degrees are adjusted to form diagonal lines This alteration enhances the aesthetic and structure of the letter. Furthermore, the use of grid lines plays a crucial role throughout this process. The grid provides a reference for maintaining proportion and consistency, ensuring that each component of the letter is correctly sized and positioned. Figure 13b illustrates these steps in detail, showcasing the transformation of the lowercase 'a' into a double-story character with the aid of geometric precision and careful modifications.

Figure 14 presents a bar chart comparing two categories: the use of existing typefaces and original designs created without copyrighted typefaces during the geometric modification of letters. modification process. As shown in Table 5, CAD inspiration has a significant impact on adherence to design principles, with a mean score of 3.3 for existing typefaces and 5.0 for original designs created without copyrighted typefaces during geometric modification. This influence is particularly pronounced when working with the anatomical features of letters and executing geometric adjustments within the CAD interface. The CAD environment enables precise modifications while fostering intuitive creativity among designer and students during the design process.

Table 5: *Level of CAD inspiring variables in relation to the letter modification process*

Design Principles	Dependent on Existing Typeface	Independent on Existing Typeface
Alignment	3	5
Proportion	3	5
Unity/ Consistency	3	5
Spacing/Kerning	3	5

Proximity	3	5
Balance	5	5
Mean	**3.3**	**5**
Anatomy		
Aperture	5	5
stem	3	5
Counter	3	3
Crossbar	5	5
Eye	3	3
Mean	**3.8**	**4.2**
Geometry		
grid lines	5	5
Convert to Curve	5	0
Nodes	5	5
Shapes	3	5
Cells	3	5
Repositioning	5	4
Perpendicular	5	5
Lines	5	5
Angles	5	5
Sides	5	3
condensing shape	3	0
Elongating shape	3	0
Mean	**4.3**	**3.5**

In the aspect of geometry, an independent sample T-test revealed no significant difference (t(1.2), p = 0.243, α =0.05) between the category reliant on existing typefaces (M = 4.3, SD = 0.9847) and the category independent of existing typefaces (M = 3.5, SD = 2.1950). This suggests that both categories exhibit similar relationships between CAD inspiration and geometry. Notably, CAD inspiration played a crucial role in the geometric modification process for both categories, but its impact is more consistent in the category dependent on existing typefaces, where numerous adjustments using convert to curve, addition or removal of nodes and other geometric adjustments are used to transform the original typeface into a new letterform. Design principles are considered more significant for geometric modifications independent of existing typefaces than for those dependent on existing typefaces (see figure 14). The inferential statistics using an independent sample T-test shows that the category dependent on existing typefaces (M = 3.3; SD = 0.82) and the category independent of existing typefaces (M = 5.0; SD = 0.00) have a significant difference (t(-5), p = 0.01, which is less than the significance level α = 0.05). Therefore, we can conclude that the mean scores for the two categories are significantly different regarding how CAD inspiration relates to design principles. With a mean score of 5.0 for the category independent of existing typefaces, CAD inspiration played a crucial role in emphasizing design principles during the modification process. This is because designing

from scratch requires careful attention to each part of the letterform, making adherence to design principles very important. In contrast, for the category dependent on existing typefaces, the original design already incorporates alignment, proportion, unity, consistency, proper spacing or kerning, proximity, and balance. Thus, CAD inspiration has less impact on design principles in this case, as the original typeface designer has already applied these principles to the type design. The inferential statistics using an independent sample T-test show that the category dependent on existing typefaces (M = 3.8; SD = 1.0954) and the category independent of existing typefaces (M = 4.2; SD = 1.0954) have no significant difference (t(-0.577), p = 0.580, which is more than the significance level α = 0.05). Therefore, we can conclude that the mean scores for the two categories are not different regarding how CAD inspiration relates to design principles. The crux of the matter is that CAD inspiration played a crucial role in emphasizing anatomy in similar pattern during the modification process for both category dependent on existing typefaces and category independent of existing typefaces. This affirms the importance of the knowledge of anatomic features which this study intents to achieve in the aspect of encouraging originality that can happen when the students are familiar with structures of the letterform in every possibilities of unique appearance.

Result for Objective 3: procedures that can encourage apathetic students to becoming motivated or inspired to seek originality in design project such as letter design

Figure 15a, 15b and 15c show the procedure suggested to encourage indifferent students to becoming motivated or inspired to seek originality in design project such as letter design. Design students are encouraged to incorporate the use of design brief, mentorship and sketching while generating idea for their creative letter design. It is hoped that students' adoption of mentorship will enable them to get better ideas for their project and it is expected this should be interesting to them.. Also, sketching is not a new practice in design. They should brainstorm for ides through sketching. For easy communication, both instructor and the students can present design brief. For example, if the instructor has presented design brief for a particular assignment, the students can present design brief for the execution of the given assignment about how he or she intends

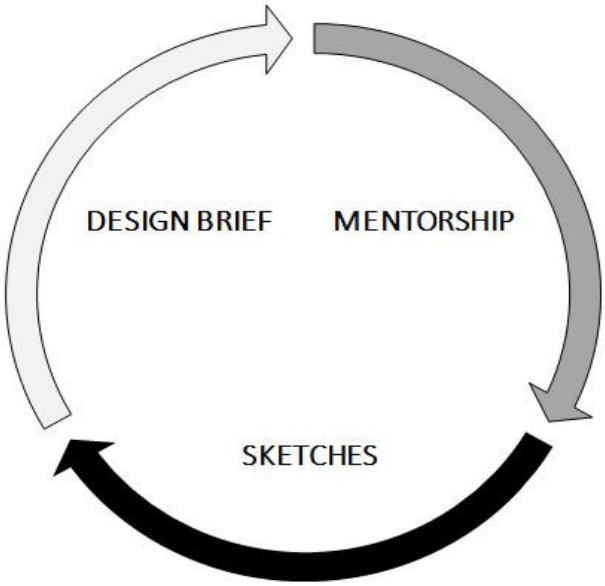

Figure 15a: *Suggested ways of generating initial idea for the letter design before proceeding to CAD*

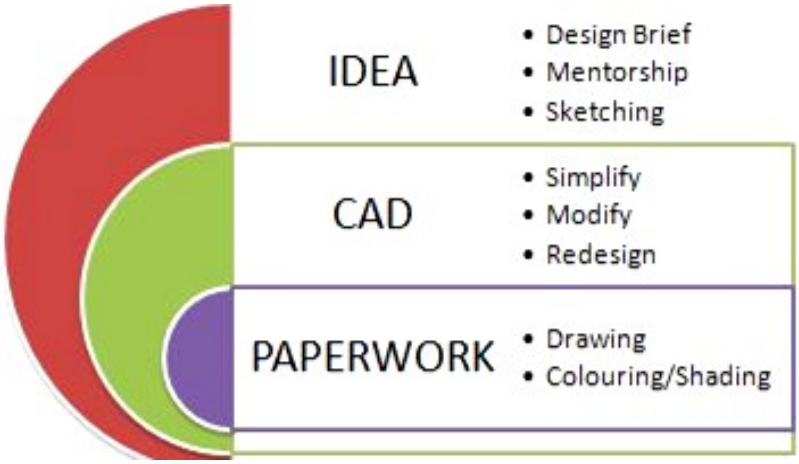

Figure 15b: *activities that students can inculcate during the letter design class exercise*

to approach the assignment. Then through, mentorship, such students can be guided. Based on TBA (Theory of Planned Behaviour), it is expected that students' compliance with these procedures may encourage them to be more creative, original and innovative during the design project. According to TBA, the interest of the students, typical norms or practice, and the perception of the students to identify what is best for them can influence them to perform a target behaviour in the appropriate way. The more positive the students' attitude, subjective norms and PBC (perceived behavioural control), the greater their behavioural intention (Guo et al., 2023).

Figure 15a is a cycle of process that is expected during the attempt to finalize idea for the design project before further inspiration through the use of CAD. After the students have drafted the design brief, it is expected to be accompanied with some preliminary sketches. These two should be shown to the mentor for guidance. After the contribution of the mentor, further sketches can be done for better idea before proceeding to the use CAD.

But, at this point CAD should be considered as means of inspiration to imagine the design either according to already conceived idea or outstandingly new idea better than what is already planned. That is the reason for either modification, simplification or redesigning (see Figure 15b). CAD is still a remarkable tool which can be harnessed correctly by using both hand lettering and computer fonts together (Turgut, 2014).Thus, it is the assumption of present study to inspire design students by suggesting the aforementioned procedures and also explore geometric modification of letters by using CAD.

CAD is not expected to be the ultimate in this process. It should be like a 'middle-man' and made penultimate in the creative process (see Figure 15c). It is expected that the use of CAD should inspire the students towards producing creative paper work for the letter design. Perhaps, various ways of visualizing the design beyond what the mind has initially conceived can occur within the CAD environment. Though it might seem playful, a student is expected to see other different interesting ways of doing their design works. This is referred to as CAD inspiration in this study. CAD is the

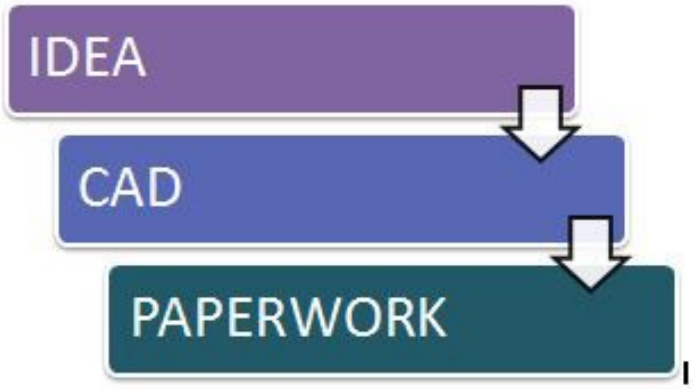

Figure 15c: *The position of CAD for source of inspiration towards producing paperwork for the letter design*

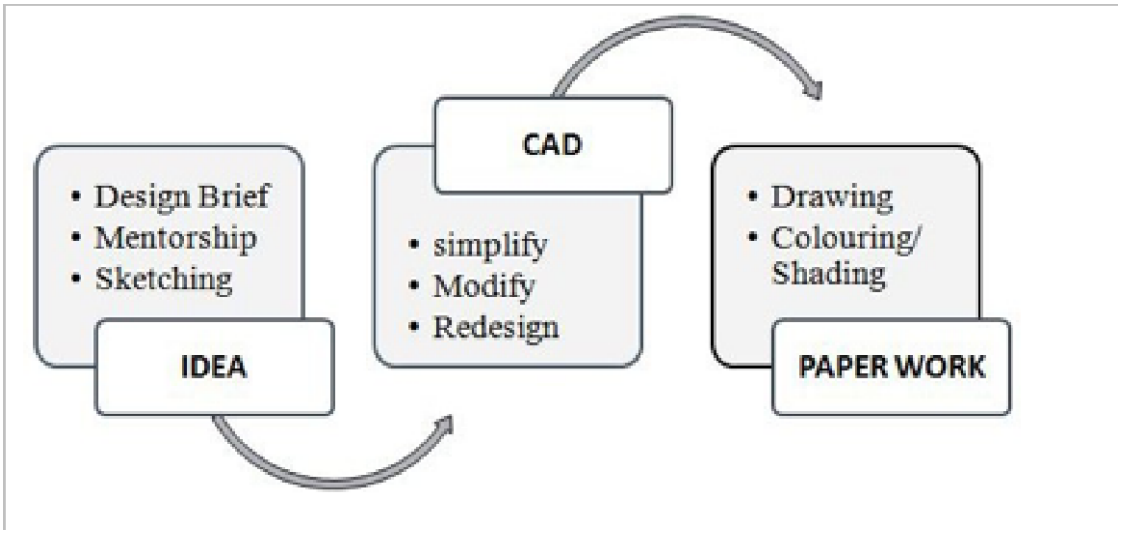

Figure 16: *Procedures that can encourage student's originality through penultimate use of CAD*

penultimate in this process as seen in Figure 15c as well as in Figure 16. The ultimate is the paper work; so the students draw the letters, shade or paint the letters with the use of their drawing sets. This is to moderate the use of CAD as source of inspiration and not to be over dependent on CAD as the final production of their project.

Their idea from the sketches can be further adjusted, simplified or redesigned through the use of CAD and finally, the manual production of the letters are drawn on paper. The notion of this study is that students should find it interesting to explore this modification by both drawing on paper and as well as making use of CAD.

Design brief involves describing the intended path to the outcome of the design (Read & Bohemia, 2012). Thus, if students should draft design brief for their project in letter design, instructors will clearly decipher their intention. This can create room for better feedback interpretation of instruction during typography and lettering class. It can minimize the limitation that may occur in the communication route between the students and instructor. Moreover, the students will understand their works better. Phillips (2004) defines a design brief as '… a written description of a project that requires some form of design' (p. 1), containing project overview, its objectives, tasks, timeframes and outcome expectations (Sadowska et al., 2017). It is an early description

of the design problem and the possible description of the solution or strategies that can be used to solve such design problems (Philips, 2004; Read and Bohemia, 2012). One of the function of a brief is to inspire new and innovative ideas; thus, design brief will enable the success of innovative activities (Read & Bohemia, 2012). Many a times, what may be included in a design can include: project goals, aims and objectives, background research, future aspiration, target audience, process or stages, deadlines or time-frame, performance measures/evaluation and project deliverables. It is worthy of note that the drafting of design brief for design project will guide them to achieving innovative designs. So, participants in this study are encouraged to draft design brief for their project. They are instructed to indicate whether they need mentorship/guide for more knowledge and refinement of their idea. Accordingly, the students are encouraged to communicate their idea through the use of design brief as well as producing sketches before proceeding to the use of CAD (see Figure 16, 15a and 15b).

Result for Objective 4: the efficacy of the suggested procedures:
The male participants demonstrated greater consistency in sketching, with a standard

Table 6: *Adoption of some of the suggested procedures according to gender.*

Group Statistics

Suggested Procedures	Gender	N	Mean (M)	Std. Deviation (SD)	Std. Error Mean
Sketching	Male	12	6.67	4.887	1.411
	Female	8	10.25	6.274	2.218
Design Brief	Male	12	1.08	.289	.083
	Female	8	1.13	.354	.125
Mentorship	Male	12	1.17	.389	.112
	Female	8	1.13	.354	.125
Rate of CAD Usage	Male	12	1.42	.793	.229
	Female	8	2.13	.641	.227

Table 7: *Adoption of design brief as a procedure*

		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	No Design Brief	18	90.0	90.0	90.0
	There is Design Brief	2	10.0	10.0	100.0
	Total	**20**	**100.0**	**100.0**	

deviation of 4.887. However, some female participants (M = 10.25, SD = 6.274) engaged in more frequent sketching than their male counterparts (see Table 6, Figure 17 and appendix). The greater consistency among male participants may be attributed to their perception of sketching as easier or simpler. For instance, one female student refused to sketch, while some male students sketched only once. Notably, there is a female participant who generated ideas by creating 21 sketches (see appendix).

Table 7 shows the extent of adoption of design brief, 90% of the participants refuse to draft design brief while 10% of participants engage in the drafting of brief for the design project. The fact that few male (M = 1.08, SD = 0.289) and female (M =1.13, SD = 0.354) engage in the drafting of design brief may be because it is new to them and they need more time to get accustomed to it (see Table 7).

The need for mentorship is expected to help in generating ideas and with the collaboration of design brief and sketches, it is believed that instructors will be guided on mentoring a student better. If such students have cultivated the habit of doing these suggested procedures, it is expected that useful ideas and more original or creative works will be produced. Table 8 shows the extent of the adoption of mentorship as helpful procedure. 85 % of the participants fail to see the need for mentorship when seeking

Table 8: *Mentorship as a procedure*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No need of Mentorship	17	85.0	85.0	85.0
	Mentorship	3	15.0	15.0	100.0
	Total	**20**	**100.0**	**100.0**	

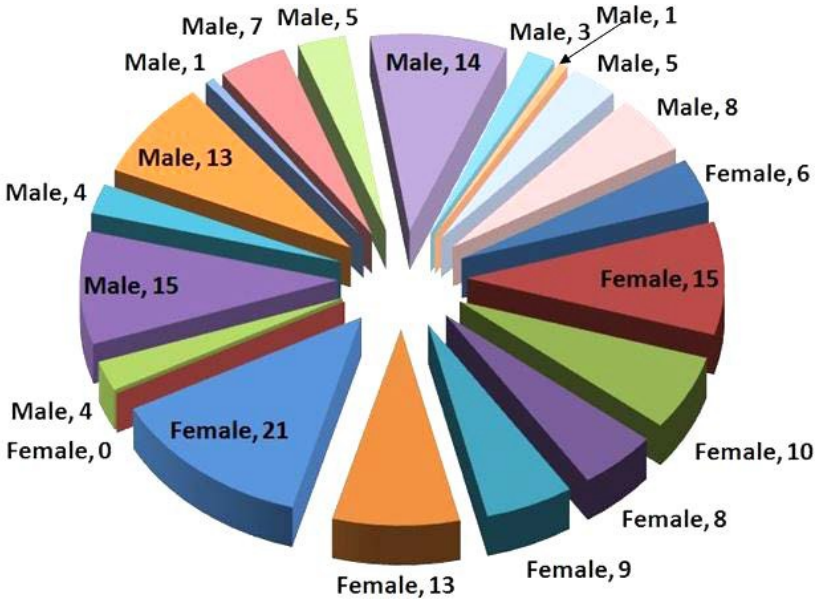

Figure 17: *Number of sketches done to generate ideas by both Male and Female Participants*

Table 9: *Originality of the paperwork produced in relation to how participants used CAD*

How the student used CAD * Originality Cross tabulation

Count

		Originality			
		Least Significant	Somehow Significant	Significant	**Total**
How the student used CAD	ultimately to Simplify	0	3	0	**3**
	ultimately to Simplify and modify	0	1	0	**1**
	utimately to simplify, modify and redesign	0	9	0	**9**
	Pen-ultimately to Simplify and Modify	1	5	1	**7**
Total		**1**	**18**	**1**	**20**

to accomplish a design project. Only three (3) which is just 15 % of the participants adopt the suggestion of seeking the contribution of a mentor when seeking for ideas for the letter design project. The fact that there are few male (M = 1.17, SD = 0.389) and female (M =1.13, SD = 0.354) ready to be mentored may be because they considered the task as an easy one or probably, some of them do not like to work under supervision.

Table 9 shows how the students used CAD towards achieving originality and reveals that 7 out of 20 used CAD in a penultimate way .i.e. they do not finalize their work based on works produced on the screen. They only use CAD as source of inspiration towards producing creative paper work for the letter design. Visualization of the design beyond what the mind has initially conceived within the CAD environment does not trash their sketches but it serves a continuation of the design process in a process of implementing ideas (Walia,2019). This creates room for further modification, simplification or redesigning. Having allowed the students to freely participate in the project without interfering with their creative activities, only 3 out of 20 ultimately used CAD to simplify the letterforms with somehow originality. Only one participate modify the letterform ultimately through the use of CAD. Also, the originality of the participant is somehow. Majority of the participants simplify and modify the letterforms by using CAD but they fail to use CAD as a 'middle-man'. They depend more on CAD and this is not the appropriate way expected. In Table 9, nine out of the twenty participants fall into this category. They also reflect somehow significant originality. Examples of their paper works are shown in Figure 18 and appendix C.

Majority of the students used CAD to ultimately simplify and modify the letters but their originality are mutual (.i.e. somehow questionable in terms of significance to the CAD inspiration) because of the similarity in their works. For reasons such as 'copy-cat' attitude, laziness, lack of need for mentorship, lack of need of doing several sketching, lack of design brief, lack of redesigning or re-modification, lack of need for originality and to mention a few can be assumed to be responsible for some of the works looking like exact replicas of one another. This is the reason for the somehow significant originality (.i.e. 18 out 20 have somehow significant originality). Very few have noticeable originality. Perhaps, none

Figure 18: *Examples of the student' paper works*

of them carryout redesigning which would have distinguished their originality when they discovered the mutualism in terms of similarly looking works.

Table 10 shows chi-square tests for originality of paperwork produced in relation to how the participants used CAD. Pearson chi-square value when positive as seen in table 10 signifies that there is some relationship between originality and the way participants used CAD. But, null hypothesis been that there is no significant relationship between the two variables means p-value is greater than α (0.05). In table 10, asymptotic significance (2-tailed) is 0.659. Thus, the way the participants used CAD in this study has no relationship with the paper work produced. The likelihood ratio (LR) shows how likely is the possibility of the originality in relation to how the participants used CAD. LR greater than 1 shows that there is possibility of the influence of how CAD is used towards fostering the originality of the paper work. LR value of 4.628 shows that there is possibility of producing paper works with very significant originality but due to lack of adherence to the suggested procedures makes it seems that there is no relationship between the

Table 10: *Chi-Square Tests for originality of paperwork produced in relation to how student used CAD*

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.127[a]	6	.659
Likelihood Ratio (LR)	4.628	6	.592
Linear-by-Linear Association	.000	1	1.000
N of Valid Cases	20		

a. 10 cells (83.3%) have expected count less than 5. The minimum expected count is .05.

Table 11: *Rate of CAD usage*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low	10	50.0	50.0	50.0
	Moderate	6	30.0	30.0	80.0
	Excessive	4	20.0	20.0	100.0
	Total	**20**	**100.0**	**100.0**	

way the participants used CAD and the paper work produced.

Since p>0.05 there is no sufficient evidence to conclude that the observed distribution is different from the expectation. The expectation is that CAD should be used pen-ultimately by simplifying, modifying and redesigning their initial idea before finally producing the paperwork. The low compliance of the students to the suggested procedure does not create room for originality. X2(df = 6, N = 20) = 4.127a, p = 0.659 shows that there is no association between the two variables (originality and the way the students used CAD). There are a lot of similarly looking design probably because they fail to adhere strictly to the suggested procedure. Some of the works are as if they are not modified at all because they are similar to the typical typeface. For example those students that aimed that adapting Gothic letters seems not do any modification to the letters. They only copied or duplicated exactly what is displayed in the computer's screen. There are others that have slight modification which may not be easily observed unless when closely and meticulously checked.

In Table 11, four (4) out of the twenty (20) participating students decided to use CAD beyond expectation. These four (4) participating design students probably considered the use of CAD as the ultimate. 50 % of the participants used CAD below expectation while 30% used CAD moderately as it is expected. It can be assumed that female (M =2.13, SD = .641) may adhere to the instruction than the male (M = 1.47, SD = 0.793).The rate of CAD usage among male and female have significant difference (t(-2.104), p = 0.050, which is equal to the significance level α = 0.05). Therefore, we can suggest that the mean scores for the two categories (male and female) are different regarding how CAD inspiration relates to the letter geometric modification.

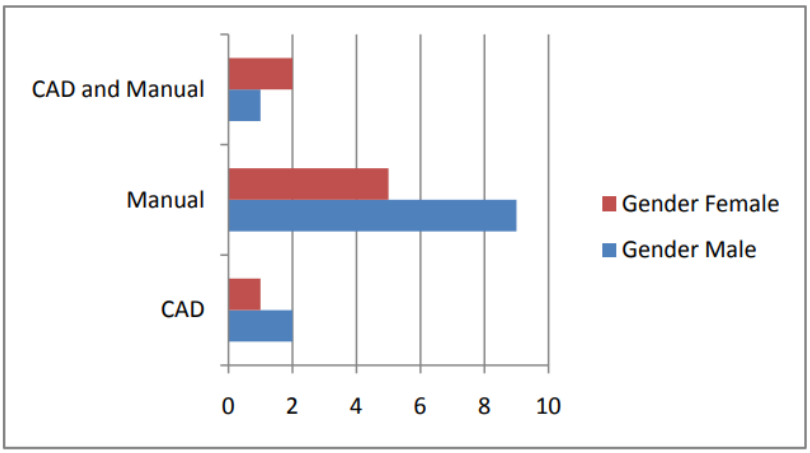

Figure 19: *Harnessing CAD and manual approach for the letter modification in relation to gender*

Thus, generating ideas for letter modification through the suggested procedures has more effect on the female than male in terms of compliance (see Figure 19). The male might refused to comply because they do not think it is necessary while the female might have complied because the instructor require that it should be done. Thus, female may be performing better than male, simply because they may be abiding by the rules or principles more than the male counterpart. Although, among those that refused to use CAD also include those that have low CAD proficiency. Only six (6) (i.e. 30% of the participants attempted using CAD moderately as instructed (see Table 11).

In Figure 20, participants with low flexibility are those that used only manual approach while those with high level of flexibility are among harnessing CAD and manual approach.

In Table 12, it can be inferred that the flexibility of the students and the use of design brief as procedure are effective during the CAD inspiration (for design brief, ANOVA is (F (1.18) = 0.084, p = 0.776); and for flexibility, ANOVA is (F (1.18) = 0.325, p = 0.576)). Meanwhile, participants using CAD only and manual only are among those that fail to adopt the drafting of design brief for their project. Participants who used CAD and manual together for letter modification adopt the drafting of design brief (see Figure 21) and they are flexible as well (see Figure 20) and there is no enough evidence to support the claim that there is difference between the mean for students' flexibility; since, 0.325 is less than 0.576. Likewise, 0.084 is less than 0.776. Thus, it is likely that the suggested procedure have significant effect on the student's creative letter design especially when they are flexible and not when they are unyielding.

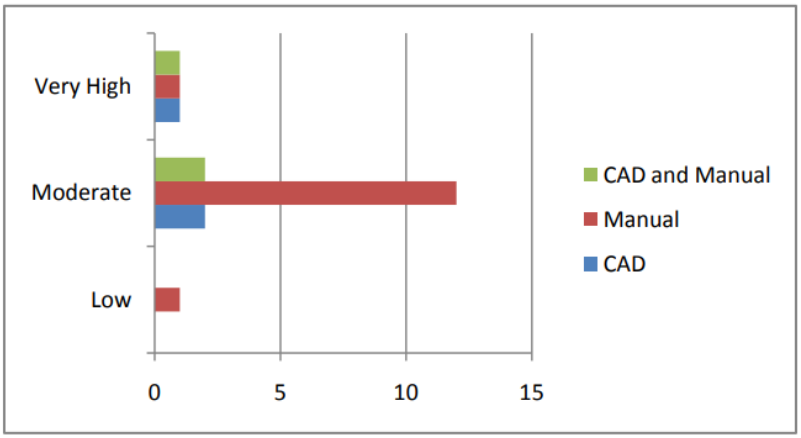

Figure 20: *CAD Inspiration for Letter design Geometric Modification in Relation to the students' Flexibility*

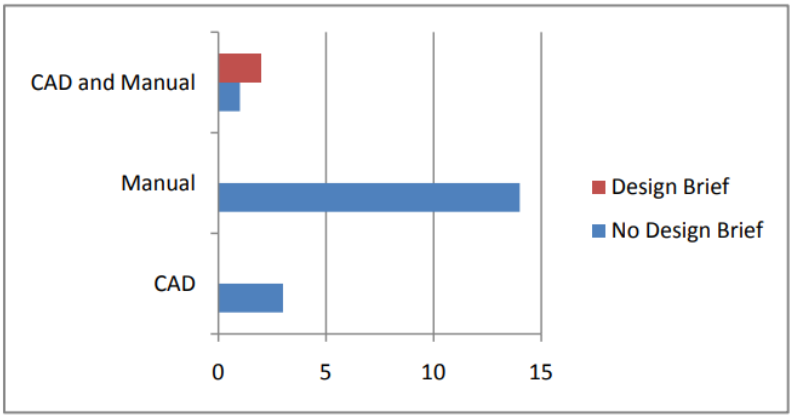

Figure 21: *CAD Inspiration for Letter design Geometric Modification in Relation to the use of Design Brief*

Table 12: *Overview of the Effectiveness of the Suggested Procedure by using One Way ANOVA*

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Mentorship as a Procedure	Between Groups	.008	1	.008	.059	.811
	Within Groups	2.542	18	.141		
	Total	2.550	19			
Intuition	Between Groups	.033	1	.033	.040	.843
	Within Groups	14.917	18	.829		
	Total	14.950	19			
Understanding of the Procedure	Between Groups	1.200	1	1.200	1.271	.274
	Within Groups	17.000	18	.944		
	Total	18.200	19			
Sketching as a Procedure	Between Groups	61.633	1	61.633	2.061	.168
	Within Groups	538.167	18	29.898		
	Total	599.800	19			
Rate of CAD Usage	Between Groups	2.408	1	2.408	4.427	.050
	Within Groups	9.792	18	.544		
	Total	12.200	19			
Motivation of the Student	Between Groups	2.700	1	2.700	2.663	.120
	Within Groups	18.250	18	1.014		
	Total	20.950	19			
Interest of the Student	Between Groups	1.875	1	1.875	3.418	.081
	Within Groups	9.875	18	.549		
	Total	11.750	19			
Appropriateness of Design	Between Groups	.533	1	.533	.655	.429
	Within Groups	14.667	18	.815		
	Total	15.200	19			
Flexibility	Between Groups	.208	1	.208	.325	.576
	Within Groups	11.542	18	.641		
	Total	11.750	19			
Design Brief as a Procedure	Between Groups	.008	1	.008	.084	.776
	Within Groups	1.792	18	.100		
	Total	1.800	19			

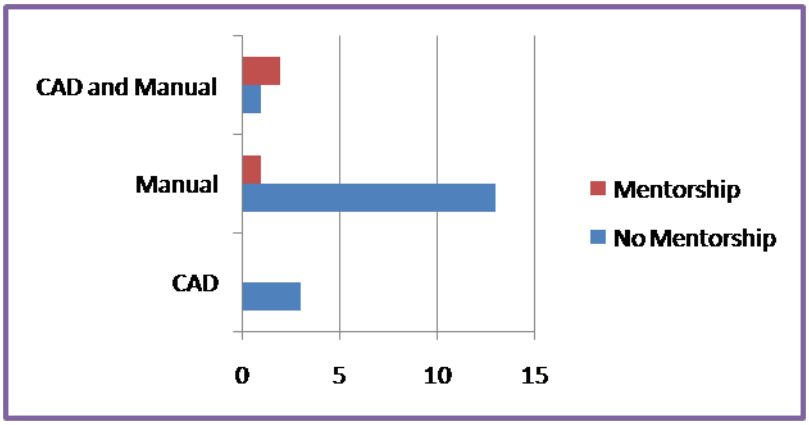

Figure 22: *CAD Inspiration for Letter design geometric modification in relation to mentorship*

The one way ANOVA conducted to compare the mean of the criteria proves the effectiveness of the suggested procedures and shows (F (1.18) = .059, p = .811) in terms of how mentorship affected the student works' during CAD inspiration for letter design. Participants who used CAD and manual (see figure 22) for letter modification adopted mentorship in similar pattern and there is no enough evidence to support the claim that there is difference between the mean; since, 0.059 is less than 0.811. In figure 22, majority fail to show the need for mentorship especially among those fail to follow the suggested procedure appropriately. This may be one of the problem that made them to use CAD in such a way that seems not to reveal significant and interesting originality in their paper work. The one way ANOVA shows (F (1.18) = 4.427, p = .05) in terms of rate of CAD usage. That is, majority of the participants fail to behaviour in similar pattern in terms of using CAD and there is difference among the means. Some of them used CAD excessively above expectation; some failed to use CAD; and some used CAD below expectation. CAD inspiration is expected to increase their motivation to create unique letterforms that will not result to similarly-looking paper works. It is as if the works are done by the same person. The one way ANOVA shows (F (1.18) = 2.663, p = .120) in terms of the students' motivation. There is high variability in the students' level of motivation .i .e. majority of the participants fail to behaviour in similar pattern in terms of motivation and there is difference among the means. Two participants have very high motivation as result of using both CAD and manual. If the remaining 18 participants used CAD and manual probably they may be motivated to produce works devoid of similarly appearance and will not be copying another students' work.

In Figure 22, majority fail to adopt mentorship but there is the likelihood that if the participants adopt mentorship, the originality will be more distinctive. Thus, it is likely that the suggested procedures have significant effect on the student's creative letter design. In table 12, the one way ANOVA conducted to prove the effectiveness of the suggested procedures shows (F (1.18) = .040, p = .843) in terms of how the students' intuition become useful during CAD inspiration for Letter design. Participants who used CAD and manual (see figure 23) for letter modification are able to use their intuition in similar pattern and there is no enough evidence to support the claim that there is difference between the mean; since, 0.040 is less than 0.843. Thus, it is likely that the suggested procedure have significant effect on the students' intuition during the creative letter design in geometric modification. Figure 23, shows that the students are able to use high level of intuition as result of the CAD inspiration. The intuition is only moderate when it is only done manually but very higher when CAD is harnessed with manual. (see Figure 23).

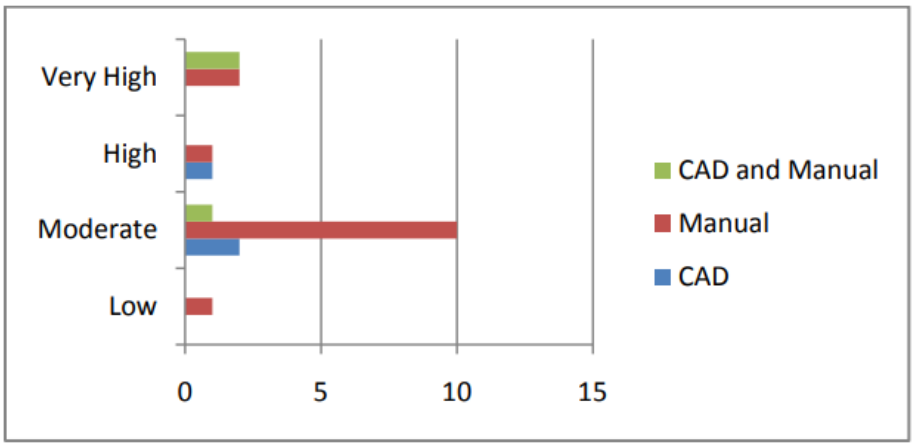

***Figure 23**: CAD Inspiration for Letter design geometric modification in relation to the students' intuition*

The one way ANOVA conducted to compare the mean of the criteria proves the effectiveness of the suggested procedures and shows (F (1.18) = 1.271, p = .274) in terms of the students' understanding of the procedures. This becomes useful during CAD inspiration for the letter design. There is high variability in the students' understanding of the procedure .i .e. majority of the participants fail to behaviour in similar pattern in terms of understanding and there is difference among the means. For instance, it seems they do not understand the suggested procedure perfectly but those using both CAD and manual have very good understanding of the procedure (see figure 24). Thus, the suggested procedure is still effective; even though, it can be inferred that majority of students may not like the new procedure because of it several tasks like sketching, drafting of design brief and to mention a few that may be lingering, difficult or not interesting to them. If participants adhere to the suggested procedures, it is expected that CAD inspiration will enabled them to have better performance than what they have actually done during this exercise. For instance, figure 25 shows that those harnessing CAD and manual approach have high performance but there are few that complied.

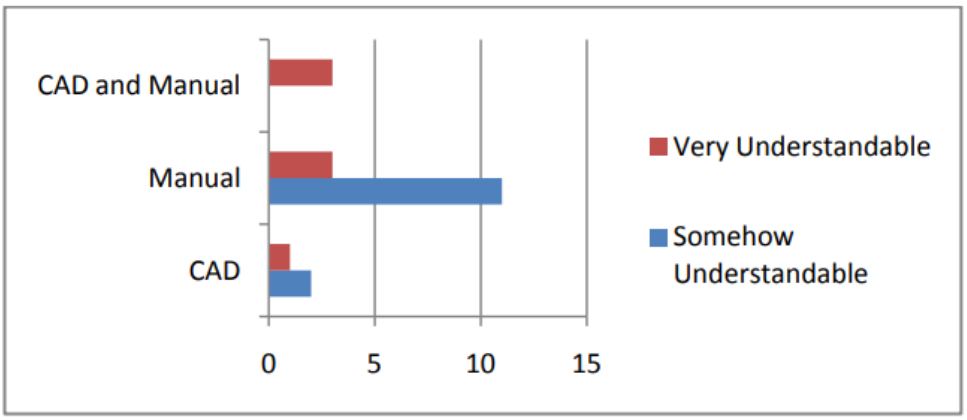

***Figure 24:** CAD inspiration for letter modification in relation to the students' understanding of the procedures*

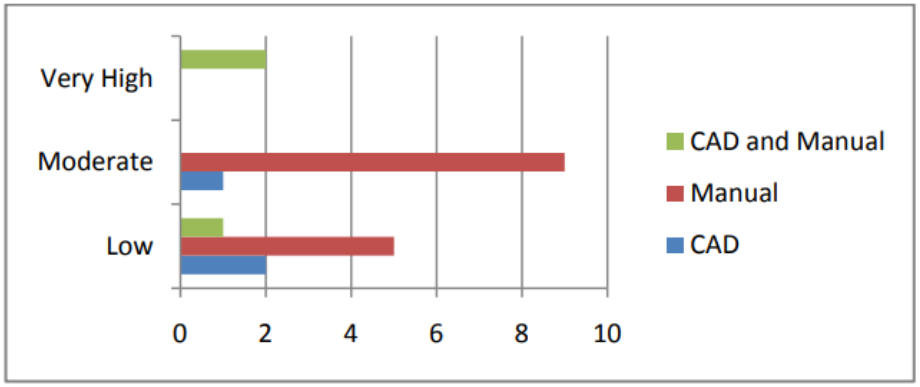

Figure 25: *Level of Performance as result CAD inspiration for letter modification*

These few participants that complied are those that produced the appropriate design. Table 10, shows (F (1.18) = 0.655, p = 0.429) in terms of the appropriateness of design. Thus, there is enough evidence to support the claim that there is difference between the mean for students' appropriate design produced; since, 0.655 is greater than 0.429. Likewise, there is high variability in the other criteria such as design students' motivation, the usage of CAD, sketching, appropriateness of design, and the interest of the student. This means they are significantly different. Majority of the participants fail to behave in similar pattern and there is difference among the means. For instance, one way ANOVA shows (F (1.18) = 1.271, p = .274) in terms of the students' interest. There is high variability in the students' interest. In figure 26, it seems those using only manual or CAD are indifferent and not prompted to harness CAD and manual together but those using both CAD and manual are interested in the procedure (see Figure 26). Thus, for the effectiveness of the suggested procedure, the interest of the student is very important. Also, if the suggested procedures are appropriately practiced the design students will definitely produce appropriate design especially for the letter modification.

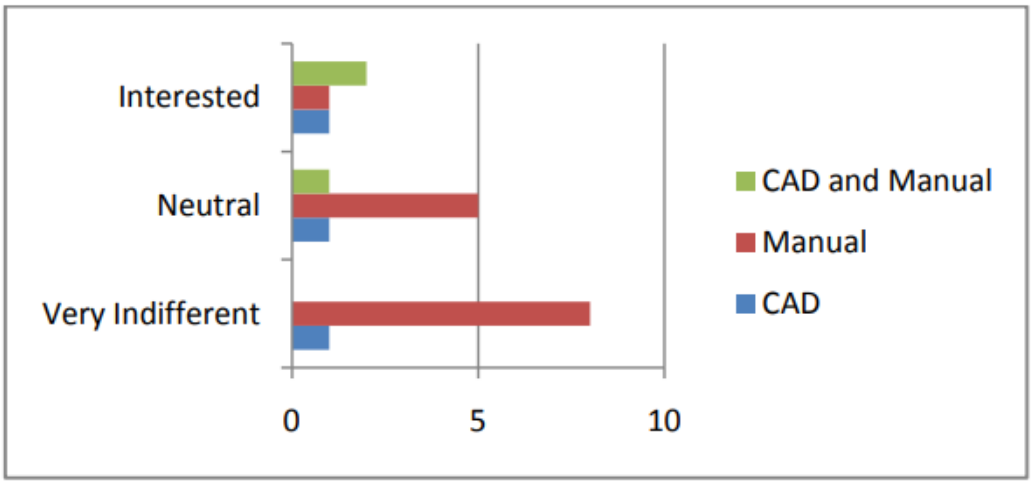

Figure 26: *CAD inspiration for letter modification in relation to the students' understanding of the procedures*

Conclusion

This study explores geometric modifications in letter design to foster originality and creativity among design students. The aim is to encourage students to view Computer-Aided Design (CAD) as a tool to enhance their intuition and reduce reliance on copyrighted materials. It is believed that this approach will make lettering project more interesting and encouraging for the student to draw on paper as well as making use of CAD as penultimate. The findings show that few students recognized the importance of adequate attention to letter design, and many faced challenges due to inadequate access to technology. The study demonstrates the effectiveness of CAD in enhancing geometric modification processes and emphasized the importance of anatomy in typography. During the illustration both uppercase and lowercase transformation are showcased. The influence of Computer-Aided Design (CAD) is evident throughout the illustration process which include the use of existing typefaces and original designs created without copyrighted typefaces. CAD tools significantly enhance the geometric modification process for both categories of letter designs. However, their impact on design principles is more pronounced in original designs created without existing typefaces, underscoring the importance of CAD inspiration in adhering to and emphasizing design principles in such contexts. Thus, the student outcome will enable students to create display and decorative letters for various applications, including outdoor spaces and editorial designs, independently by building their personal identity for the new letterform without entirely depending on existing typefaces. Also, CAD inspiration played a crucial role in emphasizing anatomy in both categories. This affirms the importance of the knowledge of anatomy in typography for creating unique appearance and structures of the letterform. Procedures such as drafting design briefs, seeking mentorship, and combining CAD with manual techniques are suggested to encourage creativity and originality. This means that this method enabled the moderate use of CAD and it serves as a means of encouraging students to develop more ideas. By sketching only, students may not produce several ideas but when the application of CAD is involved students tend to provide more ideas accompanied with the sketches. The study reveals that combining CAD with manual techniques enhanced students' intuition and creativity in letter design. Statistical analysis indicated that the suggested procedures had a positive effect on students' creative output. However, adoption of these procedures is low, and male students show less compliance. Thus, design educators should explore ways to engage both male and female students more effectively to minimize the effect of gender difference in design education. Design educators should also establish mentorship programs and adopt methods that emphasize creative thinking and originality. The study recommends addressing technological barriers and exploring ways to engage male students more effectively. Also, the suggested procedures such as design brief for students' project should be encouraged. Section can be included in the design brief where students can state areas where they need mentorship. Further studies can explore the use of emerging technologies, compare manual and digital techniques, and investigate cultural influences on design education. Such research can propose solutions for overcoming barriers to technology access in under-resourced institutions. Instead of the English alphabets, logo design, brand signatures and other distinctive design variables can be used in further studies. By pursuing these areas of further study, researchers and educators can continue to enhance the effectiveness of design education, ensuring that students are well-prepared for the evolving demands of the design industry.

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Ethics Committee Approval: N/A

Author Contributions: The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.
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References

Adkins, M. (2013). Designing a font (CorelDRAW Graphics Suite X6; pp. 1–30).

Althubiani, A. K. (2023). Clarifying Typeface vs . Fonts : Navigating Copyright Protection and Design Distinctions. Legal Speaking. https://www.linkedin.com/pulse/clarifying-typeface-vs-fonts-navigating- copyright-protection/

Aufderheide, Patricia, Jaszi, & Peter. (2011). Appendix D: Myths and Realities About Fair Use". Reclaiming Fair Use: How to Put Balance Back in Copyright. Chicago: University of Chicago Press.

Bojan, B., & Uroš, N. (2012). Font hinting techniques and the importance of applying these techniques for high- quality display of fonts on the output device screen. *Journal of Graphic Engineering and Design,* 3(1), 23– 30.

Boss, S. (2018). *Digital Type Design for Branding; Designing Letters from Their Source*. CRC Press Taylor & Francis Group.

Brown, P. (2009). CAD : Do Computers Aid the Design Process After All ? 2(1).

Bringhurst, R. (2015). *The Elements of Typographic Style* (4th edition). Hartley & Marks Publishers

Chapman, C. (2020, May 13). A Typeface History (with Infographic). Retrieved December 9, 2020, https://www.toptal.com/designers/ui/typeface-history

Cheng, K. (2006). *Designing Type*. Yale University Press.

Cheng, K. (2020). *Designing Type* (Second Edi). Yale University Press.

Elias, M., Dick, K., & Paulo, S. (2023). Influence of typographic properties on user experience in digital interfaces. *Estudos Em Design| Revista* (Online). Rio de Janeiro, 31(2), 99–109.

Eramudugolla, S. and Samarawickrama, S. (2023) 'Legibility : Sinhala typeface features for Directional Informative Sign Boards', *Journal of Graphic Engineering and Design*,14(3), pp. 15–25. doi: https://doi.org/10.24867/JGED-2023-3-015.

ETalks.23927486htvk. (2022). Modifying fonts - Font License. Adobe Community. https://community.adobe.com/t5/adobe-fonts-discussions/modifying-fonts-font-license/m-p/12864300

Fleischmann, K. (2011) 'Lettering and Signage in the Urban Environment of North Queensland's Capital: Tropical Flair or Univernacular?', *Etropic*, 10(11), pp. 83–95.

Guo, M., Wu, L., Tan, C. L., Cheah, J., Peng, J., Chiu, C., Ren, R., Aziz, Y. A., Peng, J., Chiu, C.-H., & Ren, R. (2023). The impact of perceived risk of online takeout packaging and the moderating role of educational level. In Humanities and social sciences communication (pp. 1–18).

LibreCAD. (2018). Text Font. In LibreCAD Forum. https://forum.librecad.org/Text-Font-td5716637

LibreOffice. (2018). Commercial font use for products made with LibreOffice ? The Document Foundation. https://ask.libreoffice.org/t/commercial-font-use-for-products-made-with-libreoffice/34515

Lupton, E. (2010) *'Thinking with Type'*. Princeton Architectural Press.

Kelley, T. (2002). 'The Art of Innovation: Lessons in Creativity' from IDEO, America's Leading Design Firm. N.p.: Profile Books.

Martin,Mohsen, A. and Sayegh, E. (2018) 'The Aesthetics Impact of the Typographic On the Logo Advertising and Meaning (Analytical Research)', *IOSR Journal of Research & Method in Education (IOSR-JRME)*, 8(2), pp. 18–28. doi: http://doi.org/10.9790/7388-0802051828 .

Mills, C. and Weldon, L. (1987) 'Reading text from computer screens. *ACM Computing Surveys'* , 19(4), 329- 357

Netaniel, N. W. (2011). Making Sense of Fair Use. *Lewis and Clark Law Review*, 15(3).

Oladumiye, E. B., Hassan, T. and Adelabu, O. (2018) 'Appraising the Effects of ComputerAided Design (CAD) on the Creative Behaviour of Design Students in TertiaryInstitutions in Nigeria: A Case Study of the Federal University of Technology Akure', *Global Journal of Human-Social Science: H Interdisciplinary*, 18(5), pp. 35–43.

Oluyemi, A. S., Asogwa, C. and Onwuekwe, C. (2022) 'Types, Lettering and Layout', in Introductory Notes on Basic Design and Creativity, pp. 85–94.

Oluyemi, A. S., Oladumiye, E. B. and Adelabu, O. S. (2021) 'Zobo Tea Package Design Prototype Allied with Product Onomastics', *Journal of Design Studio*, 3(2), pp. 237–259. doi: http://doi.org/10.46474/jds.1025264 .

Prasad, M., Mishra, D. and Prasad, R. S. (2018) 'Technical letters (capital) writing : A new concept', *Journal of Graphic Engineering and Design*, 9(1), pp. 45–48.

Pekta, Ö. (2014). ScienceDirect Calligraphic Forms in Contemporary Typographic Design. 122, 40–45. https://doi.org/10.1016/j.sbspro.2014.01.1300

Phalke, S. S., Shrivastava, A., & Sahgal, P. (2023). Identification of Digital Font Size and Font Type to Enhance the Attention Span of Children Living with ADHD in a Typical Learning Environment. The International *Journal of Visual Design*, 17(1), 43–60. https://doi.org/10.18848/2325-1581/CGP/v17i01/43-60

Read, D., & Bohemia, E. (2012). The functions of the design brief. International Design Conference, DESIGN 201, 1587–1596.

Ryan, H. (2008). The Complete Graphic Designer_ A Guide to Understanding Graphics and Visual Communication (p. 1991).

Sadowska, N., Laffy, D., Sadowska, N., & Laffy, D. (2017). a learning journey The design brief : inquiry into the starting point in a learning journey. *The Design Journal*, 6925, S1380–S1389. https://doi.org/10.1080/14606925.2017.1352664

Sari, L. D. and Prada, A. W. (2020) 'The Essence of Hand Lettering in the Design Industry. The Definition of Design Industry', in 1st International Conference on Interdisciplinary Arts and Humanities (ICONARTIES 2019). SCITEPRESS – Science and Technology Publications, Lda, pp. 155–158. doi:http://doi.org/10.5220/0008556301550158 .

Sharma, S., Kumar, J., Zheng, J., & King, T. H. (2023). Contextual Font Recommendations based on User Intent. Proceedings of ACM SIGIR Workshop on ECommerce (SIGIR ECom'23). ACM, New York, NY, USA, 5 pages.

Strizver, F. (2006). Type Rules: the designer's guide to professional typography. John Wiley & Sons, Ltd. Turgut, Ö. P. (2014) 'Calligraphic Forms in Contemporary Typographic Design', Procedia

Walia, C. (2019). A Dynamic Definition of Creativity. In Creativity Research Journal. Routledge. https://doi.org/10.1080/10400419.2019.1641787

Wang, Z., Yang, J., Jin, H., Shechtman, E., Agarwala, A., Brandt, J., & Huang, T. S. (2015). DeepFont : Identify Your Font from An Image.

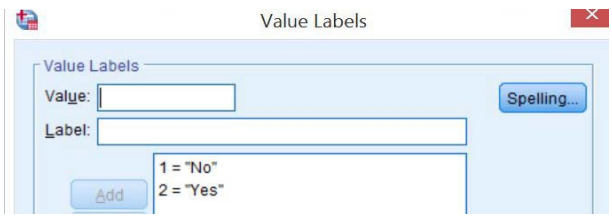
Yusoff, Y. M., Ruthven, I., & Landoni, M. (2013). Measuring Emotion : A New Evaluation Tool for Very Young Children. Proceedings of the 4th International Conference on Computing and Informatics, ICOCI, 126, 358–363.

APPENDIX A

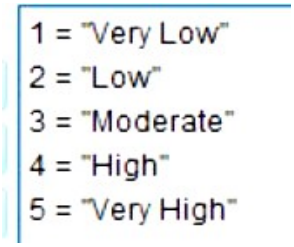
List of Abbreviation used in the Appendix B
G = Gender
F = Female
M = Male
NOS = Number of sketches
MTHD = Method
RCU = Rate of CAD Usage
IDP = Fundamental Design Principles
WC = Well Considered
AC = Averagely Considered
NC = Not Considered
I = Interest
U = Understanding
INT = Intuition
F = Flexibility
DB = Design Brief
MET = Mentorship
MOV = Motivation
A = Appropriateness
O = Originality
IOI = Interpretation of Instruction

APPENDIX B

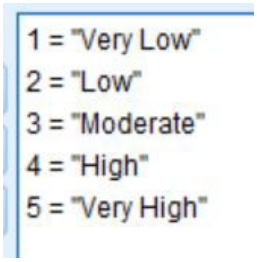
Values used for Design Brief (DB) and Mentorship (MET) as used in the IBM SPSS Statistics 23



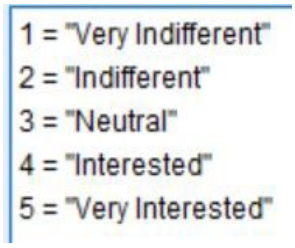
Rating Scale for Intuition (INT) as used in the IBM SPSS Statistics 23



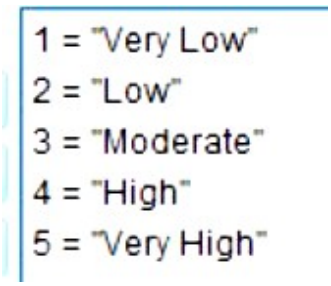
Rating Scale for Flexibility (F) as used in the IBM SPSS Statistics 23



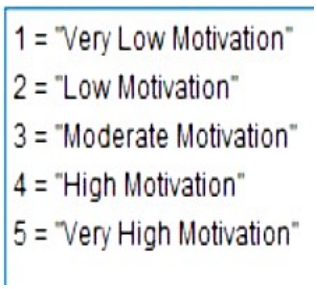
Rating Scale for Interest (I) as used in the IBM SPSS Statistics 23



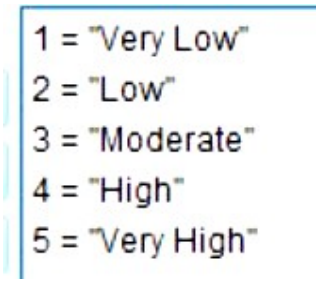
Rating Scale for Interpretation of Instruction (IOI) as used in the IBM SPSS Statistics 23



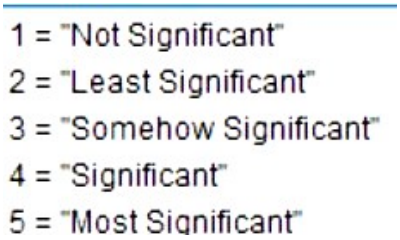
Rating Scale for Motivation (MOV) as used in the IBM SPSS Statistics 23



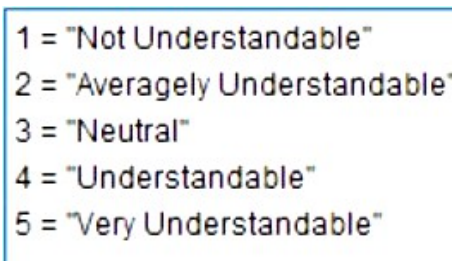
Rating Scale for Appropriateness (A) as used in the IBM SPSS Statistics 23



Rating Scale for Originality (O) as used in the IBM SPSS Statistics 23



Rating Scale for Understanding (U) as used in the IBM SPSS Statistics 23



Some Data Collection for the study

G	NOS	MTHD	RCU	FDP	I	U	MOV	A	O	IOI	INT	F	DB	MET
F	6	Manual	low	WC	3	3	3	2	2	3	2	2	1	1
F	15	Manual and CAD	Excessive	AC	4	5	5	2	3	3	5	5	2	1
F	10	Manual	Moderate	NC	3	5	5	3	3	3	3	3	1	1
F	8	Manual	Moderate	WC	3	3	3	3	3	3	3	3	1	1
F	9	Manual	Moderate	N C	3	3	3	3	3	3	4	3	1	1
F	13	Manual	Moderate	AC	3	5	3	3	3	3	3	3	1	1
F	21	Manual and CAD	Moderate	WC	3	5	3	5	3	3	5	3	1	2
F	0	CAD	Excessive	N C	3	3	3	3	3	3	3	5	1	1
M	4	Manual	Low	AC	2	3	2	2	3	3	3	3	1	1
M	15	CAD	Excessive	AC	4	5	4	2	3	3	3	3	1	1
M	4	Manual	Low	AC	2	3	2	3	3	3	4	3	1	1
M	13	Manual and CAD	Low	AC	4	5	5	5	3	3	5	3	2	2
M	1	Manual	Low	AC	2	3	2	3	3	3	3	3	1	1
M	7	Manual	Low	AC	2	3	2	3	3	3	3	3	1	1
M	5	Manual	Low	AC	2	3	3	2	3	3	3	3	1	1
M	14	Manual	Low	AC	4	5	4	3	3	3	5	5	1	2
M	3	CAD	Excessive	AC	2	3	2	2	3	3	3	3	1	1
M	1	Manual	Low	AC	2	3	2	2	3	3	3	3	1	1
M	5	Manual	Moderate	AC	2	3	2	3	3	3	3	3	1	1
M	8	Manual	Excessive	AC	2	5	3	2	3	3	3	3	1	1

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Gender	20	1	2	1.40	.503
Sketching as a Procedure	20	0	21	8.10	5.619
Rate of CAD Usage	20	1	3	1.70	.801
Application of Design Principle	20	1	3	2.00	.562
Interest of the Student	20	2	4	2.75	.786
Understanding of the Procedure	20	3	5	3.70	.979
Motivation of the Student	20	2	5	3.05	1.050
Appropriateness of Design	20	2	5	2.80	.894
Interpretation of Instruction	20	3	3	3.00	.000
Intuition	20	2	5	3.45	.887
Flexibility	20	2	5	3.25	.786
Design Brief as a Procedure	20	1	2	1.10	.308
Mentorship as a Procedure	20	1	2	1.15	.366
Geometric Modification Under Two Categories	24	1	2	1.50	.511
CAD inspiration in terms of design principles	12	3.0	5.0	4.167	1.0299
CAD inspiration in terms of anatomy	10	3.0	5.0	4.000	1.0541
CAD inspiration in terms of geometry	24	.0	5.0	3.917	1.7173
originality	20	2	4	3.00	.324
How the student used CAD	20	1.00	4.00	3.0000	1.02598
Valid N (listwise)	10				

APPENDIX C

Other Examples of Paper Works Produced by the Participants