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Understanding Design Concept Utilisation Among Architecture Students Towards Project Execution Self-Satisfaction: A Study in Jos

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Abstract

The goal of architectural education is to train competent, confident and up-to-date designers who think critically and creatively. This study looks at the theoretical modules in design curriculum which hone critical and creative skill, the impact they have on conceptual development, and the student perceptions on self-examined awareness and satisfaction with project execution. Using empirical and theoretical data obtained from schools of architecture in selected countries around the world, the study identified curriculum where design theory courses on critical and design thinking are employed to train young designers how to think like the architects they hope to become. In the study area of the Department of Architecture at the University of Jos, north-central Nigeria, the study sampled responses from students on concept formulation techniques based on theoretical teaching and the shortcomings thereof. The study findings show that courses on design theory, where they exist, are welcomed by architecture students due to the lasting impressions they leave on design potential. The study proposes the introduction of such modules/courses early enough in the curriculum to set the right foundation for design learning as well as an expansion of existing curriculum to meet best global practice. The study also proposes constant monitoring of evolving trends in design education that foster critical and creative thinking, and their impact on design studio output of which students themselves feel self-assured and satisfied.

Keywords: *Concept formulation, Critical thinking, Design thinking, Design curriculum, self-satisfaction*

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Background to the Study

The design process involves a number of verbal and non-verbal tools of communication intended to convey the designers' thoughts and feelings about the resultant structure or space created (Frederick, 2007). The design process is a response to the occurrence of problems which originate from a number of sources including the site conditions, the qualities and characteristics of the clients or users, building typologies, materials and technology, and design elements. Perhaps the most useful tool during the design process is the design concept (Watt, 2020). It is also the most misunderstood tool because the concept is not any one of the generic aforementioned sources, but a unique antiphon to these sources and becomes the essence of the project. Design concepts are a by-product of critical thinking and design thinking (Tarasova, 2018; Lewarne, 2020).

Formal design education recognises that instruction on concept formulation can appear quite vague, particularly as the concept may or may not emerge as a tangible phenomenon. Several studies have claimed the concept is abstract and therefore, unteachable (Oxman, 2001; Franck & Lepori, 2007; Tezel & Casakin, 2010; Hargrove, 2011; Aderonmu, 2013; Gray, 2013; Joyner, 2019; Deutsch, 2020). For this reason, many schools of architecture meander or skirt around structured teaching on the issue of concept formulation and opt to incorporate a practical methodology approach during design studio instruction. One of the biggest challenges to this practice is that architecture students increasingly find it difficult to grasp what a design concept really is and what makes it so great. In a recent regional study, 29.4% of a student sample base felt that inclusion of the concept formulation in a projects preliminary problem specifications was "unnecessary" and "time-consuming" (Enwerekowe & Dassah, 2021). Conversely it has been observed that student performance in design-based activity declines where evidence of a cohesive concept is lacking in the problem specifications.

This study takes a closer look at the way students develop and use a design concept to a self-satisfactory conclusion of their design projects. To do this, the study looks at 3 (three) questions:

1. Do design students put in enough effort into design concept formulation?
2. How successfully have concept formulation techniques been inculcated into design education programmes?
3. Do these techniques encourage student design confidence towards improved design competence?

Due to increasing awareness of links between mental health, productivity and academic success among design students, this study hopes to gain insight into effective practises and techniques of instruction on concept formulation in design education which promote design competence and confidence.

Literature Review

A concept is often regarded as the non-verbal or non-experiential driver of a design. That is largely due to the fact that a concept may not be seen, felt or touched until we figure out a way to put it into practice. Contrary to popular opinion, a concept is not some skeletal framework

or mock up, neither is it a visual representation of something (Watt, 2020; Babich, 2022). A concept, like most "ideas" is devoid of any dimension thereby making it zero-dimension (0D). By developing a concept into a line drawing (1D), adding dimensions (2D), including depth and layers (3D), and then embracing animations and interactions (4D), a concept then becomes a design product (Satpathy, 2020). Many design products fail because designers spend far too much time on 2D, 3D and even 4D processes, and not enough time on 0D and 1D processes which are, in fact, the origins. The increasing use of Artificial Intelligence (AI) in design on 2D, 3D and 4D processes raises concerns about the future relevance of human designers with the automation of hard skills. Designers must therefore learn to rely more on soft skills such as ideas and less on production (Akande, Olagunju & Ayuba, 2006; Maina & Salihu, 2016; Ioannou, 2018). For this reason, the development of designers who are able to conceptualise efficiently and effectively should remain the backbone of design education (McClean, 2009).

A concept is the reason or "ethos" of a design: a general idea about an abstraction rather than a literal reality (Frederick, 2007). It is a tool the designer uses to connect to their design and what experience the designer intends for the user when moving through a finished structure or space. The concept goes beyond the mere use of materials, the layout of spaces, the activities contained within the space, the user or even the site features. The concept rather fuses the research, documentation and understanding of the site, building typology, user needs and wants, requirements of the brief and programme into specific project visions and aspirations. In other words, a concept is an idea about "space, structure, inhabitation and human experience". The deeper the research into the design problems, the greater the chances of developing possible concepts (Watt, 2020). Mastery of concept formulation can be difficult for designers of all ages but poses a specific challenge to students, some of whom learn the process early on and others struggle through their first studio years (Adedapo et al., 2013; Gray, 2013). Some concepts will be effortless and direct, others may be protracted and difficult to clarify. Accomplished concept formulation is an indication of design competence (Cross, 2011). Design competence boosts overall student mental health, productivity and academic success. The influence of these three parameters have been known to make or mar the professional future of architectural designers.

The World Health Organisation [WHO] recognises that mental health is an indicator of individual self-worth, stress management, work productivity and community contribution which makes understanding the impact on design students a central theme in ongoing research (Hysenbengasi, 2005; Stallman, 2010; Skalleri et al, 2011; Kirmayer & Pedersen, 2014; WHO, 2014; Hubble & Bolton, 2020). Positive feelings and positive functioning are key aspects of mental health (Galderisi et al, 2017). Understanding the impact of successful design concept formulation practices on student mental health and overall positivity towards design competence is a seldom discussed aspect of design education, particularly in developing countries (Hegenauer, 2018). Rising concern among design educators with the quality of architectural graduates has led to calls for revised pedagogical approaches aimed at improving design competence through concept formulation (Olotuah, 2000; Ambrose et al, 2010; Aderonmu, 2013; Crowther, 2013; Adedapo, Ezema & Okpoko, 2017). The paper seeks

to address the aforementioned study questions in a bid to identify and understand the level of self-worth and value design students attach to formulation of concepts based on self-appraisal of design programmes.

Methodology

The study adopts a mixed-method approach to analysis which harmonises explanatory and interpretative research as a single, two-phase study given the benefits to the multi-dimensional factors under discussion. The first phase focused on a quantitative feature to generate student perceptions about design concept utilisation and self-satisfaction with their design output. The second phase used qualitative findings from information gathered from focus groups of students over an extended period of time. The study data was compiled over nearly fifteen years during studio-based and non-studio-based evaluations of third- and fourth-year students in the Department of Architecture at the University of Jos. The purpose of the mixed-method study was to clarify topics under discussion that are not easily inferred from either purely quantitative or qualitative data. The literary research reviewed existing knowledge on concept formulation and the impact on student design competence. The literature also underscored the importance of healthy concept formulation practices on student mental health and over all emotional wellbeing as they navigate through design education. The descriptive analysis of the data obtained was interpreted using tables, charts, and other simple means of statistical analysis such as percentages and Severity Index (SI) ranking. Interviews and statements from student participants over the years were archived, transcribed and interpreted based on their contextual relevance. Using the 1974 Moser-Kalton derivation method prescribes a minimum of 50 participants with a standard error margin of 5% from a student population of approximately 1,900 students over time (Onwuegbuzie & Collins, 2007; Fincham, 2008; Uji, 2009). The responses of all the students were used for the quantitative analysis and those of 67 documented students were used for the qualitative analysis from open-ended questions and in-depth Severity Index analysis of the interview responses.

Results and Discussion

The results presented in this study examine three aspects of design concept utilisation among architecture students which impacts their self-satisfaction during design project execution. Samples of a focus group of student responses taken from 3rd and 4th year students were examined more closely being the training period when non-studio-based theoretical courses on concept formulation in design thinking were taught in the Nigerian model. The focus group findings were obtained from transcribed interviews, email replies and social media direct messages. The inferences drawn from the qualitative and quantitative approaches underscored the aforementioned three main areas of discussion, namely: evidence of adequate design theory in architectural programmes of study, conceptualisation guided by design thinking and critical thinking, and student self-evaluation of teaching and learning on design theory.

1. Evidence of adequate design theory in architectural programmes

Design education is geared towards identifying and developing design ability from novicehood to a level of expertise or advanced competence. Curriculum or programmes of

study in schools of design are tailored to specific ideologies which nurture schools of thought amongst the participants. Architectural education draws from a transdisciplinary background of both the sciences and the arts which includes instruction in arts and drawing, historical and theoretical studies, building systems and technology, humanities and social studies, environmental control studies and the physical sciences. Traditional schools of architecture incorporate each of these modules over the course of undergraduate and (or) postgraduate study at select durations and emphasis. Table 1 below shows a comparative analysis of the various modules in architecture in the US, Europe, Asia, Africa and specifically in Nigeria.

Table 1: Comparative assessment of selected architectural education modules in universities across the world

		Asia				US/Canada					Europe			Africa			Nigeria			
		Year of undergraduate study																		
s.no.	Module/Course	1	2	3	4	1	2	3	4	5	1	2	3	1	2	3	1	2	3	4
A	**Architectural design Studio**	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
B	**Arts and Drawing**										x			x	x					
i.	*Freehand drawing/sketching*					x		xx									x	x		
ii.	*Modelling*	x							x								x			
iii.	*Descriptive geometry/Technical Drawing*					x		x									x	x		
iv.	*Architectural graphics*					x											x			
C	**Historical and Theoretical Studies**										x	x	x	x	x	x				
i.	*Critical thinking/theory*	x						x							x	x				
ii.	*Design thinking/theory*	x																	x	x
iii.	*Art/Architectural history*	x	x			x	x	xx	xx		x	x	x				x	x	x	
iv.	*Current issues & ideology*				x			x											x	
D	**Building Systems & Technology**										x	x	x	x	x	x				
i.	*Architectural Structures & Mechanics*				x	x	x	x										x	x	x
ii.	*Building Components & Construction*		x			x		x	x	x								x	x	x
iii.	*Building Materials Study*		x			x	x	x	x									x	x	x
iv.	*Building Climatology*		x					x										x	x	
v.	*Traditional Architecture & Technology*																	x	x	
E	**Humanities and Social Studies**										x	x	x			x				
i.	*Interior design/furniture design*									x						x				x
ii.	*Geography/GIS*									x							x			x
iii.	*Sociology*								x								x	x		
iv.	*Building Economics*			x					xx	x									x	x
v.	*Professional Practice & Ethics*							x		x										x
F	**Environmental Control Studies**										x	x	x		x	x				
i.	*Urban design*			x	x	x	x	x	x											x
ii.	*Landscape design*																		x	x
iii.	*Sustainability*																		*	*
G	**Physical Sciences**													x	x	x				
i.	*ICT/Computer Applications*	x	x			x	x	x	x	xx				x	x	x	x	x	x	x
ii.	*Mathematics & Physics*																x			
iii.	*Statistics*	x																x		
iv.	*Land surveying and photogrammetry*																	x	x	

Sources: Asia – National University of Singapore, Singapore; US/Canada – Columbia University, New York, USA & Carnegie Mellon University, Pittsburgh, USA; Europe – London Metropolitan University, England; Africa – University of Cape Town, South Africa; Nigeria – University of Jos, Plateau state.

Design education in developing countries derive a lot of their structure and content from antecedents in western countries such as the Bauhaus School, the Académie d'Architecture and the Ecole des Beaux-Arts. Programmes then become contextualised to incorporate local content. The findings from the review of the undergraduate curriculum in schools of architecture in different countries shows that all the prescribed modules for holistic architectural education are included. Course structure and course content, however, differ along ideological or contextual lines. A close examination of the curriculum across the selected schools in architectural historical and theoretical studies shows a higher occurrence of courses dedicated to art and architectural history across several years of study, especially in

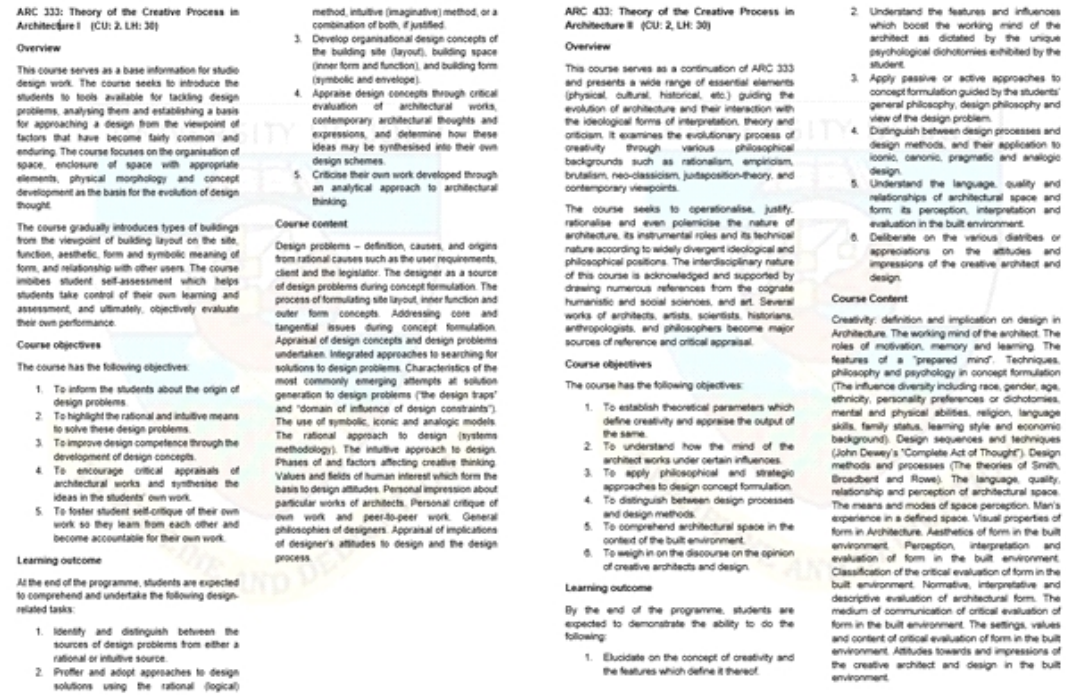
the US and Canada, and Europe. Courses on critical thinking are taught in selected schools in Asia, the US and Canada, and Africa. Design thinking is also taught in Asian school (in the first year of study) and in Nigerian schools of architecture, in the 3rd and 4th years of the programme.

Given the complexities of critical and design thinking in architectural education, inferences that can be drawn from these observations include the appreciation of the inclusion of courses on design theory in modern architectural curriculum (in Asia and Nigeria), particularly alongside practical courses on design studio where the theoretical knowledge is applied. Design teaching and learning integrates a number of precepts from design theory (vis-à-vis evidence of design theory and design practice from architectural education). Previous studies (Uluöglu, 2000; Tezel & Caskin, 2010; Almendra, 2012; Aderonmu, 2013; Crowther, 2013; Eshun, 2016; Enwerekowe & Dassah, 2021) have established several links between design theory and design competence exhibited in the studio. Critical thinking promotes decision-making and develops specific techniques which enable designers deal with difficult problems, situations or choices effectively. Theoretical courses on critical thinking improve self-empowerment and confidence leading to design competence which is borne out of efficiently-gathered knowledge, faster processing of information and intelligent analysis of data. In conjunction with courses on design thinking to promote problem solving skills which generate innovative solutions and lasting value for consumers, it is a significant finding from this study that theoretical courses on design and critical thinking exist as part of a robust design curriculum in most schools of architecture, including Nigeria.

2. Conceptualisation guided by design thinking and critical thinking

The mere presence of an architectural curriculum supported by theoretical teachings in design thinking and critical thinking however, does not necessarily translate into commensurate success in design output. This is, naturally, the goal of design education. This then shifts the focus away from "if" a curriculum contains courses on design and critical thinking to "what" the course objectives are and the strategies to achieve them. Critical thinking is an objective assessment of an idea, concept or data from different perspectives to arrive at an unbiased optimum solution (Tarasova, 2018; Deutsch, 2020; Lewarne, 2020). Design thinking, on the other hand utilises stages of observation, understanding, problem formulation, solution inference, testing, adjustment and repetition. Each stage of design thinking requires some level of critical thinking (Oxman, 2001). A balanced curriculum of architectural education, therefore should incorporate content devoted to both critical and design thinking. This was the situation observed in the curriculum utilised in the Asian model. There is sufficient evidence of course content on critical thinking in North America and content on design thinking in the Nigerian model. Figure 1 (a & b) contains a summary of the course content on design thinking in the Nigerian model.

Figure 1 (a & b): Summarised course content on design thinking in a Nigerian School of Architecture



ARC 333: Theory of the Creative Process in Architecture I (CU: 2, LH: 30)

Overview

This course serves as a base information for studio design work. The course seeks to introduce the students to tools available for tackling design problems, analysing them and establishing a basis for approaching a design from the viewpoint of factors that have become fairly common and enduring. The course focuses on the organisation of space, enclosure of space with appropriate elements, physical morphology and concept development as the basis for the evolution of design thought.

The course gradually introduces types of buildings from the viewpoint of building layout on the site, function, aesthetic, form and symbolic meaning of form, and relationship with other users. The course imbibes student self-assessment which helps students take control of their own learning and assessment, and ultimately, objectively evaluate their own performance.

Course objectives

The course has the following objectives:

1. To inform the students about the origin of design problems.
2. To highlight the rational and intuitive means to solve these design problems.
3. To improve design competence through the development of design concepts.
4. To encourage critical appraisals of architectural works and synthesise the ideas in the students' own work.
5. To foster student self-critique of their own work so they learn from each other and become accountable for their own work.

Learning outcome

At the end of the programme, students are expected to comprehend and undertake the following design-related tasks:

1. Identify and distinguish between the sources of design problems from either a rational or intuitive source.
2. Proffer and adopt approaches to design solutions using the rational (logical) method, intuitive (imaginative) method, or a combination of both, if justified.
3. Develop organisational design concepts of the building site (layout), building space (inner form and function), and building form (symbolic and envelope).
4. Appraise design concepts through critical evaluation of architectural works, contemporary architectural thoughts and expressions, and determine how these ideas may be synthesised into their own design schemes.
5. Criticise their own work developed through an analytical approach to architectural thinking.

Course content

Design problems – definition, causes, and origins from rational causes such as the user requirements, client and the legislator. The designer as a source of design problems during concept formulation. The process of formulating site layout, inner function and outer form concepts. Addressing core and tangential issues during concept formulation. Appraisal of design concepts and design problems undertaken. Integrated approaches to searching for solutions to design problems. Characteristics of the most commonly emerging attempts at solution generation to design problems ("the design traps" and "domain of influence of design constraints"). The use of symbolic, iconic and analogic models. The rational approach to design (systems methodology). The intuitive approach to design. Phases of and factors affecting creative thinking. Values and fields of human interest which form the basis to design attitudes. Personal impression about particular works of architects. Personal critique of own work and peer-to-peer work. General philosophies of designers. Appraisal of implications of designer's attitudes to design and the design process.

ARC 433: Theory of the Creative Process in Architecture II (CU: 2, LH: 30)

Overview

This course serves as a continuation of ARC 333 and presents a wide range of essential elements (physical, cultural, historical, etc.) guiding the evolution of architecture and their interaction with the ideological forms of interpretation, theory and criticism. It examines the evolutionary process of creativity through various philosophical backgrounds such as rationalism, empiricism, brutalism, neo-classicism, juxtaposition-theory, and contemporary viewpoints.

The course seeks to operationalise, justify, rationalise and even polemicise the nature of architecture, its instrumental roles and its technical nature according to widely divergent ideological and philosophical positions. The interdisciplinary nature of this course is acknowledged and supported by drawing numerous references from the cognate humanistic and social sciences, and art. Several works of architects, artists, scientists, historians, anthropologists, and philosophers become major sources of reference and critical appraisal.

Course objectives

The course has the following objectives:

1. To establish theoretical parameters which define creativity and appraise the output of the same.
2. To understand how the mind of the architect works under certain influences.
3. To apply philosophical and strategic approaches to design concept formulation.
4. To distinguish between design processes and design methods.
5. To comprehend architectural space in the context of the built environment.
6. To weigh in on the discourse on the opinion of creative architects and design.

Learning outcome

By the end of the programme, students are expected to demonstrate the ability to do the following:

1. Elucidate on the concept of creativity and the features which define it thereof.
2. Understand the features and influences which boost the working mind of the architect as dictated by the unique psychological dichotomies exhibited by the student.
3. Apply passive or active approaches to concept formulation guided by the students' general philosophy; design philosophy and view of the design problem.
4. Distinguish between design processes and design methods, and their application to iconic, canonic, pragmatic and analogic design.
5. Understand the language, quality and relationships of architectural space and form: its perception, interpretation and evaluation in the built environment.
6. Deliberate on the various diatribes or appreciations on the attitudes and impressions of the creative architect and design.

Course Content

Creativity: definition and implication on design in Architecture. The working mind of the architect. The roles of motivation, memory and learning. The features of a "prepared mind". Techniques, philosophy and psychology in concept formulation ("the influence diversity including race, gender, age, ethnicity, personality preferences or dichotomies, mental and physical abilities, religion, language skills, family status, learning style and economic background). Design sequences and techniques (John Dewey's "Complete Act of Thought"). Design methods and processes (The theories of Smith, Broadbent and Rowe). The language, quality, relationship and perception of architectural space. The means and modes of space perception. Man's experience in a defined space. Visual properties of form in Architecture. Aesthetics of form in the built environment. Perception, interpretation and evaluation of form in the built environment. Classification of the critical evaluation of form in the built environment. Normative, interpretative and descriptive evaluation of architectural form. The medium of communication of critical evaluation of form in the built environment. The settings, values and content of critical evaluation of form in the built environment. Attitudes towards and impressions of the creative architect and design in the built environment.

Source: Department of Architecture, University of Jos CCMAS 2023

In the programmes observed, the Asian model introduced critical thinking in the first year of study. Design thinking was consequently introduced in the second year of study. Asian models commence design studio programmes from the first year of study. However, in the North American model, although design studio activity also typically commences in the first year of study, identified courses on critical thinking are only introduced at the third year of study. A similar observation was made in the Nigerian model where design studio activity begins in the second year of study but courses on design thinking are only introduced at the third and fourth years. The foundational course on design thinking in the Nigerian model taken at the third year introduces design students to the causes of design problems (both rational and intuitive), and the complementary approaches to solving those design problems as and when they occur. The course then proceeds to educate on self-, peer-to-peer or asynchronous critiques through "an analytical approach to architectural thinking". The course sequel at the fourth year of study takes a more philosophical approach to understanding design processes and methods, as well as space evaluation and the critical assessment of the built environment.

While the course content in the Nigerian model has been described as a "revelation" and an "inspiration", qualitative discussions from past participants in the course have often criticised the introduction of the two courses in the latter years of study, rather than at the beginning of the programme as in the Asian model. Said one past participant:

> "The course was one of the fully interactive courses I had as a student. The teaching style was quite new to me but allowed for easy understanding…sadly it is taught towards the twilight of our schooling. I feel it should have been a basic year one course" (Set 2013, Male)

Another participant opined that the course would also be better utilised as a "postgraduate course" specifically designated to "address critical thinking" during advanced level research and design (set 2013, Male). Other notable responses from participants include:

> "I enjoyed [the course] teaching style; very little pressure to memorise anything – just stay in class, listen to the gist and make sense of it all when you get the study material. It worked well for me…It was one of the lectures I looked forward to because it allowed me think in the way I wanted to without being told what to do…" (Set 2011, Female)

> "…[the course] helped me to know and develop the…architectural style most suitable to for my person…and [I am] grateful for that…[the course was] fun and even simpler to understand" (Set 2005, Male)

> "…[the courses] inspired me to do better in Architecture, which actually happens in the Theory of the Creative Process…my design approach took a whole new level…I don't struggle with any [design] brief, no matter how difficult" (Set 2005, Male)

> "[The] teaching methods were simply epic…[they] helped me to transform a lot of my thoughts and ideas into finished products. I also developed the ability to resolve a problem in ten ways…architecture made easy. I don't struggle with any design till date" (Set 2010, Male)

> "[The course] gave me a sense of direction to my design thoughts, which at the time [seemed] so abstract and out-of-touch with most folks around me (course mates) at the time…blame my love for [Santiago] Calatrava! ...I got to understand I was analogical in my approach to design which in actual fact was okay… [the course gave] a framework upon which one [could] explain his design thoughts logically first to himself and then toothers" (Set 2005, Male)

Participants of the course(s) historically welcomed teaching methods and techniques which foster easy and open dialogue on all topics of discourse, exchange of ideas and fresh perspectives, and, in recent times, up-to-date delivery aids such as webinars, multimedia presentations, smaller peer-to-peer discussion groups and other forms of interactive dialogue. Table 2 which presents the evaluations of student performance in the design course from the Nigerian model between 2004-2021 shows that the average third year performance stands at

9.7% - excellent, 34.1% - very good, 35.1% - average, 9.7% - below average, 5.1% - poor and 6.3% - poor. Summarily, 43.8% of the students performed in the top 25th percentile, 35.1% performed in the 50th-75th percentile and 21.1% performed in the bottom 25th percentile. Significant improvements in student performance in the 4th year shows 16.3% of the students performed excellently, 38.5% - very good, 27.3% - average, 7.8% - below average, 6.3% - below average and 3.8% - very poor. This represents an increment to 54.8% in the top 25th percentile, 27.3% in the 50th-75th percentile, and a decline to 17.9% in the bottom 25th percentile. Inference therefore holds that student performance improved with prolonged exposure to theoretical studies on design thinking. Following the introduction of more student-friendly teaching approaches into the architectural curriculum in the Nigerian model in recent years, the findings also suggest a resultant improvement in student performance as shown in Table 3. This, in turn has a significant impact on the ability of students to correctly form, understand and utilise concepts in their design activity (Enwerekowe & Dassah, 2021).

Table 2: Student performance in design thinking modules/courses (Nigerian model)

	3rd Year						4th year					
	No. of students						No. of students					
Academic session	Excellent	Very good	Average	Below average	Poor	Very poor	Excellent	Very good	Average	Below average	Poor	Very poor
2004/2005	10	42	50	10	13	9	15	59	26	9	4	4
2005/2006	30	36	23	7	7	8	29	35	27	8	5	4
2006/2007	3	24	32	9	9	7	22	35	22	11	11	6
2007/2008	8	18	28	6	5	5	9	18	31	7	9	7
2008/2009	6	9	24	7	13	3	6	20	29	5	3	3
2010/2011*	3	15	20	4	3	3	10	25	15	5	6	3
2011/2012	6	31	24	8	1	0	6	14	18	4	4	0
2012/2013	5	20	25	5	8	2	19	30	15	2	2	0
2013/2014	17	35	20	2	0	1	12	33	15	3	3	0
2014/2015	1	14	26	4	7	0	12	32	19	7	3	1
2015/2016	4	18	20	10	6	5	4	24	15	2	3	2
2016/2017	6	32	21	8	0	3	2	30	21	2	2	2
2017/2018	0	21	32	9	-	7	10	21	21	9	-	7
2018/2019	2	25	18	9	-	7	10	31	20	7	-	0
2019/2020	4	30	27	10	-	4	15	18	19	2	1	2
2020/2021	7	23	15	5	-	9	11	31	10	10	-	4

Table 3: Year-on-year median student performance in the Nigerian model under evolving teaching methods

Course module/Session	Median Score (%)		Method of Instruction
	3rd year	4th year	
1. Historical/Theoretical Studies			
2016/2017	59.9	59.5	In-person
2017/2018	54.6	58.1	In-person
2018/2019	55.2	63.2	In-person
2019/2020	57.8	64.5	Blended/Networked
2. Humanities and Social Studies			
2016/2017	54.3	57.6	In-person
2017/2018	52.0	59.1	In-person
2018/2019	44.0	55.7	In-person
2019/2020	47.7	52.4	Blended
3. Environmental Control Studies			
2016/2017	64.8	61.6	In-person
2017/2018	68.4	57.3	In-person
2018/2019	54.7	59.2	In-person
2019/2020	64.1	59.3	In-person
4. Building Systems and Technologies			
2016/2017	51.2	62.3	In-person
2017/2018	56.8	57.4	In-person
2018/2019	46.8	64.3	In-person
2019/2020	57.9	60.0	In-person
5. Physical Sciences			
2016/2017	47.7	55.2	In-person
2017/2018	48.3	49.5	In-person
2018/2019	48.3	54.0	In-person
2019/2020	47.7	47.6	Blended

3. Student self-evaluation of teaching and learning on design theory

The ability to think critically throughout the design process remains one of the most useful skill sets of the architect. When students are taught to think critically over the duration of their architectural education, it helps them adapt to the real-world circumstances they face beyond the classroom setting. Design concepts borne out of critical thinking are less likely to fall short of intended goals, are less likely to need retrofits or deal with unexpected shortcomings. Due to the evolution of design curriculum over the years, there is a need to examine learning outcomes of critical thinking in design education in order to effectively bridge the widening gap in how students think and learn to think. As part of critical learning, this section of the study focused on understanding how well the students sampled applied concept formulation techniques borne out of critical thinking to their own practical design realisation. The weighted perceptions were ranked and inferences were drawn about how critical thinking affected concept formulation during the design process.

Nearly two-thirds of the students sampled (61.7%) acknowledged the positive impact of taught courses on critical and design thinking on their ability to form a design concept. Responses to frequently documented opinions about concept formulation are presented on Table 4. The least ranked opinion of the sample was that design activity takes place in the absence of a concept (2.11) and the most ranked opinion in the sample suggested more

students place emphasis on the building form over the building function (3.78). Other significant findings show the process of concept formulation is presumed to "take a long time" (3.72) and background research and analysis into the design problems is often limited, leaving out much of the valuable "stuff" for critical thinking needed to form workable concepts. However, there were many who still struggled with the application of concept formulation techniques to practical design realisation, and this was observed to cause a lot of anxiety and disillusionment about the level of self-assessed design competence among the sampled students. Concept formulation is still largely seen as an abstract, intangible process which is not easily communicated from the perspective of the young designer.

Table 4: Ranked student responses on attitudes to design concept formulation

When designing, I find...	SA (5)	A (4)	D (3)	SD (2)	U (1)	SI
The process of concept formulation tedious and restrictive	20	13	10	9	15	3.21
There is no relationship between concept formulation and design competence	4	7	25	29	2	2.73
My concept prioritises building form over function	19	25	12	11	-	3.78
It is difficult to explain my design concept verbally	21	20	11	15	-	3.21
I prefer to design without thinking about a concept	13	17	12	18	7	2.11
My concept is sometimes abstract and intangible	7	5	17	16	22	2.38
I have not carried out enough research before coming up with a concept	23	22	4	17	1	3.73
I take a long time to develop design concept which delays the design process	15	30	10	12	-	3.72
Design concepts are overrated	4	44	6	2	11	3.42
I do not need a design concept if I am not designing anything new	5	40	12	9	1	3.58
Design thinking increases the risk of failure	4	4	46	13	-	2.98
Every project requires a design concept	6	38	14	9	-	3.61

*SA = Strongly Agree, A = Agree, D = Disagree, SD = Strongly Disagree, U = Undecided, SI = Severity Index

An important goal of self-criticism is self-improvement, selected strategies of which are presented on Table 5. When asked about targeted concept development strategies derived from critical thinking, the highest ranked response was to utilise updated materials of construction and technology (4.52). However, students need to learn to think without depending on technology and use it to think faster where it exists. Where students sought to use precedents of building typologies that have proven successful (or not) (4.51), they need to understand that case studies and experience enforce beliefs which may not always be representative of reality if they blind them to opportunities to improve upon them. The study findings indicated the favoured student responses to the shortfall in research conducted prior to the process of concept development are to pay closer attention to the peculiarities of the site (4.40) and perform more in-depth analyses into the site at all levels (4.15). These are also good self-editing tools of critical thinking because they teach them to focus on content and how to rejig negative spaces, improve on their judgement, develop hunches/intuition as much as rational thinking, and possibly be more open to criticism and feedback. This in turn may lead them to ask more pertinent questions during conceptualisation such as "what if…?", which builds self-confidence in design thinking and skill, and self-satisfaction with the design outcomes.

Table 5: Ranked student responses on desired improvement to concept-making skills

I do better in design activity when I...	SA (5)	A (4)	D (3)	SD (2)	U (1)	SI
Research, document and understand design factors	33	37	5	6	-	4.13
Analyse site conditions for patterns, connections and relationships at mega/macro/micro scales	19	39	9	-	-	4.15
Document existing site conditions	31	34	-	2	-	4.40
Look for precedents of similar typologies to understand best practices – what works and what does not	40	22	4	1	-	4.51
Re-analyse the brief and start to find functional relationships and patterns	22	33	7	2	3	4.03
Interrogate the brief to find the project vision and aspirations	16	14	15	12	10	3.21
Interview prospective users to fully understand their needs, wants and desires	29	29	7	2	-	4.27
Consider possible materials and technology that may be relevant or excluded	40	22	5	-	-	4.52

*SA = Strongly Agree, A = Agree, D = Disagree, SD = Strongly Disagree, U = Undecided, SI = Severity Index

Conclusions

Every good design begins with a concept. Critical thinking teaches students how to move through the process of conceptualisation step-by-step, opening ways to look at things objectively, expanding points of view, be critical of sources of inspiration and findings, and of course, be comfortable and satisfied with the product of their creativity. They are, as future building professionals, responsible for making lives better which means they have to understand that their decisions and actions have consequences – positive or negative. In the real world, architects are not always required to describe, explain, self-justify or rationalise how or why they achieved their designs. However, for students who undergo regular crits or jury exercises, communication of the conceptualisation for the design gives assessors a clearer understanding of the design goals and aspirations. And more importantly, the young designers' self-satisfaction with the design outcome and verdict. As a chain is only as strong as its weakest link, so also is a design only as good as its weakest idea. This study corroborates other findings on design theory in critical and design thinking that motivate students to develop concepts. Students from the Nigerian model who benefitted from architectural programmes which incorporate courses on critical and design thinking have a more positive outlook on their design competence and confidence. Routine curriculum review of architectural education in Nigeria would benefit from the introduction and retention of courses on design theory geared towards improving critical thinking and design thinking. Evaluation of student response and performance in such programmes should be monitored and cross-referenced with output in the design studio to determine effective ways to enhance course objectives, delivery and learning outcomes. Lastly, the study recommends further inquiry into student self-assessment and self-satisfaction to keep an eye on emerging trends on design student mental health and appreciation.

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