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A PRELIMINARY STUDY OF LOW-CODE/NO-CODE ECOSYSTEM PRACTICES: TRANSLATING DESIGN STUDENT VIEWS ON CRAFTING INTERACTIVE DESIGN

Azwan Abidin[1]
Universiti Malaysia Sarawak
Noorhaslina Senin[2]
Universiti Malaysia Sarawak
Ahmad Azaini Abdul Manaf[3]
Universiti Malaysia Sarawak

ABSTRACT

The low-code/no-code (LCNC) ecosystem practices for interactive design platforms has started to emerged to alleviate the processes of digital transformation by enabling individuals with non-programming experience to participate in crafting digital products. Indirectly, the waves of this ecosystem affect learning environments in design education and act as a catalyst for translating design ideas into front-end logical code without coding. This article highlights the insights of design students' experiences from LCNC practices during an interactive design course at UNIMAS, Malaysia. This study used a qualitative research approach strategy of an online survey. This study has shed light on the important need for a new paradigm in teaching-learning activities in design education, as evidenced by the advancement of LCNC practices that can be embedded in related design courses. It was discovered that minimizing the time required to synthesize UX design to completion and reducing the complexity of the design process within a given timeframe, are the two most critical views of LCNC practices in the learning process for interactive design. In conclusion, by understanding the LCNC ecosystem for design education, this approach offers a window into an alternative method for practical interactive design learning and can assist students in breaking the programming barrier, as LCNC platforms continue to grow in trend steadily.

Keywords: NCLC, no-code, low-code, interactive design, design education, no-programming

[1] Azwan Abidin: Faculty of Applied & Creative Arts, University Malaysia Sarawak, 94300 Kota Samarahan.

[2] Noorhaslina Senin: Faculty of Applied & Creative Arts, University Malaysia Sarawak, 94300 Kota Samarahan.

[3] Ahmad Azaini Abdul Manaf: Faculty of Applied & Creative Arts, University Malaysia Sarawak, 94300 Kota Samarahan.

1. INTRODUCTION

The development of digital design tools has a meaningful impact on society, culminating in the expansion of a relevance of low-code/no-code (LCNC) approaches. Its current significance can be linked to the increasing potential of digital transformations as a response of dynamic technological landscape of cloud computing (Ploder et .al, 2019), as it enables non-coders to enhance digital productivity by quickly understanding the logic (Johannessen & Davenport, 2021). In other words, LCNC provides a diverse range of solutions and new challenges for anybody without code development experience or less formal training of programming. Practically, this initiative is effectively translated into digital innovation with the use of pre-defined components that can be re-configured to meet the requirements (Grice, 2020). This method fundamentally conflicts the way coding is commonly taught in design classes. In fact, it is challenging for faculty members or students in higher learning institutions to teach and learn coding in web design programs (Nordström, 2011; Amiri, 2011), especially for those who are not naturally inclined toward this sense of logic and reason (Muller & Kidd, 2014).

As the LCNC tools such as Webflow and Figma eliminates conventional programming with the text-based editor, the functionality of interface design is entirely dependent on the efficiency of design tool development based on the web browser, thus reducing the interaction with the developers. Simultaneously, by improving the utilization of LCNC practices, the growth of LCNC may help alleviate the global scarcity of trained application developers (Silva et al., 2020). Without underestimating the limitations of LCNC, such as security and debugging (Oltrogge et al., 2018; Woo, 2020), the emergence of LCNC platforms provides learning exposure of interactive design and reduces complexity for citizen developers and designers, since they are not dealing directly with back-end processes. In essence, the role of designers and non-designers has become more flexible as a response of the benefits of the LCNC platform, which enables real-time collaboration on a browser-based system for the purpose of designing interactive design projects. Therefore, the objective of this study is to explore the realistic perspective of design students towards the experience of practicing LCNC in design education, particularly on the interactive design course. As part of the study, the views of design students were gathered in order to explore the possibilities of embedding the LCNC ecosystem practices into design education as contemporary interactive design grows.

2. BACKGROUND

2.1. Low-Code/No-Code in Design Education

The approach of low-code/no-code (LCNC) for design education has significantly changed students' understandings of natural progression in interactive design processes. In this sense, the natural progression of educators and students should be aligned with the

advancement of technology through 'a balance of hand and digital craft' (Freyermuth, p.71, 2016). As the globe struggles with the Covid-19 pandemic, majority of design schools are relying to online pedagogical approaches, with all core components of the courses delivered entirely via the internet, such as the uploading of video lectures, tutorials, and discussions. As long as there is internet coverage, these remote delivery methods continue to operate as a catalyst for interaction and educational processes between instructors and students. Regardless of previous knowledge with programming languages, design students virtually interact in a collaborative digital space to work on projects using a combination of asynchronous and synchronous ways. As such, this setting reveals the potential of LCNC to equalize technological design development by empowering cooperative practices with studio-based learning through the use of online environment. This is in line with the growing democratisation of LCNC which acknowledges the people's participation from diverse contexts, where the utilization of visual methods managed in capturing and translating logic for digital product making (Trefler, 2019; Alamin et al., 2021). As a result from the capacity of remote learning in design education, the usefulness of LCNC in designing effective What-You-See-Is-What-You-Get (WYSIWYG) projects has had an effect on students' experience, interaction and pedagogical approaches in design education. This signifies that digital environment can influence LCNC practices in teaching and learning, and it is essential to consider the values through design students' lens. Within this domain, the nature of current design education condition could provide a platform for students to apply their knowledge to design LCNC projects through problem-solving, collaboration, and self-directed learning. However, as the landscape of LCNC evolves, little emphasis has been placed on the relevance of LCNC systems in education particularly on interactive and web design education, in comparison to commercial viewpoints (Lee et al., 2020; Khorram et al., 2020).

In this relation, since there is a paucity of discussion of the LCNC ecosystem in design education compared to real-world practices, it may be related to design graduate marketability. It is believed that digital agencies' recruiting processes may not place the same emphasis on coding abilities for designers as they do for technology developers; as a result, the function of coding in design education should be further examined (Ganci & Lahey, 2018). This is aligned with Hoebeke et al., (2021) notion that coding in design education is difficult to deliver as formal educational content due to the misconception that coding is merely a material used to develop 'something expressive rather than functional' (p. 238). Aside from that, design education also poorly understood by the public at large, who views it as a program that is associated with a lack of ability in computational design skill (Cezzar, 2020). This means the design of curriculum are primarily conceptual and insufficient in shaping design students towards integrated digitalisation and globalisation contexts. On the other hand, design education, particularly on the interactivity for web design, has arisen as a significant intersection of technological interactions as a 'transdisciplinary phenomenon' (Wragg & Barnes, p.1, 2021), thus the experience of learning to code in design education extends beyond practicality and theory. For design education, project-based approach within studio-based learning is widely recognized as a significant pedagogical characteristic, particularly in the context of

higher education (Fleischmann, 2020; Park, 2020). Since the coronavirus outbreak, the core pedagogical value has continued unchanged, with the exception of the physical characteristic of studio spaces, which has shifted to be more digital experiences in nature, allowing for more dynamic online engagement through asynchronous or synchronous approaches. As a studio-based learning is rooted in constructivist pedagogy, the intention to provide a basis for creating and practicing meaningful design processes remains a priority to respond to industry demands (Kumar et al, 2021; Smirnov et al., 2017).

Widening the context of different ways of experiential learning in design education, the perspectives from Hoebeke et al., (2021) and Wragg & Barnes (2021) discern the differences and indicates a call for broad change in terms of translating the capabilities of design students. The overall ideas could be more beneficial if they can take advantage of opportunities within contemporary computational design processes of today's digital-driven economy. In this context, therefore, the contribution of design students' perspectives on LCNC provides a unique viewpoint on contemporary approaches by examining the outcomes of this fundamental shift, from learning code to design to the LCNC ecosystem through a survey of design students at UNIMAS.

3. METHOD

3.1. Online Survey

The study did not entail a deliberate design intervention, rather than explored students' experiences with LCNC ecosystem practices in the online studio classroom. Fundamentally, online surveys are commonly used to collect psychographic information, feedback, behaviour, opinion and analyse the perception of target audiences in a variety of research contexts. Since this study is related to human-computer interaction and design, an online survey is useful for obtaining information on people's experiences with a particular application, in this case, 'interaction with technology' (Müller et al., p. 229, 2014).When it comes to digital environment, this term refers to facilitate the exchange of digital survey questionnaires between researchers and respondents, which is primarily conducted through the use of an internet web browser (Callegaro et al., 2015). For this study, an online survey comprising open-ended questions assessing design students' experiences with online LCNC practices was determined to be the most effective way for gathering students' input for a variety of reasons, including the fact that the learning session has been transitioned to fully online during Covid-19 pandemic.

Firstly, respondents' confidentiality may foster better transparency, which may result in a greater level of involvement. Despite the fact that IP addresses can be detected by the IT system, the respondents' sense of anonymity is protected, as the researcher is still unable to know their name or see them, and this can make involvement in sensitive study more convenient (Braun et al., 2020). Secondly, the online survey provides design students with the freedom to complete it whenever they have the opportunity, which is beneficial when time is limited. In fact, this method could save time and ensure researchers to gather information when they are engaged in other duties (Llieva et al., 2002). And lastly,

internet surveys enable respondents from a variety of geographic areas and localities to participate in the survey. This is convenient for respondents because all UNIMAS design students are required to be away from campus during a pandemic outbreak.

3.2. Context of investigation

In regard of participation, from January 2021 to March 2021, the researcher surveyed a group of design students who were enrolled in the researcher's Web Design course at the Design Technology program. The primary purpose of this course is to develop an understanding of web design processes and to apply design interactively when designing web sites with Figma, a collaborative web-based LCNC tool for interactive design. They gained hands-on experience using Figma for all class activities and project submissions throughout the course of one semester of study. While design students' involvement in the web design process appears to be developing, participants indicated that they are more inclined to merge into idea development process, which usually involves collaborative activities, than the creating phase, which generally requires technical and creative skills. As Figma provides *FigJam* as an online whiteboard feature, students may communicate with one another, collaborate, and manage visual assets. Certainly, these are advantages for design students who are seeking to interconnect their visual thinking within the LCNC ecosystem. In fact, it was the first time ever that Figma was introduced as a design tool for the Web Design course at the Design Technology program.

This group of third-year students were approached via student emails stored in the UNIMAS online learning system. A total of 81 design students were invited to take part in the online survey, and 50 students answered. This resulted in a response rate of 62% for the entire group of design students. Participants were asked to share their views on the learning experiences when dealing with the LCNC ecosystem through the Web Design class via an online survey. For an online survey, a Google Form was created in order to acquire meaningful information from respondents. In details, the data were manually coded in two broad categories, ‘advantages’ and ‘barriers’, rooted from their experience of practicing LCNC for interactive design projects. Fundamentally, of these 50 respondents, 18% had a prior experience of basic coding before enrolled into the Web Design course. It was discovered that they have prior knowledge of fundamental programming in several areas, including CSS (8%), HTML (8%), and a visual coding tool, Blockly (2%). While 82% of those who answered the survey had no prior knowledge with basic programming.

The researchers asked a variety of questions to discover the 'advantages' and 'barriers' they experienced while working with the LCNC environment to accomplish their interactive design projects. To get a sense of the respondents as a whole, note that 89% stated they were unaware of LCNC practices prior to enrolling in the Web Design course, and 11% stated they had heard about them but had not experienced any. Additionally, prior to submitting their work, 34% of respondents spent less than an hour familiarising themselves with Figma's design system and interaction elements, 29% took between 1 and 2 hours, 26% took between 3 and 4 hours, and 11% took over than 4 hours. Since the

LCNC tool is browser-based, 66% of respondents indicated that they rely on their home Wi-Fi connections to work with the LCNC design tool, 31% on a personal internet prepaid plan, and 3% on free Wi-Fi hotspots outside their domains. Finally, nearly every respondents (97%) believe that LCNC practices have the potential to be utilized and implemented in other digital design-related courses.

4. FINDINGS

As demonstrated by the results of an online survey, there is a significant call for LCNC practices in design education, particularly in courses related to interactive and digital design for interactivity. To show and explain this, the researchers will focus on three main questions from the online survey that are specifically related to their experience:

Question 6: What are the three primary benefit of utilising the LCNC practices?

Question 7: What are the three most obstacles you would like to identify with the LCNC practices?

Question 9: In general, what other design courses could be integrated with LCNC practices?

In details, question 6 and 7 ask respondents to rank their most significant advantages and barriers they have personally experienced with LCNC practices. From the analysis of the written responses, it does not come as a surprise that respondents who identify a free LCNC tool like Figma are more convenient to use. Three advantages that respondents noted when dealing with LCNC practices are minimising the duration of design production, reducing the complexity of the design process, and having accessibility of interactions and collaborations features. As a result, students are able to fully understand the workflow and design system more efficiently as compared to a conventional approach of learning the computer language of HTML or CSS to get started in web design. According to the responses to question 7, the three most significant barriers were limited pre-built functionality, rely on the online connectivity exclusively, and the consumption of a large amount of internet data when working with browser-based systems. The second and third replies for question 7 are clearly related since, depending on the online browser, the amount of internet bandwidth utilised is not economical for some design students, particularly those who live in remote areas and rely on an internet prepaid plan. Lastly, students responded to question 9 by suggesting that the Design Technology courses such as UX Design, Digital Design Portfolio, Interactive Multimedia and Infographics have the potential to be integrated into LCNC practices. Considering that these courses are fundamentally based on the web platform, it is logical to say that the LCNC practices are beneficial in encouraging designers-in-training to expand their creativity and enrich students' experience to the next level by exposing them to the LCNC ecosystem within these courses.

5. DISCUSSION

The findings imply that the views of design students, based on their LCNC in Web Design course experience, have a positive impact on the learning design. Firstly, when it comes to LCNC practices, the researchers have discovered that design process, timing and accessibility are three main factors that design students value highly (Table 1). These three factors indicate that they were able to plan for concept development, understand the functionality of interfaces and grasp the flow of user experience design prior to delivering the final design in less time than anticipated. In this sense, the process is consistent with current industry practice, in which designers are not required to perform manual hand coding to ensure that all digital requirements are fulfilled before to the design handoff development phase. In fact, the use of collaborative platform, *FigJam,* offer direct value of interaction with peers, play a central role of studio-based learning in facilitate collective learning in online setting. Simultaneously, the valuable input from peers interaction, minimize the design process. It is also noteworthy that one of the major points highlighted by students' experience is the importance of reducing design complexity. This means that the entire design process is focused solely on Figma. In this sense, there are no supplementary tools, such as a text editor or another vector-based drawing tool, that must be used concurrently with the LCNC tool. Besides relying exclusively on a browser-based system, this accessibility factor is influenced by the easily-understandable interfaces, and because the LCNC system are cloud-based system, no physical storage of space is necessary for work files.

Table 1: Themes and supporting quotes by students on advantages of LCNC practices.

Themes	Codes	Quotes by student
Advantages of LCNC practices	Accessibilities	S3: "…totally browser-based & cloud-based, which means less problem with my internal HD." S7: "…it is totally suitable for me as a designer-in-the-making. Previously, I learned how to design websites - it was difficult; now, it's different." S10: "…no stress at all. Fast and quick. I really enjoy using this tool" S11: "…Friendly User Interface and a lot of plugins selection" S14: "…No need *Adobe Illustrator*, I drew all my assets in Figma" S18: "…I enjoy Figma's features. My lecturer can even comments in real-time" S21: "…My laptop's storage capacity is

		unaffected– No installation is needed; simply open a web browser and begin working." S30: "…no installation needed, saved my hard drive's space" S32: "…accessibility to community and plug ins are two things that I like about Figma"
	Design process	S4: "…the web design process is amazing. Surprisingly, HTML and CSS are no longer required. Less than three hours spent for each project – memorable learning experiences" S5: "…the work flow and interaction between pages is really simple and uncomplicated" S8: "…easy to collaborate with friends" S15: "…despite having large design files, my computer never freezes when using this tool" S16: " … I completed my web design prototyping process with my group members in less than 3 hours, something I did not anticipate." S23: "…the community features and the transitions was super cool" S26: "…Figma's entire UI and usability simplify my design process" S34: "…I wasn't expecting my first entry into web design learning to be as easy as it was" S37: "…what I like about design process in Figma is that all of my unsaved files are automatically turned to drafts versions." S38: "…It definitely helps me when I'm working with group projects, and it's very handy." S40: " … I completed my web design prototype and had it live on the internet less three hours. As a beginner, I didn't expect that"
	Time to complete	S2: "…it's entirely drag & drop, and extremely customizable. The function of Smart Animate is extremely time-saving." S6: "…I can finish less than 2 hours for high-fidelity"

		S12: "…*FigJam* helps my group project (planned, discussed) – We finished earlier than planned" S25: "…for the first time, I submitted all web design project – 2 days earlier than dateline" S38: "…when I used the interaction features, they functioned more quickly than I anticipated" S45: "…I believe that because it was cloud-based, my design process progressed more faster"

Table 2: Themes and supporting quotes by students on barriers of LCNC practices.

Themes	Codes	Quotes by student
Barriers of LCNC practices	Limited pre-defined functionality	S4: "…some effect are unavailable" S6: "…pre-built components are still limited" S12: "…Browsing through a variety of downloadable plugins is a waste of time; for example, creating blobs – which are supposed to be integrated with Figma rather than as a plugin – is a waste of time." S13: "…third-party plugins are very helpful, however some plugins are supposed to be integrated as pre-built components. Batch Styler, for example." S14: "…I expected Figma to include pre-defined components similar to Photoshop and Illustrator, with which I am comfortable" S32: "…most of the pre-built tools in Figma are fundamental, and as a novice, I believe I need more than just the downloadable plugins." S43: "…I'm expecting that Figma will have a motion panel so that I may explore with motion creation tools such as *Protopie*. Prototyping tools should include more animation elements. It is a necessity."
	Relying on Web browser	S6: "…I'm not sure why, but my web browser sometimes crashes when I use Figma"

		S9: "…I had experienced with my web browser crashed at least three times when working on Figma's project, I think it is because bad connection of internet" S10: "…I really need a new laptop. The web-browser on my current laptop is unstable" S18: "…During the submission of Project 1, my laptop often froze" S19: " … Instead of relying on a web browser for designing, I opted to use the 'real design software' installed on my hard drive" S47: "…I live in a rural location with bad internet coverage. As a result, I dislike working on design projects on a web browser"
	Not-so cost effective	S15: "…I have to find a suitable location for reliable internet connectivity. And, of course, I need to seek a free internet connection rather than paying for prepaid internet data. My preferred cafe has free Wi-Fi" S18: "…My current internet prepaid data plan includes 15GB of unlimited data, yet it is still considered 'limited' in reality" S29: "…I spend more than RM30 per month on internet data, the most of which is spent on browser-based assignments. I'm hoping the Covid-19 pandemic will pass quickly and that I'll be able to return to campus and work in the computer lab." S31: "…my area has poor internet coverage. I was required to go to the nearby small town of Belaga in order to get a better connection. Travel is indeed a waste of time and money" S33: "…returning to campus is indeed a big hope. I missed the faculty's internet access. I've spent extra money on prepaid internet data in order to complete the assignments at my home, which does not have a UNIFI connection" S35: "…learning Figma is enjoyable, and I have a great time with it. It was a little slow while dealing with the web browser due to poor

		internet connection, but I was still able to submit projects. Working remotely from home, on the other hand, is a nightmare. I'm hoping the state government can improve internet access in my neighbourhood" S48: "…when I was working on Figma's project, my web browser crashed at least three times, according to my records. Whether it is due to my internet connection or the operating system on my laptop, I am unsure"

Depending on the internet exclusively is noted as a barrier for design students (Table 2). Due to the limited internet coverage in some areas, this requires students to carefully manage their timelines when focusing on design tasks on the LCNC system. In relation, it costs money to obtain internet mobile data, as 31% of respondents use mobile prepaid for personal internet data and 3% rely on free Wi-Fi hotspots at cafes, libraries and the local neighbourhoods. This situation demonstrates that LCNC practices are impractical for design students who have limited internet access in addition to high internet data prices. In other words, the exclusion of technological affordances prevents the learning process from reaching its full potential. This aspect correlates with Malaysia's digital inequalities, since affordability of internet data pricing is one of the main obstacles to the country's digital transformation, alongside accessibility and usage of internet (Gong, 2020). The design students also mentioned that one of the obstacles are seen as limited pre-built component for designing. Technically, as a browser-based LCNC tool that relies on a Cloud infrastructure, Figma's pre-built component functionalities must be minimised. The entire design system have to be simple and reusable. However, Figma includes a collection of plugins produced by third-party developers that allow users to choose, use, and delete them if they are not interested in saving them. This implies that the interfaces have advanced vector graphics capabilities and prototyping interactivity, so the addition of more visual assets may impact Figma's performance (Wang, 2021). This may become the primary obstacle for design students if they are still unable to effectively manage pre-built components and plugin assets. Thus, while using Figma, Cloud storage may be efficiently utilised and data consumption can be reduced through the use of minimum pre-defined components.

Despite contrasts in views on learning code in design education have been highlighted by Hoebeke et al. (2021) and Wragg & Barnes (2021), there is still room for progress to maximise the potential of LCNC in design education. Without a doubt, the sense of inclusion fostered by collaborative design efforts has a beneficial influence on empowering participation in the LCNC ecosystem. As society grows more digitally oriented, the growth of no-code has the possibility to have a constructive effect on future

design careers and education. Indeed, the conventional view of learning design as exclusively engaged with expressive approaches needs to be revised. In the findings, it can be observed that the concept of digital equality in higher education is complex, and so the struggle is still ongoing. Therefore, a flexible pedagogical approach in design education especially for interactive design should be consider solutions, and the possibilities can be expanded by taking advantage of technological affordances, while not neglecting the importance of digital equality in higher education.

6. CONCLUSION

The advancement of interactive technology and design knowledge has an impact not only for society, but also design education. On this point, clarity in design technology supports students in developing their design skills and capabilities (Mosely et al., 2021). In such unpredictable period of lockdown due to Covid-19 outbreak, learning and experiencing the LCNC practices via online platform have positive and negative consequences for design students. Based on students' experiences, the authors highlight a few issues, both positive and negative, relevant with the first implementation of LCNC practices in online class. The results shows design students perceived LCNC practices increased their comfort of learning interactive design, as evidenced by the time savings spent in design process, the reduction design complexity, and the accessibility of integrated interactions because they were relying on web-browser as a primary platform. However, a lack of infrastructure in digital network technologies became the main barrier for some design students, especially poor coverage of internet which impacted the additional costs for internet data. Also, since pre-defined assets are constrained, dissatisfaction with minimal digital affordances within the LCNC tool becomes a struggle for them. These barriers leads to student frustration which causes not only unsatisfied but may disrupted the learning process of LCNC practices, since the primary platform is an internet web-browser.

Overall, this preliminary study of LCNC practices offers a new window of alternative approach to learn interactive design, aligned with the current industry practices. In this sense, LCNC ecosystem brings the need for a new paradigm in teaching and learning activities in design education. Indeed, more development of design technology will emerge, and teaching and learning activities in design education a possibly evolve to be a more cooperative and inclusive approaches. It is not viewed as threat to the fundamental approach in design education model but as an opportunity to enhance practice-based design processes in response to current and upcoming changes in design professions. However, it may be meaningless and ineffective without a digital network infrastructure. The strength of internet technology acts as a core stimulus for development of the LCNC ecosystem in line with expansion of collaborative design practices. In particular, empowering students with non-coding background to enter democratisation domain of LCNC would offer diverse viewpoints across various disciplines, which will contribute to enhance design progress. Most importantly, it will untangle stereotypes perspectives about design education, as the LCNC ecosystem continues to grow in demand.

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