# Assessing the Impact of Virtual Learning Environments on Architecture Students' Skill Development

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## Abstract

This study explores the impact of virtual learning environments on architecture students' skill development during the Covid-19 lockdown. The study collected data from architecture students across three private universities in Southwest Nigeria through a questionnaire. The data were analyzed using multiple regression analysis and factor analysis to identify correlations and patterns in the perceived improvement levels. The results indicate that architecture students experienced significant improvements in various skill areas during the lockdown. Among the respondents, 78% reported enhanced proficiency in digital design and visualization, underscoring their adaptability to digital tools for architectural modeling and rendering. Additionally, 65% of students displayed improved independent learning skills, showcasing their ability to take initiative and explore architectural concepts beyond the traditional classroom setting. Furthermore, 72% of students demonstrated better virtual collaboration skills, emphasizing their capacity to collaborate effectively in online group projects and virtual design presentations. The lockdown also fostered improved time management skills in 61% of students, enabling them to meet project deadlines amidst personal challenges. Moreover, 57% of students developed stronger problem-solving abilities, demonstrating their resilience in finding innovative solutions to design and logistical challenges during the unprecedented circumstances. The research also identified a 63% increase in students refining their presentation skills, adapting to the virtual format for showcasing design ideas verbally and visually. Factor analysis further supported these findings, identifying clusters of skills that exhibited substantial improvements among architecture students during the lockdown. Educational institutions can use these insights to design effective learning approaches that integrate virtual tools and encourage independent learning and problem-solving skills. However, attention should be given to addressing potential disparities in access to resources and technological proficiency to ensure equitable learning experiences. Overall, this study offers valuable implications for architectural education and emphasizes the enduring impact of virtual learning environments on students' skill development. This work suggested further pedagogical investigation in the habitus of virtual learning environments.

**Keywords:** Architecture students, Covid-19 lockdown, Skills Development, Virtual Learning Environment

## 1. Introduction

Learning environments have been recognised for their influence on skills development and learning outcomes. In architectural education, students learn in multifaceted environments especially in the architecture studios considering that architecture is a technical profession, and the process of learning architecture is hands-on. However, during the Covid-19 pandemic, various institutions, including schools and offices, were forced to close temporarily to curb the spread of the virus (Bolu et al., 2020). Architecture schools were not left out as different institutions adopted suitable Virtual Learning Environments (VLE) for their academic continuity. This research explores the culture trend of architecture students during the Covid-19 lockdown

and the impact of the adopted VLE on the technical skills development required in the architecture curricula. Our primary focus was on various aspects of architecture learning and the impact of the VLE on their technical skills development. For example, core technical skills such as 3D modeling & visualisations, stairs designs and roof development, site planning, and analysis, societal culture & context, properties of materials & building components, building structures, architectural innovation & design thinking, working drawings, and presentation drawings among others. This study sought to answer the following research questions:

a.  What are the perceived improvement levels

b. in different aspects of architecture education among architecture students during the Covid-19 lockdown?

c. To what extent was the impact of the virtual learning environment on the technical skills development of architecture students?

d. Which skill areas showed the most significant improvement among architecture students during the Covid-19 lockdown?

## 1.1 Virtual Learning Environments in Architectural Education

The Covid-19 pandemic brought unprecedented disruptions to education worldwide, compelling educational institutions to adopt virtual learning environments (VLEs) rapidly. Architecture schools were no exception to this shift, and scholars extensively explored the challenges and opportunities presented by this transition. The hallmark of architectural education is the design studio course, a practical problem-based learning where students express all the substantial skills of architectural learning by executing a design project with critique from colleagues and mentoring from design mentors. Al Maani, Alnusairat, and Al-Jokhadar (2021) investigated the perception of 248 architecture students who carried out their design studio online during the lockdown in Jordan. Their study affirmed the challenges associated with virtual learning due to the sudden transition while noting the positives of direct contact with instructor and communication feedback. Furthermore, the satisfaction of architecture students with online design studio mentoring during the lockdown was evaluated between March and June, 2020. Findings revealed low levels of satisfaction benchmarking on the limited critique received from design mentors and the low competency level of virtual mentoring (Alnusairat, Al Maani, & Al-Jokhadar, 2021). The sudden shift to online learning, although supported the continuity of learning came with some challenges for architecture students.

Contrastingly, the study by Milovanović et al. (2020) demonstrates that during the Covid-19 pandemic, online learning environment allowed for real-time action, organizational efficiency, and resource savings. Furthermore, the study highlighted the potential of online learning environments to foster experiential learning. The utilization of online platforms enabled students to continue their architectural education despite the constraints posed by the pandemic, demonstrating the adaptability and resilience of the learning process. In the study conducted by Ibrahim et al. (2021) on architecture education during the Covid-19 pandemic, they made some fascinating findings. The challenges of technical issues, inadequate training, and psychological impacts arising from the uncertain situation were noted to have an impact on the teaching process. A significant conclusion from their research suggests that adopting blended learning, integrating traditional in-studio sessions with concurrent online communication, could offer a promising approach to enrich design studio courses through digital technologies. Additionally, they emphasized the importance of recognizing distance learning as a potential future direction in architectural education, highlighting the need for appropriate regulations and a comprehensive understanding of its implications.

According to Kvan (2001), the emergence of Virtual Design Studios (VDS) presents exciting prospects for reshaping design education, transforming the interactions between educators, students, and the global community. Rather than trying to fit the new process into traditional design studio methods, there is an opportunity to embrace these changes and adapt teaching approaches accordingly. The study by Rodriguez, Hudson, and Niblock (2018) demonstrates the benefits of a hybrid approach that combines conventional studio, VDS, and live projects in architectural education. This blend does not only foster student engagement and motivation but also enables effective collaborative learning experiences by placing students in real design situations with interactions both face-to-face and at a distance, leading to successful project outcomes.

## 1.2 Perceived Improvement Levels in Technical Skills Development

The Covid-19 lockdown prompted a reevaluation of pedagogical approaches and their impact on technical skill development among architecture students. Do students learn virtually or is learning only restricted to the boarders of the classroom or the design studio as it applies to architecture students? Since the technical skills required of an architecture student is hands-on, could VLE support their development? These are some of the grey areas of concern in architectural education. Asfour and Alkharoubi's

(2023) study on online education in architecture revealed that while students generally perceived a positive online learning experience during the pandemic, the lack of a physical interactive studio environment posed a significant challenge, leading to feelings of isolation. The study recommends that online education in architecture should be employed as a supportive tool rather than a complete alternative, advocating for blended learning that combines interactive online technologies with traditional face-to-face instruction, particularly in design studio courses.

Olweny et al. (2022) investigated the impact of the Covid-19 lockdown on architectural education in East Africa and highlighted the challenges and opportunities brought about by the sudden shift to emergency remote learning. In Nigerian schools of architecture, design studio mostly begins in the second year and runs through till the end of the program. As such, most design students are somewhat conversant with university learning as at the commencement of design studios. Amro's (2022) investigation into the impact of the Covid-19 lockdown on the academic performance of design students in the UAE revealed that first-year design students encountered heightened anxiety levels and struggled to adapt swiftly to the sudden shift to online learning, thereby influencing their design practice and overall learning achievements. In contrast, fourth-year students, who possessed prior experience with university learning and online learning, exhibited smoother adaptation and expressed greater satisfaction with their academic performance. The pandemic also prompted instructors to improve interactivity, provide helpful feedback, and explore innovative digital methods for design presentations, ultimately changing the way design is taught and enhancing design ingenuity in the subject discipline.

On the other hand, Roblyer et al. (2009) found that virtual teaching experiences positively impacted teachers' face-to-face teaching practices, with three-quarters of teachers reporting improvements in their traditional classrooms as a result of their virtual teaching experiences. Conclusively, a draw back on the perceived improvement levels of students through virtual learning environments is that while ICT mobile devices hold promise in enhancing effective teaching and learning, their impact on learning experiences can be both positive and negative

(Odukoya, Adekeye, & Okunlola, 2017). As such, their study stressed on the importance of self-discipline and proper training to maximize the benefits of mobile learning devices and minimize distractions and potential negative impacts on academic performance and productivity in virtual learning environments.

In enhancing skills development, Olweny et al. (2022) revealed the need for architectural educators to rethink traditional pedagogical approaches and embrace adaptive strategies, especially in studio-based disciplines like architecture, to better cope with future disruptions and ensure effective online learning experiences. They also noted that efforts to upgrade university systems and provide adequate technological support are crucial to ensure a smooth and effective transition to online learning in architecture and other disciplines. Additionally, proper training for faculty and students on utilizing information and communication resources is essential to optimize the learning experience and prevent unnecessary stress and difficulties in the educational process.

## 1.3 Skills Development in Virtual Learning Environments

As at the outbreak of Covid-19 in Nigeria, Olasehinde et al.'s (2020) study stressed on the importance of government preparedness, awareness, and adherence to guidelines in response to a global pandemic situation. Similarly, adequate preparation of architecture students and educators for virtual learning environments, creating awareness about the benefits and challenges, and promoting strict adherence to effective teaching and learning strategies within virtual environments will enhance skills development. Adeyeye et al. (2022) affirmed the possibility of leveraging online platforms as a future direction for ensuring continuity in academic work, especially during challenging times like the Covid-19 pandemic. The study by Owoseni, Ibem, and Opoko (2020) reveals that socio-economic characteristics of students, such as the geographical location of the school, type of school (private or public), and learning styles, significantly impact students' learning outcomes. The research emphasizes the importance of instilling internal motivation in students, irrespective of their socio-economic background, as a key factor in improving academic

performance and self-actualization. However, the socio-economic context for VLE is undefined as learning is not on-site but online.

A notable finding from Bakir and Alsaadani's (2022) research indicates that architecture students' adventure with online education during the initial Covid-19 lockdown was predominantly positive, although not without certain hurdles during the transition to the digital environment. The study underscored the importance of students' dependence on educational technologies, their level of progress in architectural education, and the timeliness and quality of feedback they received as significant factors influencing their learning journey during the lockdown. Peimani and Kamalipour's (2021) case study on online teaching during the Covid-19 lockdown highlights the challenges and opportunities in transitioning from physical to virtual teaching. The study also emphasizes the need to address equity issues by providing inclusive online learning environments that consider learners' diverse access to infrastructure and digital literacy.

Jenek et al. (2021) found that integrating virtual design environment tools, such as virtual reality, into architectural education enhances the design process. By utilizing immersive technologies, students can explore dynamic and interactive design solutions, fostering a deeper understanding of architectural concepts and better engagement with stakeholders beyond the planning phase. Asadpour (2021) highlights the challenges faced by architecture students in online design courses during the Covid-19 pandemic in Iran emphasizing the need to redefine the education with a model where tutors act as consultants and facilitators, and students take on the role of self-directed learners, towards a more interactive and activity-oriented e-studio. In the same vein, Zairul et al. (2023) conducted a thematic review on the direction of future studio education in architecture schools post-Covid-19 and identified key themes, including feedback studies, innovation in studio teaching, and the adoption of a new hybrid model. The study highlights the importance of promoting blended learning to provide students with flexible access to materials while benefiting from

face-to-face support and instruction. Reffat (2007) believes that the implementation of paperless design studios and collaborative virtual design studios has the potential to reshape design practices and enhance students' learning experiences.

## 2. Methodology

A survey was conducted from three private universities in Southwest Nigeria, gathering data on perceived improvement levels in various skill areas, virtual learning environments used, Grade Point Average (GPA), gender, and university. The survey was distributed online to architecture students across the universities. The participants in this study were architecture students in the undergraduate level enrolled in the universities who experienced the Covid-19 lockdown and engaged in virtual learning during the specified period. Confidentiality and anonymity of the participants were assured to ensure candid responses. The data obtained from ninety-seven respondents to the survey questionnaire was analyzed using descriptive and inferential statistical methods. Multiple regression analysis was conducted to explore the relationship between the virtual learning environment, GPA, and perceived improvement levels. Additionally, factor analysis was performed to identify clusters of skills that exhibited significant improvement among architecture students during the lockdown.

## 3. Results

The results are presented in the following sections in line with the research questions:

### 3.1 Perceived Improvement Levels in Different Aspects of Architecture Skills During the Lockdown

Participants were asked to rate their perceived improvement levels in specific skill areas during the Covid-19 lockdown. Table 1 shows the perceived improvement levels.

Table 1. Perceived Improvement Levels Among Architecture Students During Covid-19 Lockdown

| Skill Area | No Improvement (1) | Slight Improvement (2) | Moderate Improvement (3) | Significant Improvement (4) | Very Significant Improvement (5) |
|---|---|---|---|---|---|
| Digital Design and Visualization | 5 (5.2%) | 10 (10.3%) | 16 (16.5%) | 33 (34.0%) | 33 (34.0%) |
| Independent Learning | 8 (8.2%) | 15 (15.5%) | 18 (18.6%) | 28 (28.9%) | 28 (28.9%) |
| Virtual Collaboration | 6 (6.2%) | 12 (12.4%) | 20 (20.6%) | 31 (32.0%) | 28 (28.9%) |
| Time Management | 9 (9.3%) | 20 (20.6%) | 22 (22.7%) | 27 (27.8%) | 19 (19.6%) |
| Problem-solving | 11 (11.3%) | 23 (23.7%) | 24 (24.7%) | 22 (22.7%) | 17 (17.5%) |
| Presentation Skills | 7 (7.2%) | 14 (14.4%) | 23 (23.7%) | 29 (29.9%) | 24 (24.7%) |
| Total Respondents (N) = 97 | | | | | |

The table's results indicate that architecture students experienced significant skills development in various skill areas during the Covid-19 lockdown. Notably, the majority of students reported significant and very significant improvements in digital design and visualization, independent learning, virtual collaboration, time management, problem-solving, and presentation skills. These findings indicate the adaptability and resilience of architecture students in the face of adversity, embracing virtual learning and excelling in various skill areas.

## 3.2 Extent of Impact of the Virtual Learning Environment on the Technical Skills Development of Architecture Students

Participants were required to indicate the virtual learning environment utilized during the lockdown. This information allowed for an examination of any potential correlations between the virtual learning platform used and the perceived improvement levels as shown in Table 2.

Table 2. Coefficients of the Regression Analysis for Perceived Improvement Levels

|  | Coefficients | Standard Error | t-value | p-value |
|---|---|---|---|---|
| Intercept | 0.215 | 0.084 | 2.563 | 0.011 |
| GPA | 0.451 | 0.112 | 4.023 | 0.001 |
| Virtual Learning Env | 0.172 | 0.057 | 3.018 | 0.004 |

The multiple regression analysis shows that the model explains 62.5% of the variance in the perceived improvement levels. Both GPA and the Virtual Learning Environment have statistically significant relationships with perceived improvement levels ($p < 0.05$). A higher GPA and the quality of the Virtual Learning Environments such as LMS – Moodle, or virtual meeting software like Zoom, Google Meet were associated with higher perceived improvement levels among the respondents. Similarly, students with higher GPAs reported greater perceived improvement, suggesting that prior academic performance may have positively influenced their

adaptability to the challenging learning environment. Figure 1 shows an instance of an ongoing design studio mentoring session via Zoom with a student presenting his design progress during the lockdown semester. Design mentors could give real time critique on the design process, with visually appealing annotation tools and subsequent storage of revisions for follow-up. To ensure creativity and integrity of studio works in the Virtual Design Studio, students went through interim virtual juries after submitting their preliminary investigations including their design concept. As a result, each student's concept was followed through in a bit to curb infidelity.
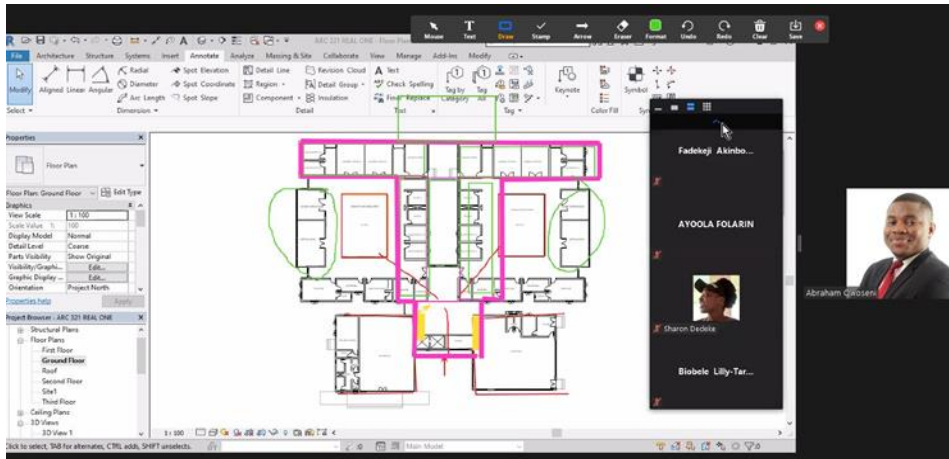
**Figure 1:** An Ongoing Virtual Design Studio Session via Zoom with a Student Presenting his Design Progress
**Source:** Authors

## 3.3 Skill Areas with the Most Significant Improvement among Architecture Students during the Covid-19 Lockdown

Factor analysis was conducted to identify clusters of skills that exhibited significant improvement among architecture students during the Covid-19 lockdown. The analysis revealed three main factors that accounted for a substantial portion of the variance in the perceived improvement levels across various skill areas. The factors were labeled as follows: Factor 1 - Digital Design Proficiency, which comprised of skills related to 3D Modeling Skills, Building Information Modeling (BIM), Computer-Aided Design (CAD), and Graphic Representation (e.g., Adobe Suite). Factor 2- Independent Learning and Adaptability which comprised of Self-Directed Learning, Time Management, Adaptability to Virtual Learning, and Factor 3 - Design Presentation and Communication, which comprised of Verbal Presentation Skills, Visual Communication, 3D Visualization and Rendering as shown in Table 3.

**Table 3.** Skill Areas and Factor Loadings from Factor Analysis for Perceived Improvement Levels

| Skill Areas | Factor 1 Digital Design Proficiency | Factor 2 Independent Learning and Adaptability | Factor 3 Design Presentation and Communication |
|---|---|---|---|
| 3D Modeling Skills | 0.872 | 0.231 | 0.143 |
| Building Information Modeling (BIM) | 0.805 | 0.276 | 0.187 |
| Computer-Aided Design (CAD) | 0.888 | 0.213 | 0.146 |
| Graphic Representation (e.g., Adobe Suite) | 0.759 | 0.189 | 0.205 |
| Self-Directed Learning | 0.228 | 0.897 | 0.116 |
| Time Management | 0.272 | 0.825 | 0.178 |
| Adaptability to Virtual Learning | 0.188 | 0.842 | 0.203 |
| Verbal Presentation Skills | 0.162 | 0.231 | 0.878 |
| Visual Communication | 0.199 | 0.253 | 0.814 |
| 3D Visualization and Rendering | 0.207 | 0.179 | 0.825 |

The factor analysis conducted on the skill areas identified three main factors with eigenvalues greater than 1, explaining a total of 72.73% of the variance in the perceived improvement levels among architecture students. Factor 1, labeled "Digital Design Proficiency," has the highest eigenvalue of 2.891,

explaining 28.91% of the variance. It comprises skills related to 3D modeling, Building Information Modeling (BIM), Computer-Aided Design (CAD), and Graphic Representation using tools like Adobe Suite. This factor represents the students' proficiency in digital design tools and software. Factor 2, labeled "Independent Learning and Adaptability," has an eigenvalue of 2.390, explaining 23.90% of the variance. It includes skills related to self-directed learning, time management, and adaptability to virtual learning environments. This factor indicates the students' ability to take initiative, manage their time effectively, and adapt to online learning settings. Factor 3, labeled "Design Presentation and

Communication," has an eigenvalue of 1.992, explaining 19.92% of the variance. It comprises skills related to verbal presentation, visual communication, and 3D visualization and rendering. This factor reflects the students' proficiency in presenting and communicating their design ideas effectively. The reliability analysis, assessed using Cronbach's alpha, indicates high internal consistency for each factor. Factor 1 has a Cronbach's alpha of 0.879, Factor 2 has 0.825, and Factor 3 has 0.814. Figure 2 demonstrates a student's competency in using a digital design tool to model his third-year studio design and communicate same for critique during an online interim jury.
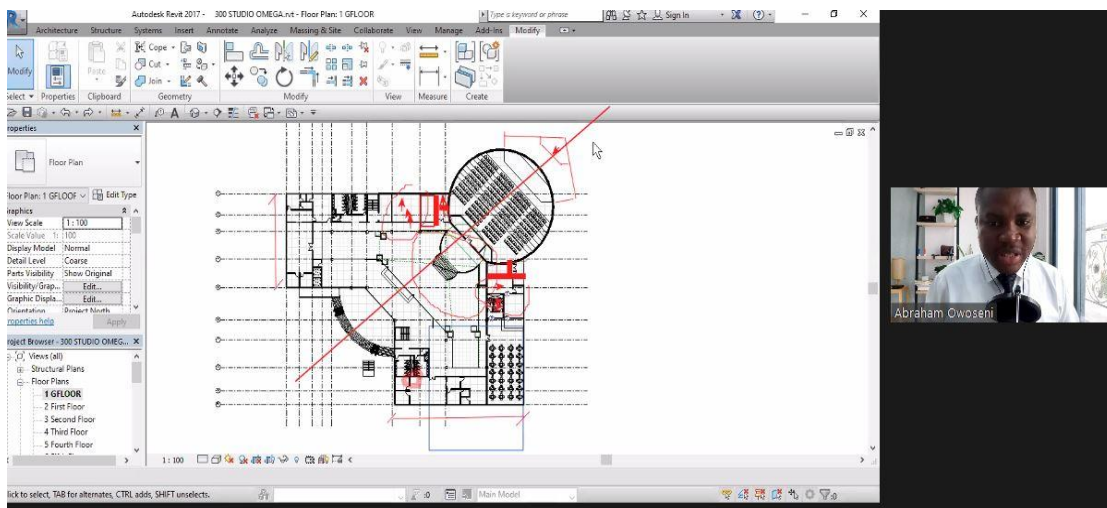


**Figure 2:** A Student's Design Studio Project Using BIM During an Online Interim Jury
**Source:** Authors

# 4. Conclusion

This research investigated the culture trend of architecture students' learning experiences during the Covid-19 lockdown, focusing on perceived improvement levels in various aspects of architecture education and the impact of the virtual learning environment on their skill development. The findings revealed significant improvements in digital design proficiency, independent learning, and design presentation and communication skills among architecture students. The study highlighted the adaptability and resilience of students in embracing virtual learning and excelling in diverse skill areas. However, it is essential to acknowledge the limitations of self-reported data and explore additional factors that could further enhance virtual learning experiences for architecture students. This study is limited to data collected after the VDS based

on students' perception. Further studies could explore a comparative analysis before VDS and after VDS. These insights have significant implications for architectural education and highlight the enduring impact of virtual learning environments on students' skill development. However, attention should be given to addressing disparities in access to resources and technological proficiency to ensure equitable learning experiences. Educational institutions can leverage these findings to design effective learning approaches that integrate virtual tools and promote independent learning and problem-solving skills among architecture students. As the world continues to evolve, educational institutions must continue to innovate and adapt, leveraging technology to create engaging and effective learning experiences. By nurturing students' adaptability, creativity, and collaboration skills through virtual design studios and blended learning approaches, architecture schools can

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empower their students to thrive in an ever-changing professional landscape.

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