

THE USE OF TECHNOLOGY TO FACILITATE TEACHING AND LEARNING IN STUDIO-BASED SPACES IN THE AFTERMATH OF COVID-19

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Abstract

Education technology has become increasingly important in South African higher education institutions. However, the efficacy of these technological innovations has not been unanimously acknowledged in the departments of Applied Design and Multimedia at CPUT. Lecturers and students have experienced difficulty in integrating education technology systems into all facets of studio-based learning. Aim: This study investigated the role of education technology tools in arts education and the extent, to which learning management systems (LMSs), such as Blackboard, are used in studio-based teaching and learning environments at CPUT. Methods: Owing to the exploratory nature of this study, the researcher adopted a qualitative approach in the form of a multiple case study as the study's research design. Data analysis was used to analyse the data that was obtained from the interviews and relevant supporting documents. Results: The findings revealed that several lecturers were reluctant to make extensive use of education technology systems due to their perceptions of the primacy of traditional face-to-face teaching methods. Implications: The findings may provide vital information for education technologists, policy makers, and curriculum and instructional designers looking to benefit from education technology in the current fourth industrial revolution. Recommendation: The study recommends extensive use of education technology tools in discipline-specific settings, such as studio-based spaces, and close collaboration between lecturers and instructional designers when developing education technology systems for studio-based courses. The study also concluded that the e-learning system, used at the time of the study, needed to be optimally designed to meet the needs of studio-based disciplines. It is highly likely, that failure to do so would preclude the possibility of successfully integrating future technological innovations into studio-based teaching and learning environments in the post-COVID-19 era and a debilitating failure to prepare students to work in technologically advanced environments would be an inevitable consequence.

Keywords: e-learning, learning management systems, studio-based learning, virtual design studio, visual communication design, multimedia.

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1. Introduction

The sudden outbreak of COVID-19 virus that is alleged to have originated from the province of Wuhan in China and its rapid spread across the globe prompted the World Health Organisation (WHO) to proclaim a global pandemic, which has necessitated a number of radical changes throughout the world [1]. Economic sectors throughout the world have been severely disrupted by government-enforced lockdowns, curfews, and travel restrictions. Responses in the higher education sector in South Africa have included a dramatic increase in the use of digital technology, in forms, such as Blackboard, Moodle, and Edmodo software and other information and communication technology (ICT) innovations, to create opportunities for teaching and learning in a bid to adapt to the radical changes that the pandemic necessitated. As it was predicted in the theoretical writings of [2] and has been subsequently confirmed in contemporary literature, such as the report that [3] published, this technology plays an integral role in higher education curricula, as it enables students and lecturers alike to develop new knowledge and skills, both individually and collaboratively. Conversely, the ability to make effective use of these technologies has been impeded at some institutions of higher learning in South Africa, often as a consequence of the unequal access to them among students and lecturers in different socioeconomic and demographic groups and also of the influence of factors, such as income, ethnicity, educational attainment, and gender. It is evident that the prevailing digital divide in the country is a direct consequence of an enduring unequal distribution of wealth and other economic resources in the country, although inequalities are no

longer predicated solely on race [4]. The unequal distribution of technological infrastructure and skills to make optimal use of digital technology results in some segments of the population having severely restricted access to the internet and lacking the financial resources to remain connected for extended periods of time [5].

These disparities remain endemic, despite the intention that the South African government articulated in the National Development Plan (NDP) (2012) to ensure that all institutions of higher learning in the country had equal access to and ability to use digital technology to facilitate teaching and learning. The outbreak of the global COVID-19 pandemic has further exacerbated the effects of the digital divide, as the introduction of new digital technology and other information and communication technology (ICT) innovations is reshaping the way, in which courses, such as visual communication design and multimedia foundations, are being taught and how they will be taught in the foreseeable future. To date visual communication design, multimedia design, and architectural design courses at the Cape Peninsula University of Technology (CPUT) in Cape Town, South Africa have been taught mainly through face-to-face interactions between lecturers and students, in traditional studio or classroom settings, such as lecture theatres or auditoriums. This teaching format entails a lecturer delivering a single lecture to a large group of students on one occasion. By contrast, the studio-based teaching and learning approach that is implemented at CPUT at present is based on the principle of learning by doing, which originates from practices that were introduced as a result of the influence of the Bauhaus movement in Germany, which lasted from 1919 to 1933 [6]. With the rapid pace of the development of ICTs and the dramatic changes that continue to occur in teaching and learning spaces as a consequence, traditional face-to-face teaching and learning in studio settings becomes increasingly likely to be augmented by innovations, such as e-learning, and techniques that further innovation makes possible.

The developments that have been described prompted an investigation of strategies for integrating technological innovations to increase the effectiveness of teaching and learning in studio-based spaces. This study is concerned specifically with e-learning strategies as a means of revitalising the role of traditional face-to-face teaching and learning [7]. Accordingly, one of the principal thrusts of this study is to demonstrate the need to equip graduates to function in structures and organisations in society that are constantly undergoing change. It is also intended to encourage university authorities, policymakers, and instructional designers to adopt a bottom-up approach and consult or ensure the participation of relevant members of faculties before decisions pertaining to the adoption of any e-learning technology are made.

1. 1. Origins and characteristics of the contemporaneous studio-based teaching and learning approach

The studio-based teaching and learning approach dates back to the industrial revolution and has its origins in the practices of the *École des Beaux-Arts* [School of Fine Arts] in Paris and the Bauhaus-Universität-Weimar in Germany [8]. The design studio undoubtedly remains at the centre of design disciplines, such as visual communication design, industrial design, and architectural design, in which the master-apprentice approach is followed in studio-based learning. As it is explained in [9, 10], this approach prioritises facilitating the development of “reflective practitioners”, who learn by doing, to prepare themselves for the industries, in which they desire to work after they graduate from university.

The academic orientation of the studio-based teaching and learning approach is informed to a very large extent by the “hidden curriculum” concept, by means of theoretical and design courses that are intended to develop and improve the design skills of students through real-life experiences. The experiences, habits, and behavioural patterns that are encouraged in studio-based spaces together comprise “studio culture” [11]. The studio culture or curriculum itself is based on the design studio model that [10] developed, which is predicated on “learning by doing” being fundamental to reflective learning practice. The term “reflective practice” was coined by [10], who defines it as a dialogue of thinking and doing, through which students improve their skills [9].

The theoretical foundations of the studio-based teaching and learning approach are rooted in the Sociocultural Learning Theory that Vygotsky (1934) propounded and the experiential learn-

ing model that Kolb (1984) developed. The intention of the latter is to promote active learning and collaboration to enable students to arrive at solutions to their problems, through either theoretical or practical means, in real-world contexts [12]. This approach enables students to develop their design solutions under the guidance of practitioners whose expertise is grounded in real-life experience in industry. It also entails presenting their designs to their peers for critical evaluation and appraisal in the form of design critiques, which are also known colloquially in the arts and other creative fields as “design crits” and are mediated by juries that comprise experts with experience in industry. Their purpose is to foster critical thinking and problem-solving skills among students in a collaborative manner, with contributions from peers, educators, and other experts in their chosen fields [13]. All crits have a single overarching purpose, namely, to assist students to refine their creative skills through constructive appraisals and criticism.

Although the members of the Faculty of Informatics and Design who lecture students who study Visual Communication Design and the staff of the Media Department continue to rely extensively on traditional face-to-face teaching methods and design procedures, newer types of curricula and instructional technology are being developed in an endeavour to redefine the landscape of education and practices in design in studio-based spaces. A conference paper that was presented by [14] a decade ago reveals significant advances in digital technologies and new applications of technology that are contributing to achieving “integrated inter-, multi-, or even trans-disciplinary design”. These advances in digital technologies are used to instil awareness of connectedness, collaboration, and cross-disciplinary communication at all stages of the development of designs [14].

It needs to be emphasised at this juncture, that the successful implementation of this approach at CPUT would require members of faculty who work in the field of Visual Communication Design, in the Media Department, and elsewhere to be encouraged to devise alternative strategies for integrating new technology into establishing workable relationships among different disciplines and specialisations. Consequently, it would be necessary for members of faculty to investigate and evaluate relevant developments in digital technology and pedagogical strategies for optimising the effectiveness of teaching and learning in relation to all aspects of design. The conference paper by [14] provides crucial insights into the need to incorporate future technological advances that increase the effectiveness of teaching and learning in studio-based spaces. The authors contend that “technology trends are influencing space in several important ways”. This assessment implies that as the nature of types of generic space in studio spaces are changing, it is necessary to adapt to the needs of future studio environments. Traditional categories of space are becoming less prescriptive as teaching and learning activities blend; physical space exerts less influence as curricula are increasingly shaped by changes in technology.

1. 2. Designing e-learning systems to facilitate teaching and learning in studio-based spaces

In keeping with general trends, there has been a significant increase in the use of e-learning systems and other technological innovations over the past decade, a trend that has gained considerable momentum in studio-based spaces since the outbreak of COVID-19 and provided integrated networked environments for students and lecturers to interact and collaborate with one another. Researchers, such as [15], cited by [16], have emphasised the potential of virtual e-learning systems for providing opportunities for easy access to information through sources, such as the internet. Blackboard software was introduced in visual communication and multimedia design departments at CPUT, for the principal purpose of facilitating blended learning (BL) in studio-based teaching and learning in the studio spaces that were being used at the time [16].

E-learning systems are being used at present to teach courses by means of blended learning at institutions, such as the Bartlett School of Architecture and Cardiff University in the United Kingdom. If learning management systems (LMSs) are correctly designed and used, they have infinite potential to transform traditional approaches to teaching and learning in studio spaces to create well-connected and networked environments that foster creativity [17]. Conversely, evolving new learning spaces and the technological means that are increasingly being used to facilitate learning contribute to the creation of virtual environments that can be used to increase the effectiveness of teaching in institutions, through their potential to bring students and lecturers from

several design disciplines together in the future [18, 19]. According to [20], virtual environments also have the potential to increase the capacity of students for learning through active engagement and collaboration in less formal interactions than are generally possible in traditional face-to-face lecturing [20, 21]. If the use of virtual technology were to be successfully incorporated into design curricula at CPUT, it would provide vital opportunities for reconsidering the priorities of teaching and learning activities in design studio spaces at present [19].

As [22] emphasises, virtual design studio spaces provide opportunities for students to practise their creative thinking skills by discussing their concepts and ideas with a broader spectrum of students and instructors from different cultural, educational, and even philosophical backgrounds. If they are adopted and implemented effectively, virtual design spaces (VDSs) provide an environment that fosters innovation through active collaboration [19]. Proponents of e-learning, such as [23], maintain that the adoption of blended learning increases the effectiveness of teaching and learning in studio-based courses, such as Visual Communication Design and Multimedia Technology, owing to an increased sense of belonging among students and lecturers. They also emphasise that blended learning facilitates fruitful interactions among students from a range of different backgrounds and can provide a media-rich, collaborative, personalised, and interactive learning environment.

Despite all of the potential benefits of e-learning systems that have been cited, there has been considerable resistance among lecturers in the discipline of Visual Communication Design at CPUT to making extensive use of e-learning systems, such as Blackboard. One of the concerns that has been voiced stems from a common doubt that Blackboard and other learning management systems that have become available on the educational technology market could be equally effective as traditional face-to-face teaching and learning [24]. In some instances, these negative perceptions can best be explained by the influence of factors, such as limitations in national and institutional policies and management practices [25]. In others, they are not only influenced by a lack of technological knowledge or poor infrastructure, but also by the greater priority that members of the teaching staffs of faculties tend to assign to their roles in their institutions. Consequently, they often base their assessments of potential pedagogical applications of new technology and their decisions to integrate them into their teaching practices on their perceptions that doing so would add educational value [26], in [27].

Resistance by members of faculty to redesigning and redeveloping curricula that entail the integration of technology can partly be explained by their established perceptions, beliefs, and opinions concerning teaching and learning. Consequently, [28] suggests the creation of safe systems for challenging existing assumptions pertaining to curricula, by affording lecturers insights into how the effectiveness of teaching and learning could be improved. In addition, it is the responsibility of institutional cultures that acknowledge, recognise, and legitimise the need for technological innovations and innovative practices to be sufficiently flexible to move away from established teaching practices when others that accommodate new skills that lecturers and students have acquired and other significant changes become practicable [29]. It also becomes imperative, that interdisciplinary teams whose members have practices in common should be formed to foster creativity and innovation in the development of appropriate curricula. In the light of the status of e-learning innovations at CPUT at present and the need to design and establish future spaces for studio-based teaching and learning, this research study was undertaken to answer the following main research questions:

- How do traditional studio-based practices and the incorporation of e-learning technological innovations promote or hinder the teaching and learning of design at CPUT at present?
- What could be done to redesign and develop the present traditional studio-based curriculum to remain abreast of technological advances in studio-based spaces in the future?

The following section is devoted to a discussion of the research methodology that was employed to conduct the study. The principal data was obtained from the narrative accounts of lecturers, to discern their attitudes, beliefs, and perceptions concerning the use of e-learning systems, such as Blackboard, in studio-based spaces and their subjective appraisals of the nature and functions of teaching and learning innovations [29].

Aim of research was to understand the seemingly paradoxical inconsistency in the (non-) application of e-learning solutions, such as learning management systems (LMSs), in studio-based teaching and learning. Whether current LMSs are adding value to studio-based practices or not, and what type of value might be at issue, remain unclear. As a result, further steps in LMS implementation could be poorly informed, with a likelihood of following the wrong path.

2. Materials and Methods

The researcher elected to use a qualitative research approach and its methods. Doing so enables researchers to obtain detailed narrative insights from collecting and analysing qualitative data to increase the breadth and depth of the understanding, which emerges from the phenomenon being studied [12]. Among other benefits of the qualitative method, research is deeper and enables deeper understanding of experiences, phenomenon and context [30]. This helps researchers to ask questions that cannot easily be quantified into numbers to understand human experience [31, 32]. Since there was limited relevant literature of the study's context, the researcher adopted a case study method since it investigates a contemporary real-life phenomenon through a comprehensive contextual evaluation of a small number of conditions and events and their relationships [33]. The case study approach was considered to be appropriate owing to the exploratory nature of the study [33].

2.1. Techniques and procedures

The participants of this study consisted of students and lecturers at a university of technology in the Western Cape province. These participants were drawn from the faculty of Informatics and Design of that institution. Majority of the sample was drawn from the Visual Communication Design and the Multimedia department of the institution's Faculty of Informatics and Design. The study targeted registered undergraduate students and lecturers from first to third year. These groups were of interest to the study because of their demographic composition and educational experience with design and IT fields. The second year students would have completed more than four terms and the transition of face-to-face studio systems during Covid 19 to online studio system would be fresh in their memory, while third years will have had a better chance to reflect on the changes that emerged in the traditional studio during Covid-19 over the course of nearly two years.

2.2. Research setting and participants

The participants in this study were employed by CPUT in three different departments of the Faculty of Informatics and Design at the time of the study from August 2022 to May 2023. The research sample comprised lecturers who had been selected by means of convenient sampling, on the basis of their familiarity with the research topic and the frequency, with which they made use of e-learning systems. The document analysis component of the study included relevant records and 12 of 15 Blackboard training, planning, and course forms. Analysing these documents provided an appropriate basis for evaluating and interpreting the qualitative data that was generated from ZOOM online interviews that were conducted with fifteen lecturers who agreed to participate in the study. Due to the nature of this study, some participants end up revealing sensitive information when reflecting on their studio experiences during Covid-19, which they wish not to be directly attributed to them. In response to this, confidentiality was maintained by using pseudonyms to represent the research participants (students and lecturers) and all collected and analysed data was kept strictly confidential in line with the UCT data management plan.

The participants for this study were also informed about the nature and purpose of the study, and the fact that participation was voluntary. Therefore, an information sheet and a consent form were designed to provide participants with needed information. This allowed the participants (students and lecturers) to understand and provide consent to partake in the study. Invasive methods in terms of privacy, anonymity or confidentiality, referring to keeping information, which is not intended for others, secret were maintained.

Participants were informed that they can withdraw from the study at any time and refuse to answer any questions they will not feel comfortable with, and that confidentiality and anonymity will be maintained in the publication report and any additional publications that might arise from the study. It was the researcher's aim to handle the participants of the study and data gathered with dignity, value and courtesy in line with the UCT data management plan. The participants were not exposed to unnecessary physical or psychological harm and were also not subjected to unusual stress, embarrassment, or loss of self-esteem. The composition of the research sample is summarised in **Table 1**.

Table 1

Composition of the research sample: Distribution of departments and subject disciplines of the interviewees

Institution*	Faculty**	Participant***	Number of lecturers interviewed	Subject /discipline
CPUT	Informatics and Design - FID	AM-L ₁ ; LD-L ₂ ; PM-L ₃ ; LP-L ₄ ; BL-L ₅ ; EP-L ₆	6	Visual Communication Design, ECP
	Informatics and Design - FID	JM- L ₁ ; JS-L ₂ ; TH- L ₃ ; CH- L ₄	4	Multimedia Foundations Design
	Informatics and Design - FID	JM- L ₁ ; MK-L ₂ ; MB- L ₃	3****	Architecture

Note: *Cape Peninsula University of Technology (CPUT); ** Faculty of Informatics and Design (FID), Visual Communication Design (VCD), Architecture (ARC) Multimedia Design (MUD); ***Abbreviations of names of participants. Full names have been withheld to ensure confidentiality, in accordance with relevant ethical standards; **** A smaller than the desired sample size, owing to limited time and access to staff

2. 3. Data collection and research instruments

The qualitative study for this study was conducted through focus groups with students and interviews with lecturers and instructional designers. To gather rich data for the qualitative study, the researcher conducted one-on-one interviews with key participants to gain an understanding of why there was a low uptake of learning management systems in studio-based spaces. Data from the focus groups discussion, facilitated by the researcher, also helped to understand the seemingly paradoxical inconsistency in the (non-) application of e-learning solutions, such as learning management systems (LMSs), in studio-based teaching and learning. The discussion also helped the researcher to understand whether current LMSs are adding value to studio-based practices or not, and what type of value might be at issue, remain unclear. The interviews had durations of forty-minutes to sixty-minutes, while focus group discussions lasted for thirty-five to an hour and half.

Data obtained from the online interviews

The data consisted of the responses of the lecturers who were interviewed to questions pertaining to the contexts, in which they used learning management systems, such as Blackboard, at the time of the conducting of the study, and the benefits that they believed could be derived from doing so. The lecturers were also asked during the online interviews to provide information pertaining to the factors that they believed affected teaching and learning adversely in the studio spaces, in which they worked. In addition, they were asked questions concerning the specific purposes, for which they felt that e-learning programmes, such as Blackboard, were most suitable, such as providing the means to support teaching and learning projects through access to the internet, communication, assessment, interactive engagement with students, and the management of courses. Other questions were framed to discern their perceptions and opinions concerning the value of using the technology to facilitate teaching and learning in design studios and the difficulties and disadvantages that doing so could entail. In addition, open-ended questions were used to gather data concerning the changes and adjustments to their curricula with respect to both design and delivery that have been necessitated by

the introduction of Blackboard in their courses and modules, the purposes that are articulated in the Blackboard planning and course request forms that were served through the integration of Blackboard, and the respects, in which the integration of Blackboard failed to facilitate the fulfilling of them.

3. Results

3.1. E-learning and its influence on teaching and learning in studio spaces at present

The analysis of the documents and the data that the interviews generated revealed that at the time of the conducting of the study, e-learning systems, such as Blackboard, and other appropriate digital technology had not been sufficiently effectively integrated into existing practices to facilitate teaching and learning or strategies that were to be implemented in the aftermath of the COVID-19 pandemic. Some of the lecturers maintained that the technology did not meet their requirements for effective studio-based learning and its use was not compatible with their teaching styles. They contended that Blackboard software and other types of digital technology that were being introduced to facilitate teaching and learning were merely substitutes for conventional teaching and learning practices in studio environments. As some of the lecturers revealed that they used the technology mainly to make materials available online for students to consult in their own time, it was evident that their use of it did not entail significant departures from existing conventional teaching practices. The analysis of the responses of the interviewees is summarised in **Table 2**.

Table 2

Summary of the effectiveness of e-learning and other types of digital technology in studio-based spaces at CPUT at the time of the conducting of the study

Department	<i>To what extent does e-learning and other digital technology promote or hinder the teaching and learning of design at CPUT at present?</i>				Explanation	Total
	Strong influence	Little influence	No influence	Not sure		
Visual Communication Design [VCD]	3	2	1	0	Explanations of why Blackboard was not used to teach some subjects emphasised the perceptions of lecturers that it did not facilitate teaching courses, such as visual communication (GD_B1-S2).	6
Architecture [AR]	3	0	0	0	Explanations of why Blackboard was not used to teach some subjects emphasised a lack of time to integrate it into the teaching methods of lecturers, which effectively marginalised its use (AR_C2-S2).	3
Multimedia Design [MD]	3	1	0	1	Explanations of why Blackboard was not used to teach some subjects centred on the perceptions of lecturers that it was suitable only for theoretical subjects, such as the history and theory of design, and not for studio-based courses (AR_C1-F4).	4
	5(50 %)	1(10 %)	3 (0 %)	1(10 %)		10 (100 %)

Several excerpts of interviews served to confirm that the role of e-learning technology tended to be confined to facilitating making material pertaining to the courses of students available and posting bulletins, as opposed to introducing significant changes to existing teaching and learning practices. As one lecturer explained:

“It makes it easy for students to have access to course content” (VCD - lecturer 1), in that students had access to their course materials at all times and no longer needed to be in specific learning environments to do so. This finding suggests that lecturers were merely using Blackboard as a means of augmenting their teaching practices in studio settings. The excerpts:

“I ensure that students receive the learning material and information that they need” and “Students are able to download notes and slides from Blackboard” (AR – lecturer 1) confirm that they perceived that Blackboard provided an effective means of ensuring that their students had access to learning materials, which could possibly preclude the need for students to visit their offices in person to request the materials.

It was also evident from the data, that the interviews generated that Blackboard was used primarily to make announcements and inform students of the dates for assessments. In the words of two of the lecturers in Visual Communication Design:

“...They will also be able to read any announcements I place on Blackboard for their attention” (VCD – lecturer 2) and *“They will also see the due dates for formative and summative assessment of their portfolios” (VCD – lecturer 3).*

These excerpts exemplify a common perception among the interviewees that Blackboard represented a means of disseminating information online to replace previous practices that had entailed handing out printed material. A lecturer in the discipline of architecture maintained that:

“...They will be able to engage interactively with the learning content through Blackboard” (AR – lecturer 2).

This statement implies that having access to the materials increases the ability of students to interact with their content. Another lecturer from the same department made a similar assessment with *“...It will give them an opportunity to have access to more design materials and improve the level of communication” (AR – lecturer 3)*, which also implies that the use of Blackboard software would not only increase access to the materials, but also increase the ability of students to become conversant with their content. By contrast, it needs to be emphasised, that although making reading materials readily accessible to students online could encourage them to absorb its content as a consequence of their general preference for online activities, increasing the amount of material that is made available online would not necessarily increase the ability of students to communicate and apply what they have absorbed in studio settings.

3. 2. Strategies to integrate present and future technology to increase the effectiveness of studio-based teaching and learning

Although a few of the lecturers were in favour of using Blackboard as a content repository, several maintained that in its present form it could not be used as a means of facilitating teaching and learning in studio-based disciplines. As a lecturer from the department of Visual Communication Design explained,

“...I use Blackboard only to present information”, but “not to teach” (VCD – lecturer 4). This excerpt illustrates the perception that although Blackboard provides a convenient means of disseminating announcements and course materials to students,

“...it has little or no potential for facilitating teaching and learning in studio settings” (VCD – lecturer 5).

The following excerpt reflects the ambivalence of a senior lecturer in Visual Communication Design: *“...In terms of teaching, I have mixed views on it; in terms of administration, it can definitely be a time saver” (VCD – lecturer 6).*

Another lecturer was even more emphatic:

“...I do not use it for anything else, except just to upload notes for students... It does not affect how I teach” (MD – lecturer 1).

The excerpts: *“...it does help to make some tasks easier” (MD – lecturer 2)*, *“it cannot be claimed that teaching is improved just because the slides are now on Blackboard” (MD – lecturer 3)*, and *“...the teaching rests with the lecturer” (AR – lecturer 3)* together express the shared perception that the quality of teaching is ultimately determined by the experience and ability of individual lecturers, rather than the integration of digital technology. Conversely, it is equally plausible to contend by drawing on connectivism learning theory, that teaching and learning that includes the

formation of online groups has infinite potential for facilitating forms of learning, such as guided and collaborative learning.

4. Discussion

The findings of the research revealed that Blackboard software was not being used extensively in traditional studio-based teaching and learning environments in the Faculty of Informatics and Design at CPUT at the time of the conducting of the study (cf. [32] and [25]). Among the chief contributory factors that were found to have discouraged the comprehensive integration of the present e-learning system at CPUT were poorly designed infrastructure and a lack of technical support from the senior management of the university. These factors have also been identified in previous studies by researchers, such as [34], who emphasises the necessity of providing robust infrastructure and advanced technical support to both members of faculty and students. Accordingly, it is imperative to design and develop innovative technology to permit synchronous communication and visualisation, specifically for studio-based teaching and learning environments [35–37].

Although [25] emphasises that the effective implementation of online teaching courses in studio-based environments requires the formulation and implementation of clearly articulated policies and strategies, it was evident from the findings of this study, that their implementation was lacking in these respects in the Faculty of Informatics and Design at CPUT. Many members of the faculty had not yet used the e-learning system and lacked knowledge and experience in the use of online educational software and resources, such as Blackboard (cf. [38]). Consequently, it is necessary that lecturers should be trained not only to use e-learning applications to teach theoretical courses, but also to integrate them into their teaching practices in traditional design studio environments. Although the findings of some previous research studies have identified positive attitudes among members of university teaching staffs concerning the use of e-learning systems [36, 39], some lecturers expressed concern about the ability of e-learning systems to meet the specific requirements of studio-based disciplines [40]. The findings that emerged from the data that the interviews and the document analysis generated revealed that while some of the interviewees were not in favour of teaching design and studio-based courses using the e-learning applications that were in use at CPUT at the time of the conducting of the study, others believed that it could be beneficial to use them to teach theoretical courses.

Conversely, some of the interviewees maintained that they did not believe that using them to teach studio-based practical courses entailed any real educational value and several expressed the conviction that online courses that were taught by means of Blackboard would not be as effective as those that were taught by means of traditional face-to-face instruction. Consequently, they recommended that the two methods of instruction should be blended, to optimise the benefits of both and enable students to have access to additional assistance and support from sources, such as the internet. Some researchers have also concluded that blended courses could enable the limitations that might be inherent in relying solely on teaching by means of e-learning systems to be overcome [40]. It should also be emphasised, that the dominant approaches to teaching in particular faculties are likely to exert a significant, if not decisive, influence on the extents, to which e-learning systems are integrated into their existing teaching practices [41]. From this perspective, it becomes crucial to determine how existing approaches to teaching might optimally be integrated into online educational practices. Although several researchers have acknowledged the usefulness of blended courses [42], it would be necessary to carry out a pilot experiment to assess the potential of blending traditional face-to-face teaching practices and online learning to increase the effectiveness of teaching and learning in studio-based settings in design disciplines at CPUT, before formulating and implementing appropriate strategies.

The findings of previous research studies that were consulted in the literature review also identified some technical limitations of virtual design studios in respects, such as the cooperative manipulation of virtual objects [36, 43]. Problems have also been encountered in integrating ar-

chitectural software, such as 3D modelling, virtual environment, and simulation software, into online learning systems. These findings serve to underscore the need to identify and eliminate potential technical problems during the course of developing strategies to integrate technological innovations into existing teaching and learning practices in design disciplines in studio-based environments.

The antipathy towards teaching design courses online that could be detected in the responses of some of the interviewees could be traced to their perceptions of a number of considerations, such as concerns pertaining to shortcomings of the ICT infrastructure at the time of the conducting of the study and a lack of technical knowledge among the teaching staff, particularly with respect to planning and running virtual design courses online. By contrast, the conclusions that were drawn from the findings of previous research studies that were consulted suggested that virtual design studios could provide real benefits to students and lecturers, as they have great potential for exceeding the limitations of traditional physical design studios. The conclusions also suggested that teaching by means of virtual design studios could be successfully blended with traditional approaches to teaching in design studios, thereby improving and transforming present studio-based teaching and learning environments [8, 20, 22]. Accordingly, it would be potentially beneficial to demonstrate the benefits of the concept of the virtual design studio and revised approaches to teaching and learning to the members of staff of design departments at the university. Reaching a constructive consensus would make it possible to discuss the development of virtual design courses to determine how they could be optimally integrated into traditional design studio settings and curricula [39] and also to take effective steps to overcome present limitations with respect to considerations, such as technical problems, policy, and inadequate knowledge and skills. To improve the rate of adoption and accelerate the usage of e-learning tools in studio-based practices, this study makes several recommendations. These recommendations focus on raising awareness among various stakeholders, such as senior university management staff, e-learning coordinators, lecturers and instructional designers, on the need to adopt good practices to implement e-learning tools in studio-based practices. The recommendations emphasise the necessity of providing a technologically functional environment: one in which there is reliable Internet connectivity and a well-trained service desk that is always available to provide technical support. The recommendations also propose key strategies to improve the status of e-learning tools in studio-based practices. These strategies are informed by the relevant findings, which point to the factors that cause confusion or a lack of clarity in perceptions of the usefulness of LMSs in studio-based practices. To achieve the above goals, new online studios or virtual studios should be guided by the key following principles:

Effective system management

One of the key challenges to the use of LMSs and e-learning tools inside the studio is that of poor system management. This factor was found to be a major hindrance to effective engagement with the system, and the main reason why some abandon it completely. The effective management of the enabling processes of e-learning is central to the transformation of goals and activities into outcomes. The problem of the limited use of LMSs in studio-based practices was also linked to managerial issues in the e-learning department, which is made up of two separate units called Fundani and the CTS help desk. It was found that the main reason for poor system management was the limited interaction between the main parties and a lack of collaboration in solving the problems that arise on a daily or weekly basis. This study therefore recommends that the university revisit its e-learning implementation policy and strategies to foster closer cooperation among the stakeholders, involved in e-learning. Relationships between inter-dependent units, such as e-learning and IT network structures, should also be consolidated. On the basis of this study, it is also recommended that those wishing to develop and implement e-learning technologies for studio-based practices should bear in mind the structure of social interactions that characterise studio-based practices

Effective infrastructure management: environmental and technical factors

Infrastructural failures, system malfunctions and poor technical support are major causes of the slow adoption of e-learning tools and other web-based technologies in studio-based teaching and learning at CPUT. This study submits that the regular servicing and constant maintenance of existing infrastructure are activities that must be prioritised. Whilst the institutional adoption of systems is important, using faulty networks and inaccessible or poorly maintained computer facilities creates a negative impression. University authorities, technology infrastructure and network administrators, as well as academic developers and e-learning units, all need to collaborate in the planning and implementation of effective e-learning systems.

Good system design: courseware and interface design

Poor system design and a user interface that is difficult to navigate are some of the factors leading to a low rate of adoption of e-learning tools and other web-based technologies inside studio-based practices. Most participants in the study complained about how difficult it was for them to use the current e-learning system due to its poor interface design, with too many nested tabs not easy to navigate. Emphasis should always be placed on ease of use (EOU). This study therefore recommends a good system design with a minimalist approach. A minimalist approach will ensure that the system is easily navigable:

- system features and usage procedures must always be easy to understand and use.
- the relevance of features to the tasks to be performed, the use of non-sophisticated terms, and minimising the number of steps, required to complete a single task, all play a significant role in this respect.

Simple navigation opens up participation opportunities to a broad range of people. Understanding student perceptions of online platforms is important in the process of their design. As contemporary studio-based teaching and learning spaces are evolving towards fully networked and knowledge-based spaces, the views on learning, on what needs to be learned and on how to learn need to evolve as well to meet the requirements for transforming studio-based teaching and learning practices into a fully online-networked environment. Emphasis should be placed on ease of use (EOU), so that system features and usage processes are always simple to understand for users. The minimalist approach to designing course content does not only promote flexible on-line learning environments, it also helps to deliver quality of content, learning resources and discussion.

Limitation and scope for future studies. As the study focused on learning management systems and role of education technology in studio-based spaces, the researcher placed great emphasis on technology implementation and usage patterns, as they are widely acknowledged to be among key drivers of education technology in higher education. A more comprehensive research may have involved an examination of students and lecturers' digital literacy skills levels. The study could have also investigated how we can transform current studio pedagogy to online studios to strengthen undergraduate student's acquisition of 4C's of 21-st century learning: critical thinking, creativity, collaboration and communication to meet the requirements of the current digital age.

Another concern is the multidisciplinary nature of the study. While the study may have taken a multidisciplinary approach, it is currently limited to the fields of design and information and technology. The study only focused on the fields of design and IT because of the rise in demand to train more knowledgeable graduate in the area of critical skills (skills considered as scarce and rare in South Africa). Future studies could focus on the merits of studio pedagogy to transform other disciplines outside of design and information technology. Since studio-based pedagogy focuses on learning by doing and producing different kinds of artefacts. In the current knowledge economy with the rise of ChatGP and artificial intelligence, we see the rise in the need to produce different kind of artefacts be it text, programming code, sound or images. Students must be trained to develop their digital literacy skills; studio-based pedagogy might help to develop their digital literacy skills and prepare for their career in design and information technology industry.

5. Conclusion

While digital technology and education technology have made considerable strides in the past years, the expected development in studio-based spaces has not been fully realized as of yet. On the basis of the findings of this study, it could be concluded that lecturers need to be provided with appropriate educational technology support to enable them to develop their knowledge and skills to attain advanced levels in the use of e-learning and digital technologies. This conclusion implicitly acknowledges the need for a radical overhaul of the training that is intended to equip members of the teaching staff at CPUT and other institutions that offer studio-based design courses to integrate e-learning into their instruction at present. Consequently, it is essential that curriculum developers, instructional designers and academic development practitioners should prioritise encouraging lecturers to align their teaching methods and the tasks that they set for students with the potential of innovative educational technology to equip students to pursue careers in a manner that enables them to make optimal use of the technology that is constantly being integrated into contemporary design practices. The formation of multidisciplinary collaborative teams that include education technologists, curriculum designers, instructional designers, students, and education developers would facilitate the emergence of teaching and learning practices that are informed by the curricular objectives of engaging students in active collaborative, meaningful, and transformational learning.

Present studio environments also need to be redesigned to create active learning spaces that stimulate and foster the creative ability of students. As the spaces should not be merely arbitrary empty spaces or open spaces, they should be supported by appropriate technological infrastructure that facilitates learning activities and meets the fundamental needs of students. Accordingly, a design studio and its adjacent space should be designed to be functional in a manner that enables the capacity of generic space to facilitate change to be exploited effectively. As modern societies are making increasing use of knowledge-based systems in a wide range of different disciplines, conceptions of learning, how to learn, and the types of knowledge that need to be acquired need to evolve in a corresponding manner, to meet the requirements of integrating innovative technology successfully in an equally wide range of different disciplines, which necessitates the transformation of studio-based teaching and, in-turn, significant and constantly evolving changes in learning environments.

A final conclusion from the findings of this study was the need to discover and create new opportunities for increasing the ease of access to information and disseminating course content in future studio teaching and learning environments. The findings also enabled ways of improving the e-learning technology that was being used at the time of the conducting of the study to be identified, to ensure that it meets the requirements of the technologically enabled teaching and learning studio environments of the future. It is to be hoped that these alternatives could help to redefine and improve the present traditional studio-based spaces to anticipate the requirements of design disciplines as the 21st century unfolds. In addition, the findings of this research study could prove to provide a viable means of mapping an effective course for making a critical reappraisal of existing e-learning technology and supplanting it with transformative technology that can be used in all the design disciplines that are taught in studio-based spaces.

Conflict of interest

The author declares that there is no conflict of interest in relation to this paper, as well as the published research results, including the financial aspects of conducting the research, obtaining and using its results, as well as any non-financial personal relationships.

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Data availability

Data will be made available on reasonable request.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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