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Reassessing technology-enhanced learning: Striking a balance between technological integration and pedagogical effectiveness

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ABSTRACT

Although the belief that technology has revolutionized learning is widely accepted, a handful of researchers continue to argue that this belief is based on claims rather than empirical evidence. Guided by this argument, we chose to reexamine the state of online education at Papua New Guinea University of Technology (PNGUoT), with a particular focus on establishing whether faculties are equipped to effectively apply technology to guide learning beyond lower-order to higher-order levels of knowledge creation and problem solving. Using interactive inquiry and observational techniques as the main forms of data collection, three major findings emerged: (1) technology and learning are critical aspects of education, but technology should be seen as an enabler not as a substitute or subset of learning; (2) online education demands new pedagogies and epistemologies that go beyond traditional teaching approaches; and (3) technology will continue to transform teaching and learning processes, our willingness to embrace it notwithstanding. The study concludes that a focus on technology rather than learning is a false dichotomy, while limited expertise to critically evaluate how learning can progress effectively with technology being used as an enabler remains an early implementation hurdle.

Contribution/Originality: While technology is a revolutionary force, the ability of teachers to inspire learners to reach their full potential while using technology as an enabler remains a subject of debate. This inquiry proposes a context-specific e-pedagogy for PNGUoT and other similar contexts for adoption to enhance learner engagement and creativity as a way forward.

1. INTRODUCTION

In recent years, a technological revolution in the field of education has been remarkable. A radical shift in the way knowledge is produced, acquired, and shared has become evident, largely due to significant investments in instructional technologies. Technology and learning have become so interconnected that understanding current educational processes requires considering both. While some argue that this connection is asymmetrical, substantial scholarly evidence suggests it is reciprocal and warrants attention from educators. Nevertheless, the predictive impact of technology on learning remains debated; at one extreme, some scholars are not convinced that *'technology'* will deliver the pedagogical benefits often claimed (Barrow, Markman, & Rouse, 2009; Jhurree, 2005; Peat & Franklin, 2003). At the other extreme, scholars such as Bawden (2008); Allen and Seaman (2013); Adair et al. (2014) and Carroll-Miranda (2011) claim that technology will change the educational landscape forever in ways that will engender a dramatic increase in learners' academic performance..

In between the two extremes, there lies a balanced approach; proponents of this school of thought claim that, although technology may be considered a "*magic wand*" in stimulating students' interest in learning, it should not be forgotten that learning has long been effective with little or no digital learning technologies (Apkan, 2002; Bork, 2003; Thompson, 2003). Therefore, placing much attention on technology as seems to be the case today, may in itself defeat the main intention technology is set out to address. This suggests that while technology is proven to be effective in today's learning processes, it is not the only predictor variable in the causal chain. There is a need to apply it judiciously, authentically, and in accordance with students' learning needs and real-world contexts, with a focus on answering questions such as: what is our learning context? What kind of technology best suits our learning context? What unique features in our technological space best align with the desired learning attributes? And what implications do our technology-enabled instructions have on higher education (HE) as a whole? If these concerns are given priority, then the journey to attaining a balanced, technology-enhanced learning model becomes much smoother.

Although in the recent past, a sizable body of research has been produced to address some of these concerns (APEC, 2019; Grifoll et al., 2010; Sinclair, Kable, & Levett-Jones, 2015), the question whether the focus should be on *technology or learning* has not received the much-needed attention, for it rightly deserves. A few reports such as UNICEF (United Nations Children's Fund) (2000) and APEC (2019) have addressed this question from a quality point of view. They independently, though consistently, mentioned that the focus should not be limited to the interplay between technology and learning, but rather on how the said interaction produces a holistic mind with desired knowledge, skills, values, and attitudes. This, therefore, implies that the question of whether the focus should be on *"technology" or learning* is *essentially a utility satisfaction principle* in which one's pursuit of satisfaction depends on meeting expectations within the desired quality scope. Therefore, utility satisfaction, which in the teaching and learning context is a byproduct of epistemological and pedagogical synergies, was used in this study as a suitable yardstick to evaluate and establish whether technologies can sufficiently aid online educators in achieving desired learning outcomes. While studies from Australia and New Zealand show a somewhat clear response to this question (APEC, 2017; OECD, 2020a, 2020b; Oliver, 2001; Poftak, 2001; Rossiter & Watters, 2000) there is almost no substantial evidence from the largest portion of Oceania to substantiate it, for a majority of researchers seem to address e-learning from a generic view point, with much inclination to adoption, access, usability, and resourcing (Nuru, Fred, Oyekola, & Ngene, 2021; UNICEF, 2021). Correspondingly, a web search shows that fewer than 15 peer-reviewed papers on e-learning were published in Papua New Guinea (PNG) between 2020 and 2023, and none of them focus on examining the question under investigation in this study or address quality-related issues in e-learning. The explanation for this may be that e-learning is a relatively new development in PNG, and while the speed of adoption has been relatively high since the eruption of COVID-19, the e-learning scholarship space is still filled with gaps. Therefore, this novel inquiry aims to serve as a bridge that fosters a connection between research and practice, and vice versa, with a particular focus on the PNGUoT e-learning environment.

2. RESEARCH QUESTION

The researchers wondered whether the instructional challenges encountered in e-learning today are not a result of failing to delineate technology from learning and whether the assumption of extending traditional pedagogies into e-learning can really work.

3. LITERATURE REVIEW

Although the contribution of technology to instructional processes may not be overemphasized, the conventional mindset that underscores universities as mere *"ivory towers of academia"* where teaching and learning exist within a closed environment and ontology (Barnett & Bengtsen, 2017) is still very much in evidence; notwithstanding a clarion call to leverage the technological gains of the 4th and 5th industrial revolutions to refine teaching and learning

strategies. Resistance to change is a befitting narrative! Even in the face of evidence that e-learning works as effectively as traditional onsite learning, still faculty and students resist (Arkorful & Abaidoo, 2015) although their resentment may not necessarily mean that e-learning is inferior to in-person learning. Important to note is that while some universities and colleges in the South still struggle to overcome resistance to change, their counterparts in the North have already made technology an integral part of learning; nonetheless, evidence shows that some universities in the South are inevitably joining the movement for fear of being labeled misfits and outmoded. In these institutions, a paradigm shift mediated by technology is being observed as learning shifts from universal learning to customized learning, from learning by absorption to learning by doing, from confined physical classrooms to virtual classrooms, from teacher-directed to learner-directed, and from deductive teaching to interactive teaching.

In light of these changes, students are not only prepared to cope with the changing world but also to become change makers themselves. They are required to acquire skill sets and mindsets to thrive in the world of Industry 4.0 (based on automation, artificial intelligence, Big Data, and the Internet of Things), which is evidently evolving into Industry 5.0, where knowledge creation is not limited to humans but is also generated by algorithms in intelligent machines from an abundance of sensor data (Cawood et al., 2018; Friedman, 2016; Kamp, 2016). Although a typical traditional university that is still struggling to appreciate the technological waves of Society 4.0 may find this hilarious, intimidating or even frightening, the reality is that the world has already entered this space. It is now up to these institutions to rise to the challenge; otherwise, their relevance in this digital era may continue to shrink and eventually fade away. This appeals to reason that the survival of these institutions partly depends on effective technology integration. But how can they achieve this? How much technology should be integrated into learning? And how much learning can realistically be achieved through technology? The existing body of literature is replete with gaps that prevent us from adequately addressing these questions. Nevertheless, our practical experiences in both conventional and digital learning suggest two things: (1) the importance of negotiating a delicate balance between technology and learning; and (2) establishing whether the adopted technology for learning is genuinely impactful. While these opinions may seem reasonable and convincing, we have yet to reconcile them with the findings of this study. According to Grabe and Grabe (2005) a balanced e-learning model is one that supports university-wide initiatives to implement student-centered learning engagement, meets students' learning needs, and promotes continuous technological support for teachers. On the other hand, Zhao and Frank (2003) define impactful technology as one that is particularly well suited to support students' all-around development in academics, personality grooming, as well as many other aspects of their lives.

From the above, it is tempting to assume that a balanced e-learning model is one where teachers have access to a variety of e-learning tools that match the learning task at hand and the ability to use them authentically to transfer a learning experience. In this case, the teacher's role shifts from being a "sage on the stage" to being a "guide on the side," as students take responsibility for their own learning while using technology as an aid or enabler rather than an end. Although this conceptual definition meets the minimum quality standards of a reasonable e-learning context, its implementation seems to be a challenge, as most universities tend to focus on technology rather than learning. Evidently, during and after Covid-19, online facilitators paid overwhelming attention to technology at the expense of actual learning. This imbalance raises a critical question; does technology genuinely extend into learning or does learning simply get lost in technology? Further it provokes a deeper concern: if the doctrine of techno-centrism continues to dominate among practitioners, what will be the fate of learning in the years ahead?

In view of these pressing questions, we are compelled to examine the Technological, Pedagogical, and Content Knowledge (TPACK) Framework by Harris, Mishra, and Koehler (2009) to determine whether the practice of over-concentrating on technology at the expense of learning is justified by the framework. The TPACK model stands out as one of the few theories central to educational technology, designed to guide educators in integrating technology into teaching and learning processes (Hew, Lan, Tang, Jia, & Lo, 2019). The intersection of these three overlapping

fields creates a zone of convergence called TPACK, where technology is seamlessly blended with pedagogy and content to produce a balanced, technocentric learning environment.

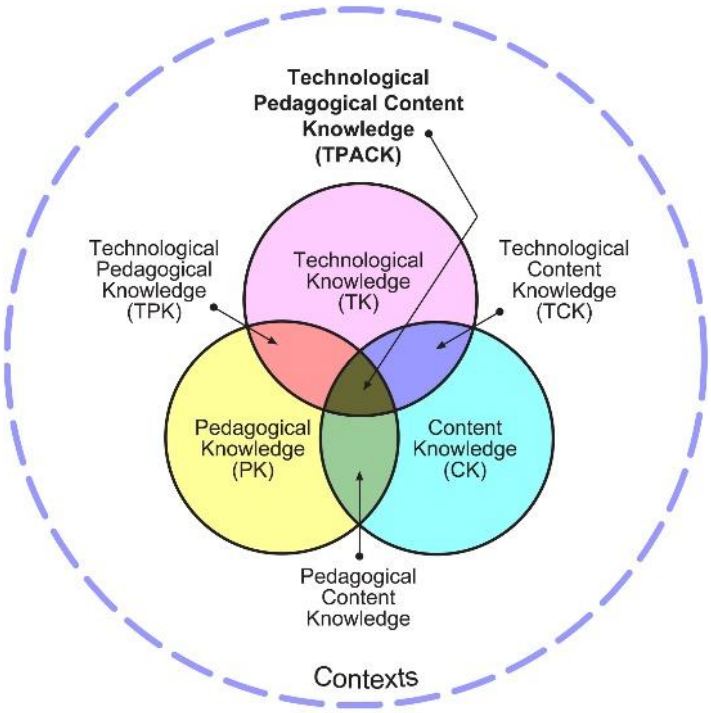

Figure 1. The constituents of the TPACK framework (graphic from http://tpack.org).

Figure 1 Illustrates the constituents of the TPACK Framework.

Although this model has long enjoyed a warm reception in the field of e-learning for its simplicity and ability to demonstrate what teachers need to know to appropriately incorporate technology into their teaching, it does not transcend beyond its prescriptive value. The fact that teachers still struggle to strike a balance between technology and learning for effective e-learning delivery is a testimony that practice and theory are in dispute. While this gap may be attributed to teachers' failure to interpret and effectively apply the TPACK model in real teaching and learning contexts, it should not be forgotten that the model does not guide teachers on how to adapt traditional instructional strategies (traditional pedagogy) to fit e-learning contexts. It neither suggests a suitable pedagogical approach for e-learning nor proposes how traditional pedagogy can be effectively applied in e-learning environments. It is no wonder that the implementation of e-learning continues to create rifts, mountains, and valleys regardless of our efforts to exploit it. The focus is so much on integrating technology into traditional pedagogy, forgetting that it is not simply a matter of replicating traditional teaching and learning techniques in a new medium; it is not that straightforward! It is true that technology and learning are intertwined, but as implementers, we should assess how much technology can be integrated into learning and how much learning can be achieved with technology.

Although technology and learning are interconnected (De', Pandey, & Pal, 2020), the investment universities are currently making to improve ICT infrastructure to support instructional technologies is substantially larger than investments in learning. It is reported that the costs universities incurred worldwide to enhance ICT infrastructure between 2020 and 2023 are significantly higher than a decade of investments in learning (Sunar, Yükseltürk, & Duru, 2022). It is not automatic that when technology is secured, so is learning. With technology becoming an additional layer in the classroom, a reasonable investment is required to align learning with technology through careful scientific investigation, leading to pedagogical refinements and sound implementation. The rapid transition to remote online education engineered by Covid-19 *(online emergency learning)* cannot be considered a normal application of online teaching, as academics overnight had to shift their courses prepared for face-to-face instruction to online learning platforms with no adequate preparation to meet the epistemological and pedagogical requirements.

However, in all fairness, we need to remember that, at this particular juncture of the transition, the primary focus was not on empowering students to engage meaningfully in the learning process, but rather on using technology as an alternative medium for learning continuity, regardless of whether the intended learning outcomes are achieved or not. This became evident during the declarations of a state of emergency and social distancing restrictions, where educators, with no other options, mechanically and desperately shifted traditional teaching techniques to the online learning space as the only alternative for maintaining learning continuity. While educators can be excused for this desperate move, it is important to note that technology-mediated learning is not a mere transposition of traditional pedagogy to a new medium; it is not, and will never be! As Andrade (2015) and Serdyukov (2015) rightly urge, old methods cannot be adopted for online education; rather, a "special pedagogy" is not only prudent but also imperative. Guided by this view, researchers in this study argue that for PNGUoT to establish a robust e-learning environment, a new, context-specific philosophical foundation with unique theoretical premises must be established a priori, moving forward.

4. METHODOLOGY

This study adopted a qualitative approach, focusing on interactive inquiry and observational techniques as the primary methods of data collection. In the interactive inquiry, we employed a qualitative approach aligned with constructivist and interpretive philosophical perspectives (Creswell, 2007; Denzin & Lincoln, 2005; McMillan & Schumacher, 2006; Patnaik & Pandey, 2019). Within the realms of these philosophical strands, reality varies depending on context, time, and experience. Therefore, we employed this approach to explore teachers' levels of appreciation and understanding of technology and learning based on their experiences in e-learning at PNGUoT. To obtain in-depth data, the researchers applied structured interviews to produce a holistic understanding of the phenomenon under investigation while using online facilitators' opinions and their lived experiences in the e-learning context as a reference point. In addition, the structured interview approach to data collection was not only preferred for its simplicity but also was the only realistic method to standardize questions for increased reliability (Amin, 2005). The interview sessions were transcribed and coded to identify patterns (Ssemugenyi, 2023; Ssemugenyi & Obsiye, 2022) and common themes (Amin, 2005) reverberated through online facilitators' submissions for easy analysis and interpretation. These themes were identified based on two major categories of questions that guided this study: one category containing two question items on Quality Networks, Access, and Support (QNAS), and a second category containing two question items on Quality Teaching and Learning Processes (QTLP), as indicated in Table 1.

Table 1. Interview tasks.

Sets	Task
QNAS	What are the computing software and tools considered to be the most beneficial for aiding learning outcomes in your subject? In your opinion, do you consider technology (software and tools) as an aid to learning or as a sub-component of learning?
	Are the preferred computing software and e-learning tools for your subject accessible to everyone affected by your subject, and are you given enough support to seamlessly engage with your students (remotely) using the same technology?
QTLP	Does the adopted technology align itself with the four main pillars of quality learning (e.g., engagement, motivation, critical thinking, and creativity), or is the emphasis solely on the use of technology and less on learning?
	Effective teaching is developmental and dynamic. Teachers should be continuously growing as they construct new knowledge and change their beliefs and levels of understanding. In light of this, do you think the integration of technology as a second layer in traditional pedagogy is helpful, or does digital learning require a dedicated pedagogy of its own? If so, what steps have you taken as a teacher to reflect, develop new paradigms, and organize schemes for a deeper understanding of the effective use of technology in learning?

To minimize bias and develop a deep understanding of the phenomena under investigation, the interactive inquiry was triangulated with the observational technique to assess participants' behaviors and actions from a

naturalistic point of view. The researchers specifically adopted a disguised naturalistic observation technique, where participants are not made aware that they are being studied to avoid reactivity (Ryan, 2019). With this approach, we aimed to obtain a quick overview of the participants' social behavior and/or actions, as well as to observe aspects that might not have been encountered in interviews. Guided by the teaching timetable, observations were conducted over a full semester, with each of the 12 participants observed twice in a single subject. Each session lasted a minimum of 2 hours, resulting in a total of 24 observations. During these sessions, the goal was to determine whether lecturers could distinguish technology from learning, use technology appropriately to impact learning, and assess whether extending traditional pedagogies into e-learning is effective. In light of these hypotheses, the following questions in Table 2 were generated to guide the observation process.

Table 2. Observation items.

No.	Task/Item
1	What computing software and tools were observed to be more beneficial in aiding learning outcomes?
2	What computing software and e-learning tools were observed to be more accessible to tutors, and how did they affect learning?
3	To what extent were the tutors supported during their engagement with students (remotely) while using the same technologies, and how did this affect learning?

4.1. Participants

This study specifically targeted respondents with relevant experiences related to online teaching and learning at PNGUoT. These respondents were online facilitators for the first year, second semester of the 2022 academic year, selected from the departments of Business Studies, Survey and Land Studies, and Communication for Development. At the time of this inquiry, these were the only departments offering online education through the Department of Open and Distance Learning (DODL). Since the total population of this group was small (12), the researchers did not employ any statistical sampling techniques or procedures, fearing a lack of precision. For confidentiality, the names of the 12 participants were recorded using pseudonyms, corresponding to two categories of questions: QNAS and QTLP. The pseudonyms are as follows: $qnas_1$, $qnas_2$, $qnas_3$, $qnas_4$, $qnas_5$, $qnas_6$, $qnas_7$, $qnas_8$, $qnas_9$, $qnas_{10}$, $qnas_{11}$, $qnas_{12}$ and $qtlp_1$, $qtlp_2$, $qtlp_3$, $qtlp_4$, $qtlp_5$, $qtlp_6$, $qtlp_7$, $qtlp_8$, $qtlp_9$, $qtlp_{10}$, $qtlp_{11}$, and $qtlp_{12}$. This implied that the 12 participants were expected to respond to 4 questions (e.g., 2 on QNAS and 2 on QTLP) from which transcripts were drawn as indicated in Table 3.

Table 3 shows the online facilitators' participation rate in the interview sessions regarding the four interview tasks on QNAS and QTLP, respectively. The QTLP questions attracted a significant response (i.e., 100% and 91%, respectively), as opposed to QNAS questions, whose response rate was slightly above average. Given that the total number of participants was small, all their views on the four discussion tasks were considered in the selection of the transcripts. Although one may argue that a total of 39 transcripts was relatively small to generate enough themes for increased generalizability, it should be noted that the main focus was not on generalization of the study findings, but on producing rich and nuanced data regarding teachers' opinions, assumptions, and experiences in e-learning engagements, with a view to improving practice within the context under study.

Relatedly, the participation rate for observations was convincing because all the targeted 24 observations were secured as provided in Table 4.

Table 3. Staff contributions, participation rate, and selected transcripts.

Sets	Tasks	Total contributions	Participation rate	Selected transcripts
QNAS	What are the computing software and tools considered to be the most beneficial for aiding learning outcomes in your subject? In your opinion, do you consider technology (software and tools) as an aid to learning or as a sub-component of learning?	45	8 (67%)	8
	Are the preferred computing software and e-learning tools for your subject accessible to everyone affected by your subject, and are you given enough support to seamlessly engage with your students (remotely) using the same technology?	52	8 (67%)	8
QTLP	Does the adopted technology align itself with the four main pillars of quality learning (e.g., engagement, motivation, critical thinking, and creativity), or is the emphasis solely on the use of technology and less on learning?	51	11 (91%)	11
	Effective teaching is developmental and dynamic. Teachers should be continuously growing as they construct new knowledge and change their beliefs and levels of understanding. In light of this, do you think the integration of technology as a second layer in traditional pedagogy is beneficial, or does digital learning require a distinct pedagogical approach? If so, what steps have you taken as an educator to reflect, develop new paradigms, and organize schemes for a deeper understanding of the effective use of technology in learning?	49	12 (100%)	12

Table 4. Participation rate for observations.

No.	Task/item	Session 1	Session 2	Total	(%)
1	What computing software and tools were observed to be more beneficial in aiding learning outcomes?	12	12	24	100%
2	What computing software and e-learning tools were observed to be more accessible to tutors, and how did they affect learning?	12	12	24	100%
3	To what extent were the lecturers supported during their engagement with students (remotely) while using the same technologies, and how did this affect learning?	12	12	24	100%

4.2. Data Analysis and Ethical Considerations

Data analysis for interviews took an inductive thematic approach (Nowell, Norris, White, & Moules, 2017) that involves a careful reading and re-reading of the transcribed data to generate themes (King, 2004; Olive, Mugenda, & Mugenda, 2003). With the inductive approach, data were coded without necessarily trying to fit the themes into the pre-existing coding framework or aligning them with our theoretical interests in the study. Instead, themes emerged from the data itself without being influenced by our preconceptions or the existing themes in other studies. After a rigorous review of the collected data, we then paid attention to the emerging themes depicting the common and shared teachers' views while focusing on the research questions. In view of ethical standards, this inquiry was conducted within the permissible ethical framework. For instance, the online facilitators willingly participated in this inquiry by sharing their sincere opinions and lived experiences in e-learning engagements at PNGUoT. Additionally, we anonymized their identities using unique identification codes such as; $qtlp_1$ to represent the transcript of participant one on QTLP questions. This was done to protect participants from any form of inconvenience that could arise from their sincere opinions.

On the other hand, since the guiding observational tasks or questions (ref. Tables 2 & 4) were categorical or nominal in nature, coupled with a relatively smaller sample size, data collected through observation were analyzed

using a non-parametric tool (the Chi-square) to summarize the observed frequencies and also to establish whether a difference between the observed and expected data is due to chance or due to a relationship between variables under study. Thus, the test statistic used for this purpose is; $\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e}$;Where f_o and f_e respectively represent observed and expected frequencies per cell.

5. FINDINGS

In this section, we present the study findings based on online facilitators' reflections on whether the focus should be on "technology" or "learning" in the implementation of e-learning as a mode of education. When describing the study results, the main research question was divided into four micro-research questions as a framework to present the themes identified as relevant in addressing these questions, along with supporting vignettes.

5.1 What are the computing software and tools considered to be the most beneficial to aiding learning outcomes in your subject? In your opinion, would you consider that technology (software and tools) as an aid to learning or a sub-component of learning?

After a careful examination of data on whether online facilitators are aware of the most beneficial technologies for learning, and whether technology is simply an aid for learning or it is learning itself, two main themes emerged, thus.

5.1.1. Awareness of Reliable Technologies for Teaching and Learning

Teachers demonstrated their awareness of existing computing software and tools and their willingness to explore more of these teaching-learning tools. This sentiment is expressed as follows.

We all know that technology-enabled learning is no longer an afterthought; it is here to stay, and our duty as teachers is to embrace it and improve our competencies from time to time. (qnas$_2$)

In my engagement with online studies, I have come across a number of learning management systems (e.g., Moodle, Google Classroom, Blackboard, etc.) and game-based tools such as Kahoot and Quizlet, among others, all of which are user-friendly and effective for learning. (qnas$_3$)

I was introduced to game-based platforms a few weeks ago at the Digital Workshop, where the presenter demonstrated how digital games such as Kahoot and Quizlet are beneficial for improving motivation and engagement in virtual classes. I have since tried to apply them, and my class is becoming more enjoyable. (qnas$_6$)

Although sometimes our context pauses a contradiction to technology use, I still believe that technology will continue to advance and shape our instructional methods, our willingness to embrace it notwithstanding. (qnas$_8$)

5.1.2. Contradictions between Technology and Learning

Teachers expressed their concerns about emerging misconceptions between technology and learning, explaining that it is a misconception to assume that when technology is secured, learning is also secure. These two aspects may appear interconnected, but are distinct and should be addressed separately.

We seem to forget that technology just complements learning, but it is not learning in itself, as practice seems to demonstrate. It is merely a teaching aid that needs to be applied carefully and judiciously to influence learning. However, the question of how much technology should be applied in learning remains a contentious issue to this day. (qnas1)

I notice that our focus is so much on technology and less on learning. How I wish learning as a domain could receive at least half of the budget that is allocated to technology. How beautiful would the digital learning environment be! We have instead invested heavily in technology and intentionally ignored learning, assuming that we are renowned teachers with tested teaching and learning strategies. Yes, this may be true, but this emerging style of learning demands a unique pedagogy, which the majority

of lecturers and professors across universities lack. Education experts need to act very quickly to address this gap through scientific investigations. (qnas$_7$)

Relatedly, observational data revealed that Kahoot and Quizlet were the most beneficial e-learning tools, as provided in Table 5.

Table 5. Tools beneficial to learning.

Platform	Students' curiosity			Total	χ^2	P-value
	Low	Medium	High			
Kahoot	7	5	1	13	9.399	0.009
Quizlet	1	3	7	11		
Total	8	8	8	24		

The results in Table 5 indicate that the use of Quizlet as a supportive learning tool is more beneficial for learning compared to Kahoot. Specifically, out of the 11 instances in which Quizlet was used by the lecturers, students' curiosity used here as a standard parameter to measure learning effectiveness was observed to be high 7 times. This suggests that whenever Quizlet is applied, students' curiosity, which in this study refers to engagement, motivation, critical thinking, and creativity, increases 7 times more than with Kahoot, which has a negligible impact. Overall, Pearson's chi-square results show a strong association between the use of game-based tools and students' learning outcomes. However, the cross-tabulation results reveal that this strong association is more positive with Quizlet and less so with Kahoot.

5.2. Are the preferred computing software and e-learning tools for your subject accessible to everyone affected by your subject, and are you given enough support to seamlessly engage with your students (remotely) using the same technology?

A careful review and analysis of teachers' opinions on technology access and support produced two main themes. They are presented as follows:

5.2.1. Accessibility

Access to technology has not only been a concern for the wider public but has also been central to our discourse in academia for some time. Teachers expressed their views with a great deal of satisfaction, although they appealed for increased access if technology is to become a new face of learning.

I have access to all digital platforms endorsed for teaching and learning at PNGUoT. I apply them depending on the type of learning outcomes I intend to achieve. For example, if my goal is to increase engagement through interaction, I use web-based tools (i.e., Zoom and Google Meet) and gamifications (i.e., Kahoot and Quizlet). However, if the goal is to share learning materials with my students, I simply post on Moodle with accompanying instructions. All these technologies are readily available and accessible to all of us. (qnas$_6$)

I believe the level of usability is currently high, unlike before. All the endorsed LMS and supporting web-based tools for online education at DODL are accessible, reliable, and easy to use. The simplicity of these technologies has enabled some of us (old-school users) to adopt them easily, as they are user-friendly, available, and fit for purpose. (qnas$_2$)

Although all teachers have access to technology, our students in the external environment lack it. Many times, they complain about frequent power outages, internet fluctuations, and the lack of good computers, tablets, or smartphones. This presents a serious challenge to learning and acts as a barrier to developing suitable learning methods for all. (qnas$_8$)

While the traditional approach to learning is accessible to disabled learners (e.g., the blind and hearing impaired), the current digital platforms at our university do not support this. This means that some categories of prospective students are denied access due to this barrier. We need to address this gap as well. (qnas$_2$)

Relatedly, the observational data on accessibility revealed that Kahoot and Quizlet were the most accessible supportive e-learning tools and drivers of effective learning as provided in Table 6.

Table 6. Extent to which access to game-based tools affects learning.

Ease of access to platforms	Students' curiosity			Total	χ^2	P-value
	Low	Medium	High			
Low	3	2	2	7	2.013	0.733
Moderate	2	1	3	6		
High	3	3	5	11		
Total	8	6	10	24		

Both access to platforms and students' curiosity (e.g., engagement, motivation, critical thinking, and creativity) were scaled as high, medium, and low, as provided in Table 6. The observational data reveal that in instances where Kahoot and Quizlet were found highly accessible and easy to use by the lecturers, curiosity varied 11 times on average. Of these, 5 instances demonstrated high curiosity, with 3 instances showing medium curiosity. Conversely, in cases where access to platforms was low among teachers, students' curiosity varied 7 times on average. Out of these, high curiosity was observed only twice, with 2 instances of medium curiosity. Although the p-value was found to be insignificant, these data suggest that increased access to technology correlates with improved student learning effectiveness and vice versa.

5.2.2. Support

To improve user experience, the university encouraged a great deal of usability through standby support from the LMS administrators and managers. Teachers expressed their views on this matter as mentioned below:

Technologically, we receive reasonable support from DODL through periodic onboarding trainings on the effective use of technology to influence learning. Although achieving learning outcomes remotely is somewhat challenging, we remain hopeful that through continuous improvement, we will succeed. ($qnas_{11}$)

We need to acknowledge the fact that ensuring effective learning is not easy in both conventional and remote learning environments, although it is somewhat more challenging in remote environments. The university should not only offer technological support to teachers but also extend support to external students in all possible ways. Additionally, it should challenge teachers to investigate how effective learning can occur in external environments with minimal support from teachers. ($qnas_{12}$)

Compatibly, the observational data on technological support and its corresponding impact on learning effectiveness seem to agree with the interview responses as provided in Table 7.

Table 7. Extent to which support affects learning effectiveness.

Level of support for platforms	Students' curiosity			Total	χ^2	P-value
	Low	Medium	High			
Low	6	5	0	11	13.779	0.008
Moderate/Medium	1	3	3	7		
High	1	0	5	6		
Total	8	8	8	24		

Both technological support and students' curiosity (e.g., engagement, motivation, critical thinking, and creativity) were scaled as high, medium, and low, as provided in Table 7. The observational data suggest that in cases where technological support was low, students' curiosity varied 11 times on average. Although the variation in curiosity was high, there were no instances of high curiosity observed among learners, but cases of low curiosity were numerous (6 times), with 5 instances of medium curiosity. Conversely, in situations where technological support was high,

students' curiosity varied 6 times; five of these demonstrated high curiosity, with one case of low curiosity. In cases where technological support was moderate, students' curiosity varied 7 times, with 3 instances of high curiosity, 3 of medium curiosity, and 1 of low curiosity. Although the P-value was greater than 0.05, indicating no statistical significance, there is compelling evidence to suggest that increased technological support correlates with reduced variation in students' learning, alongside consistent improvements in learning effectiveness.

5.3. Does the adopted technology align itself with the four main pillars of quality learning (e.g., engagement, motivation, critical thinking, and creativity) or the emphasis is just on the use of technology and less on learning?

Drawing on the analyzed data, one theme emerged regarding whether the adopted technologies address the learners' needs and whether the focus should be on the application of technology or on learning itself. The theme is presented below:

5.3.1. Alignment of Learning with Technology

Regarding this theme, teachers believe that the available technologies are, to some extent, aligned with the four pillars of quality learning, although it sometimes becomes difficult to attain some learning outcomes remotely.

I have noticed that achieving certain learning outcomes remotely requires a certain level of creativity and commitment. I have to use a variety of tools and platforms to motivate my students, foster engagement, and encourage creativity. Through periodic activity forums where all students share their views regarding a learning task, group discussions, and presentations, certain critical learning attributes such as critical thinking, creativity, and effective communication are achieved. ($qtlp_5$)

In my view, engaging students cognitively has been quite easy with technology, although inculcating a sense of moral uprightness, shaping their cultural orientations, socialization, and mindset change which, in my view, are important ingredients of quality education are difficult to instill using our current technologies ($qtlp_{10}$).

Socialization as a core learning aspect in the traditional setting is still lacking in my online classes. I don't see technology mediating this much-needed learning attribute at the moment. We need to do something about this. ($qtlp_7$)

So far, so good! With technology, I have always managed to achieve my learning outcomes, although the rate of commitment to achieving them is always high compared to traditional approaches. ($qtlp_4$)

5.4. Effective teaching is developmental and dynamic. Teachers should be growing continuously as they construct new knowledge and change their beliefs and levels of comprehension. In view of this, do you think the creation of technology as a second layer in the traditional pedagogy is helpful, or digital learning deserves a special pedagogy of its own? If so, what steps have you taken as a teacher to reflect, construct new paradigms, and organize scheme for deeper understanding of effective use of technology in learning?

A careful analysis of data on teachers' commitment to establishing whether e-learning deserves a special pedagogy through scientific investigations produced two main themes. They are presented below:

5.4.1. Need for a Special Pedagogy

Teachers reported that shifting traditional pedagogies to digital platforms is a common practice across higher education at the moment, but for sustainability reasons, a special pedagogy for online education may be considered. They explained as follows:

I notice that online education creates a learning environment that, compared to traditional classroom-based learning, is less personal and more independent. The challenge is not the use of technology but the absence of a reasonable theoretical framework based on sound continuous pedagogic research as the foundation of quality online learning. ($qtlp_{12}$)

Personally, I am not a teacher by profession, but when I joined my department, I enrolled in a Post Graduate Certificate Course in the Teaching and Learning Methods Unit (TLMU) to acquire traditional pedagogical skills for effective delivery of the subject matter. Similarly, we should consider this approach moving forward. Let us develop a simple course on e-pedagogy

and encourage all our staff to undertake it. This will help teachers understand how to measure teaching and learning effectiveness in e-learning environments and avoid confusing traditional pedagogy with online pedagogy. (qtlp$_{10}$)

To understand how teachers teach and how learners learn in an online environment requires extensive investigation. Although we may leave this part to professional experts in education to address this challenge, our duty as online facilitators is to think of a context-specific approach to improving our skills in both technology and pedagogy. The support we receive from DODL on technology use is sufficient, but we are not yet pedagogically proficient. (qtlp$_3$)

I am pleased that the University through DODL has introduced us to this new approach to teaching and learning. However, I suggest that instead of treating technology as an additional layer in the classroom, it should be embedded within the design of teachers' lesson plans and instruction to create a new form of pedagogy for e-learning that is distinct from existing conventional approaches. This requires proper alignment of technology with teachers, students, and curriculum through extensive research engagements. (qtlp$_4$)

5.4.2. Continuous Improvement

Teachers reported that classic pedagogy has served several generations of brick-and-mortar university academics and students; however, it may not satisfy learners of the digital age. We then need to improve our instructional skills by continually learning how to teach and continually supporting learners to learn how to learn with technology mediating the process. They explained as follows:

In my opinion, e-learning is entirely different from conventional learning in terms of structure, instructional methods, processes, and learning styles. All of this presents a challenge to many of us who have been comfortable with traditional teaching methods for years. We need to adapt, embrace this change, and support each other for continuous growth and improvement in e-learning processes. (qtlp$_2$)

Unlike us, online students are a new breed of learners: they have grown up in a technologically rich environment that is so rapid and chaotic in change. They are self-centered, independent-minded, and are less likely to succumb to any authority of their teachers. We need to learn how to deal with this breed! (qtlp$_6$)

Most of us are burdened with traditional pedagogy. It is a method that teachers used to train us in the past, and we have, in the same spirit, embraced it in our careers until recently. It is just very hard to shift the mindset; however, with the speed at which higher education is technologically evolving, we need to reorient ourselves through training if we are to keep afloat. (qtlp$_{11}$)

6. DISCUSSION

In our quest to broaden access to education for a larger portion of society through digital-enabled learning, we are prompted to reconsider the entire process of delivery by addressing a fundamental question: should the focus be on "*technology*" or "*learning*"? Based on this question and the study findings, three critical aspects have emerged: (1) both "technology" and "learning" are essential components of education, but technology is merely an aid and should not be mistaken as a subset of learning, (2) online learning requires new pedagogies and epistemologies, and (3) digital technology will continue to transform teaching and learning processes, regardless of our willingness to adopt it.

6.1. Both "Technology" and "Learning" are critical aspects of education, but technology should be seen as an enabler not as a substitute or subset of learning.

Results indicate that the extent to which technological innovations permeate the teaching and learning processes at PNGUoT is at an impressive rate. A paradigm shift mediated by technology is already being observed as learning shifts from universal learning to customized learning, from confined physical classrooms to virtual classrooms, from teacher-directed to learner-directed, and from deductive teaching to interactive teaching. This aligns with the scholarly work of Scott (2015) which in part predicted that the future of educational systems is expected to shift from institutions with a strong emphasis on conventional teaching to institutions with increased emphasis on technology-mediated learning. Although our university is well aligned with Scott's prediction for the future, there is an emerging

tendency among some faculty members elsewhere to assume that technology can in itself facilitate learning with minimal involvement of a teacher, forgetting that a computer is simply an extension of human abilities, not a replacement or substitute. Technology should be regarded as an instructional aid used by teachers to enhance engagement in teaching and learning, but it is neither an equivalent of teaching nor a subset of learning. While technology and learning are interconnected, securing technology does not automatically guarantee learning, as some educationists seem to suggest. In support of this, Sunar et al. (2022) illustrate that the overwhelming attention universities gave technology at the expense of learning during and after Covid-19 is solid evidence to presuppose that digital education is basically about mastering e-learning tool. Its inclination is much on technology than on learning to the extent that one wonders whether technology has itself become learning (Watermeyer, Crick, Knight, & Goodall, 2021). Although this may be a truism, we propose in this study that teachers need to expand and maintain their knowledge of learning technologies and develop the ability to critically assess digital learning tools in order to identify those which offer the greatest benefit to their students.

6.2. Online Learning Requires New Pedagogies and Epistemologies

Findings revealed that online education requires new pedagogies and epistemologies to sufficiently meet the objectives it aims to address. According to Bruner (1999), pedagogy is a science that makes educators aware of different teaching and learning standards and strategies, which guide what, to whom, how, and when to teach. Consistent with this definition, the study findings present a gap that needs to be addressed going forward. It is reported in this study that a few misconceptions teachers currently experience are a result of a lack of an established pedagogy for online education, coupled with their sincere belief that technology can fix all the problems they encounter in virtual classrooms. It is also noted that the focus remains very much on "*what*" types of technologies are required to teach virtually, rather than on "*how*" learning can progress effectively without violating learning principles while using a particular type of technology. Be that as it may, at the time of this inquiry, the university was very much determined to embark on a research-driven journey of conceptualizing, experimenting, and implementing an e-learning pedagogy suited to the context under study. Additionally, it is important to note that the journey to establishing a suitable pedagogy should start with answering the question of *"what"* and then progress to answering *"how"*. It is not possible to establish *how* effective learning can be with the aid of technology unless the dimensions of that particular technology *(what)* are well defined in the context of learning. Given that online education is still a new development in this study context, the effort remains focused on defining the *"what"*, notwithstanding the concerted effort to establish a reliable, context-specific e-pedagogy that can sufficiently address the *"how"*.

On the other hand, epistemology is the philosophical study of what knowledge is and what it means for someone to know something (Siemens, 2005; Ssemugenyi, 2023). Central to the field of epistemology are questions regarding the nature of truth, the nature of justification, and types of knowledge, such as knowing how (skills) or knowing that (facts). Although this study addresses the latter through online facilitators, the former still requires more attention. It is noted in this study that imparting certain skills and fostering values such as communication skills, writing skills, social skills, and ethical and cultural values remains a challenge. Consistent with this finding, Johnson et al. (2013), Sunar, Novak, and Mladenic ´(2020), Hidalgo, Gabaly, Morales-Alonso, and Urueña (2020) and Winter, Costello, O'Brien, and Hickey (2021) mention that much of what works in traditional education may not apply to online education, as practical skills are still difficult to impart using technology. Although this may be the case, at the time of this study, the university was preparing to intensify the use of gamification technologies to increase engagement and social interaction among peers and to access virtual simulation laboratories for practical courses. Therefore, pedagogy and epistemology are essential because, through epistemology, teachers define the type of knowledge they intend to impart, using a well-defined and applicable pedagogy.

6.3. Digital Technology will continue to Transform Teaching and Learning Processes, our Willingness to Embrace It Notwithstanding

The study found that technology in higher education has become an integral part of teaching and learning effectiveness, and the duty of the teaching staff is to embrace it without hesitation. The conventional mindset that underscores universities as mere *"ivory towers of academia"*, where teaching and learning exist within a closed environment, and ontology (Barnett & Bengtsen, 2017), is no longer permissible. Further, this study notes that knowledge production is no longer a commodity produced for everyone, as in the conventional academic setting; rather, students access knowledge depending on the relevance of a particular learning load at a given time. This presents a challenge because it calls for continuous customization of content and the production of courses based on learners' needs and expectations. This not only demands alignment between new technologies and emerging educational approaches but also requires online facilitators to be open to technology, considering aspects of efficiency in teaching, effectiveness in learning, and equity in education. It is also noted that technology is changing very rapidly, to the extent that specialists find it difficult to predict the future of online education. However, one indisputable fact is that technology is consistently transforming the landscape of higher education, and our duty as educators is to adapt to this movement.

7. CONCLUSION

The study concludes that a focus on technology rather than learning is a false dichotomy; while limited expertise to critically evaluate how learning can progress effectively with technology being used as an enabler is an early implementation hurdle. The evidence presented in this study validates the scholarly works of Andrade (2015) and Serdyukov (2015), which in part claim that online education is progressive for some, an obstacle to proper instruction for others, but an undeniable paradigm shift that has consistently and progressively changed the instructional landscape in higher education regardless of our willingness to accept or reject it. This suggests that online education is no longer an option but a necessity, although making it impactful remains the most challenging aspect, which researchers in this study and other educationists are still addressing today. The focus is shifting from *what* we offer with technology to *how* we offer it. In other words, we are increasingly concerned about how students learn and subsequently develop teaching and learning approaches accordingly.

Just like in the traditional setting where decades of research have led to an established theoretical and pedagogical foundation; guiding learning from the acquisition of lower-order learning skills (remembering and understanding) to higher levels of analyzing data, evaluating information, and creating knowledge, our online learning is directed towards achieving these much-needed learning ingredients through scientific inquiries to empower and expand teachers' ability to elevate students' learning potential.

7.1. Limitations of the Study

Needless to mention, that is synonymous with interpretivism school of thought (interpretive studies), is the conviction that reality is socially constructed and can be interpreted and/or understood differently depending on context, time, and experience (Kroeze, 2012; Marcon & Gopal, 2005). Given that the investigations for empirical evidence in this study relied partly on teachers' opinions and experiences, it is likely that some of the opinions were subjective and posed a potential threat to validity. However, the researchers were very aware of this threat and mitigated it through non-biased selection of participants, adequate briefing of participants on honesty, obtaining informed consent, and triangulating interviews with observational data to control reactivity. With this, the study findings can be generalized to external environments with similar contexts, but this should be done with caution because the main focus of this study was not on generalizability, but on producing rich and nuanced data regarding teachers' opinions, assumptions, and experiences in e-learning engagements, with the aim of improving practice within the context of the study.

In addition, one may also argue that being a qualitative study, the sampling strategy (purposive) adopted was non-probabilistic in nature and prone to bias because the selection of the participants in this case solely depended on the researchers' subjective judgment rather than random selection. While this may be a truism, the researchers mitigated this bias by considering only those lecturers who, at the time of this inquiry, were active facilitators of online courses. These were purposely considered because they possessed the necessary information that the researchers intended to use to interrogate the research question. It would be unwise to include lecturers with little or no experience in e-learning instruction. Therefore, it was neither an oversight nor a mistake that the study employed a non-probability sampling strategy. On the same note, one should be reminded that non-probability sampling strategies are best applied when the population targeted for the study is believed to possess similar traits (Amin, 2005; Creswell, 2007; Ssemugenyi, 2023).

7.2. Recommendations

In view of the theoretical framework, the TPACK model (Harris et al., 2009) that was developed to describe what teachers need to know in order to appropriately incorporate technology into their teaching for effective delivery has offered unclear prescriptions. The complexity of the TPACK model tends to make sense conceptually to teachers, but applying the framework in practice is arguably more difficult. It neither suggests a suitable pedagogical approach for e-learning nor proposes how the traditional pedagogy, which the majority of teachers are accustomed to, can practically and effectively be applied in e-learning contexts without violating virtual learning processes. In light of this observation, and in accordance with the major findings of the study, the researchers believe that a proposition for a new philosophical foundation with unique theoretical premises and the adoption of an effective and impactful pedagogy, coupled with a thorough examination of the interplay between education and current market trends, may be an appropriate step toward improving and/or building a sound online education system. Like traditional pedagogy, e-pedagogy in our context would describe the purpose of online education in terms of current educational theories, principles, and methodological directions built on research over time to understand how critical elements of instruction influence knowledge acquisition, desired skills, values, and attitudes among learners. Now that the demand for online education is growing exponentially, the need to develop a sound pedagogy (e-pedagogy) for this purpose is urgent; and it is for this reason that we propose a one-semester postgraduate certificate in e-pedagogy for all online educators to improve teaching and learning engagement. This proposition is informed by an extensive review of existing traditional pedagogies, our expertise in teaching and learning processes, and the absence of a well-established e-pedagogy for effective teaching and learning engagement. The proposed e-pedagogy in this study is premised on four main domains: the classic and modern educational theories, educational psychology, sociology, and technology.

The educational theories provide a conceptual basis for understanding why and under what conditions certain learning methods and strategies are effective, through examining the underlying mechanisms involved in teaching and learning processes. Educational psychology emphasizes that individual learners have unique approaches to learning, and the role of a teacher is to recognize this individuality and provide suitable learning strategies that align with how each student learns and retains knowledge. While sociology and technology view education as a web of social interactions and a network of interconnected digital learning platforms and tools, respectively. It is important to note that the effectiveness of this proposed e-pedagogy in our context depends on achieving the desired student learning outcomes.

1. **Foundations of e-pedagogy**

1.1 Pedagogy as a science.

1.2 Education as a pedagogic and social process.

1.3 Aligning traditional pedagogies with e-pedagogy.

1.4 Educational psychology.

1.5 Educational theories.

1.5.1 Community of inquiry framework (Garrison, Anderson, & Archer, 2001).

1.5.2 Technology, pedagogy, and content-knowledge model-TPACK- (Mishra & Koehler, 2006).

1.5.3 Behaviourist learning theory (Skinner, 1968).

1.5.4 Constructivist learning theory (Schell & Janicki, 2013).

1.5.5 Connectivism learning theory (Siemens, 2005).

2. Digital teaching and learning

2.2 Teaching and learning as an iterative process.

2.3 Laws of learning.

2.4 Transferability of learning.

2.5 Alignment of instructional strategies, learning tasks, and learning outcomes.

2.6 Quality control in education: Feedback, reflection, assessment and evaluation.

3. Educational technologies

3.3 Closed and open learning networks.

3.4 Online learning technologies.

3.4.1 Asynchronous learning technologies.

3.4.2 Synchronous learning technologies.

3.5 Social networking tools.

3.6 Mobile learning tools.

4. Higher education in and for modern societies

4.1 Economic and social benefits of knowledge.

4.2 Higher education for informed citizenship.

4.3 Higher education for healthy and inclusive societies.

4.4 Transformation of future-fit education.

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Institutional Review Board Statement: The study involved minimal risk and followed ethical guidelines for social science fieldwork. Formal approval from an Institutional Review Board was not required under the policies of Papua New Guinea University of Technology, Papua New Guinea. Informed verbal consent was obtained from all participants, and all data were anonymized to protect participant confidentiality.
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
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