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Harnessing AI for Education 4.0: Drivers of Personalized Learning

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Abstract: Personalized learning, a pedagogical approach tailored to individual needs and capacities, has garnered considerable attention in the era of artificial intelligence (AI) and the fourth industrial revolution. This systematic literature review aims to identify key drivers of personalized learning and critically assess the role of AI in reinforcing these drivers. Following PRISMA guidelines, a thorough search was conducted across major peer-reviewed journal databases, resulting in the inclusion of 102 relevant studies published between 2013 and 2022. A combination of qualitative and quantitative analyses, employing categorization and frequency analysis techniques, was performed to discern patterns and insights from the literature. The findings of this review highlight several critical drivers that contribute to the effectiveness of personalized learning, both from a broad view of education and in the specific context of e-learning. Firstly, recognizing and accounting for individual student characteristics is foundational to tailoring educational experiences. Secondly, personalizing content delivery and instructional methods ensures that learning materials resonate with learners' preferences and aptitudes. Thirdly, customizing assessment and feedback mechanisms enables educators to provide timely and relevant guidance to learners. Additionally, tailoring user interfaces and learning environments fosters engagement and accessibility, catering to diverse learning styles and needs. Moreover, the integration of AI presents significant opportunities to enhance personalized learning. AI-driven solutions offer capabilities such as automated learner profiling, adaptive content recommendation, real-time assessment, and the development of intelligent user interfaces, thereby augmenting the personalization of learning experiences. However, the successful adoption of AI in personalized learning requires addressing various challenges, including the need to develop educators' competencies, refine theoretical frameworks, and navigate ethical considerations surrounding data privacy and bias. By providing a comprehensive understanding of the drivers and implications of AI-driven personalized learning, this review offers valuable insights for educators, researchers, and policymakers in the Education 4.0 era. Leveraging the transformative potential of AI while upholding robust pedagogical principles, personalized learning holds the promise of unlocking tailored educational experiences that maximize individual potential and relevance in the digital economy.

Keywords: Personalized learning, Artificial intelligence, Education 4.0, Individualized instruction, Systematic review, Adaptive learning

1. Introduction

Due to the fourth industrial revolution, the current world is marked by constant change, uncertainty, and ambiguity. In this context, education faces significant challenges in adapting to the complex dynamics of this new era (Sangole, Desai and Jain, 2022) As Aziz Hussin (2018) emphasizes, it is of paramount importance to bring learning processes closer to personalization. In this era of automation, artificial intelligence, the Internet of Things, robotics, and other exponential technological advances, personalized learning enables individuals to focus on specific areas of interest and need, maximizing their potential and relevance in the digital economy. Furthermore, by offering a teaching approach tailored to each student's abilities and aspirations, personalized learning empowers individuals to thrive in a society driven by innovation and digitalization, where adaptability and continuous skill acquisition are crucial for success (Khandelwal, Shankar and Siddiraju, 2022).

In this perspective, UNESCO (2017, p. 5) defines personalized learning (PL) as an "educational approach that places the learner at the centre, considering their prior knowledge, needs, and capacities". Several authors, such as Parra (2016), Hwang et al. (2013), and Lee et al. (2018), underline the importance of considering individual differences when designing personalized learning. Schuwer & Kusters (2014) indicate that PL seeks to address these differences through differentiation and individualization. Differentiation focuses on adapting instruction to students' preferences, such as offering personalized options for setting goals and content. On the other hand,

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individualization aims to adjust instruction according to the needs and pace of each student's learning, such as modifying the level of difficulty and the rate of progress.

However, some researchers have pointed out the lack of clarity in interpretations of the term "personalized learning." For example, Shemshack & Spector (2020) identified the use of different terms like adaptive learning and individualized instruction to refer to this concept. In fact, Villegas-Ch and García-Ortiz (2023) and Nurcahyo and Agustina (2023) are some examples of an entire line of research that associates personalized learning with adaptation. In addition to the above, Schmid & Petko (2019) highlight the need for a precise definition due to the multifaceted and complex nature of personalized learning. This lack of consensus has resulted in multiple definitions and heterogeneous implementation of this educational approach.

Achieving personalized learning has not been an easy task. According to Cain (2022), for over a century, personalized learning has been a subject of discussion regarding its conceptualization and implementation. This has led to the consideration of various approaches and methods by researchers such as Montessori, Parkhurst, and Bloom, which have served as a foundation for developing strategies that address diverse learning modalities and educational objectives. Among these strategies are flipped instruction, project-based learning, effective group work, personalized questioning, and metacognitive guidance, among others. All of this is done to overcome the limitations inherent in conventional learning systems.

In the context of the use of digital technologies in education and more specifically related to e-learning, the personalization of learning has been addressed mainly associated with the adaptivity of learning management systems (LMS) (Ghallabi *et al.*, 2015; Aplugi and Santos, 2022; Nurcahyo and Agustina, 2023), to the adaptation of content through learning objects (Luna-Urquizo, 2019; Gan and Zhang, 2020) and to gamification processes and use of serious games (Kickmeier-Rust and Dietrich, 2009; Makarenya, Stash and Nikashina, 2020).

Furthermore, authors like Zheng (2018) and Vanbecelaere et al. (2020) have considered the use of digital technologies as an alternative to promote personalized learning. Some of these technologies currently stand out above others, such as artificial intelligence, which is generally understood, as Li and Wang (2020) state, as the capacity of machines to employ algorithms, acquire knowledge from data, and utilize this acquired knowledge in decision-making processes, mirroring human-like cognitive abilities.

With a tradition dating back several decades of continuous development, artificial intelligence tools have multiple facets. From early intelligent tutoring systems to personalized learning environments reported by Holmes et al. (2023), AI has begun to enable the provision of resources tailored to each student, considering their profile, learning style, and cognitive levels, as indicated by Dwivedi et al. (2018) and Murad et al. (2020). In this regard, biometric and contextual tracking technologies have also begun to be developed to detect emotions and learning preferences, allowing for more precise adjustments of learning systems to students' needs (Kaklauskas *et al.*, 2015; Thompson and McGill, 2017; Ennouamani, Mahani and Akharraz, 2020).

Despite the advancements reported in the literature, the implementation of personalized learning remains a challenge due to the lack of clarity regarding the practical aspects required to achieve it effectively (Schmid and Petko, 2019; Shemshack and Spector, 2020), and even more so, the knowledge is less for its application in intensely interconnected educational contexts or mediated by highly disruptive digital technologies.

To address this concern, this study provides an extensive review of literature published in the past decade on personalized learning, aiming to identify its key drivers and subsequently offer a critical reflection on the role of artificial intelligence in enhancing them.

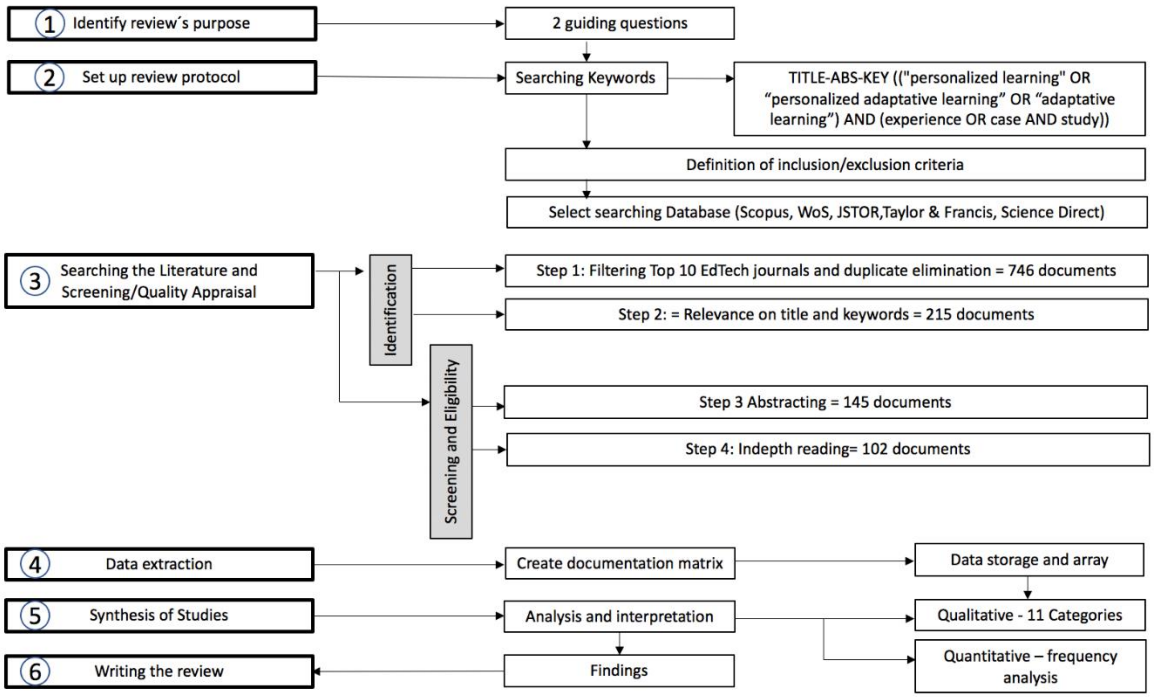
2. Method

Howell Smith and Shanahan Bazis (2021) mention that there is a diversity of studies classified as literature reviews, including meta-analyses, content analyses, mapping reviews, narrative reviews, scoping reviews, and systematic literature reviews, each with its methodological particularities. In particular, the methodological approach typically used in systematic literature reviews aligns best with the purpose of this review, which is why it has been chosen as the most relevant option.

For this systematic review of the literature, we considered the guidelines of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement and the recommendations and methodological structure proposed by Okoli (2010), whose application details are presented in Figure 1.

The PRISMA statement provides standardized guidelines for conducting systematic literature reviews, improving the quality and transparency of these studies. It helps researchers identify biases, ensure replicability, and

facilitate the interpretation and comparison of results between studies. By following these guidelines, a rigorous process is established that includes clarification of inclusion criteria, an exhaustive search of relevant literature, and a critical evaluation of the methodological quality of the included studies.



Source: Own elaboration based on Okoli (2010)

Figure 1: Method diagram

2.1 Identify the Review´s Purpose

Considering the main objective of the review, two guiding questions were posed to analyze the reviewed studies:

- What drivers have been identified to achieve Personalized Learning?
- What aspects of personalization enhance learning?

Based on these questions, it is intended not only to identify pertinent elements related to the personalization of learning but also that such elements will become the basis for generating insights about the role of Artificial Intelligence in strengthening said personalization.

2.2 Setup Review Protocol

To address these questions, search keywords were defined and consolidated into a single search string: TITLE-ABS-KEY (("personalized learning" OR "personalized adaptive learning" OR "adaptive learning") AND (experience OR case AND study)). Next, inclusion criteria were established to select (or exclude) relevant articles, as follows:

- Articles published in the top 10 journals within Google Scholar Metrics (2022) with quality indicators and Scientific Journal Ranking (SJR) impact factors will be considered.
- Articles presenting research results, in English, published between 2013-2022 will be considered.

Subsequently, to strengthen the reliability of the information sources, the top 5 major databases of indexed journals with thematic coverage in "social sciences" and specifically in "educational technology" were selected: Scopus, Web of Science, JSTOR, Taylor & Francis Online, and Science Direct.

2.3 Searching the Literature, Screening/Quality Appraisal

The definition of the final set of documents for in-depth review was carried out in four steps, where the PRISMA guidelines were applied, specifically in the Identification, Screening and Eligibility processes:

- Step 1: The search string was applied in the databases, applying the previously determined selection criteria and eliminating duplicate records, resulting in an initial sample of 746 documents.

- Step 2: The 746 previously identified documents were reviewed, and relevance was assessed concerning the guiding question by reading titles and keywords, reducing the sample to 215 articles.
- Step 3: The sources identified in Step 2 were further reviewed, seeking a closer relationship with the keywords through abstract reading. This further reduced the sample to 145 relevant articles.
- Step 4: An in-depth reading of the articles identified in phase 3 was conducted, in which 102 definitive and relevant studies were identified for inclusion in the review. The results of this process are presented in detail in Table 1.

Table 1: # articles selected in steps 1-4

Journal	SJR Impact Factor 2022	Step 1	Step 2	Step 3	Step 4
Computers & Education	3.682	239	71	49	39
British Journal of Educational Technology	2.116	31	13	11	7
Internet and Higher Education	3.327	5	4	3	1
Journal of Educational Technology & Society	4.020 (JCR)	121	31	22	14
Education and Information Technologies	1.249	53	22	16	13
The International Review of Research in Open and Distance Learning	0.787	17	9	6	2
Educational Technology Research and Development	1.516	65	16	11	9
Interactive Learning Environments	1.170	155	40	19	13
Computer Assisted Language Learning	1.754	29	4	3	1
International Journal of Educational Technology in Higher Education	2.051	8	5	5	3
Total documents		746	215	145	102

2.4 Data Extraction

For the data extraction process aimed at identifying drivers of personalized learning, 11 categories of analysis were established:

- Teaching and learning strategies based on student needs.
- Identification of individual student characteristics.
- Customization of the curriculum content.
- Customization of learning assessment.
- Customization of the user-machine interface or environment.
- Development of adaptability technologies and/or the use of AI to provide different learning personalization systems.
- Literacy and other benefits for educators.
- Frameworks, theories, and/or models used in personalized learning.
- Public policies.
- Training domain.
- Level of training.

2.5 Synthesis of Studies

The reviewers conducted the synthesis of studies through qualitative data analysis obtained from the definitive articles using a categorization process. Additionally, basic quantitative analysis was performed through counting processes (n) and frequency analysis (f).

2.6 Writing the Review

Finally, based on the results found and related to the guiding questions of the review, the reviewers proceeded to write the review report following the IMRaD structure. They used the synthesis of the studies to develop the results section of the report.

3. Results

The results of the review are presented below based on the application of the methodological process shown in Figure 1 from the perspective of the guiding questions.

3.1 General Aspects of Personalization That Favour Learning

First, some personalization strategies (n=61, f=59.8%) were identified that demonstrated significant results in the learning of specific populations, explicitly validating the positive impact on learning. Some of these strategies include adaptive instructional sequences using badges (Bush, 2021), adaptability learning games (Pflaumer, Knorr and Berkling, 2021) and intelligent tutoring systems using robots (Chen, Park and Breazeal, 2020).

Second, the literature has frequently investigated strategies that favour non-cognitive characteristics of the student and their impact on learning. According to Yang et al. (2013) and Zou et al. (2021), motivation plays a crucial role in learning success, especially in complex e-learning environments, along with other elements such as meaningful activities for students. Several relevant characteristics were identified in this area, including motivation (n=35, f=34.3%), individual learning pace (n=20, f=19.6%), and eliminating time and place barriers (n= 17, f=16.7%). Some studies addressing these topics are El-Sabagh (2021), Kew & Tasir (2022) and Khan & Mustafa (2019).

Finally, several studies (n=53, f=52%) focus on positive perceptions about the usability and usefulness of personalized learning strategies. Both students and teachers found benefits in these strategies. According to Sahin and Uluyol (2016), perceived usefulness is important for evaluating users' ability to use a system and improve their performance, while usability concerns the system's ease of use. Some of the research includes the work of Aslan & Reigeluth (2016), Benmesbah et al. (2023) and Schuwer & Kusters (2014).

3.2 Main Drivers of Personalized Learning

How to drive personalized learning? The reviewed literature shows various ways to respond to this question. Some studies mention drivers that promote confidence, autonomy, initiative, and commitment of students in the teaching-learning process. In this regard, Scheiter et al. (2019) support the existence of a learning improvement opportunity when the adaptive mechanism contributes to increasing the learner's self-regulation control. The following are some relevant groups of drivers highlighted in the literature.

3.2.1 Driver #1: Identifying individual student characteristics

100% of studies highlight the importance of personalizing learning according to student characteristics. Each student must be individually recognized so that they can achieve the proposed learning objectives, thus offering an alternative to “one size fits all” schooling approaches (Schuwer and Kusters, 2014; Zhang *et al.*, 2023). The options used range from questionnaires to artificial intelligence techniques that aim to identify the unique characteristics and preferences of each learner, as a starting point to adjust other components of the teaching-learning process (Narciss *et al.*, 2014; Pliakos *et al.*, 2019). This driver highlights five subcategories: (1) Cognitive factors (n=83, f=81.3%), which mainly include prior knowledge levels and learning objectives; (2) Characteristics changing during learning (n=81, f=79.4%), among which learning pace, interest level, knowledge and skill progress stand out; (3) Stable characteristics (n=54, f=52.9%), such as learning styles and personal background; (4) Behavioral factors (n=18, f=17.6%), such as activity tracking, learning habits, engagement level and student behaviour in the system, and finally (5) Affective factors (n=13, f=12.7%), such as emotions, mood, self-esteem and feelings like stress, anxiety and neuroticism. Some research addressing the above includes Adewale et al., (2022); Barbagallo & Formica (2017) and Konijn & Hoorn (2020).

3.2.2 Driver #2: Content Personalization

This driver is frequently studied (n=87, f=85.3%), and refers to adapting the study content and its delivery according to the student profile, considering the selection, order, and structure of the material, as well as instructional mechanisms. More specifically, studies recommend generating learning paths (Feng and Yamada, 2021), courses with layers related to the student profile (Benton *et al.*, 2021) and incorporating student opinion in curriculum formulation (Lee *et al.*, 2018). In addition, student goals and motivations are linked to content (Hooshyar *et al.*, 2016), with up-to-date, quality resources to maintain interest and participation (Esteban-Millat *et al.*, 2014). This driver highlights five subcategories: (1) Delivery of content adapted to student characteristics (n=66, f=64.7%), whose most used techniques were recommending appropriate learning materials by intelligent analysis of the student profile, designing adaptive instructional sequences and module plans; (2) Instructional methods (n=40, f=39.2%), among which blended learning stands out, followed by asynchronous activities

according to student profiling and context-aware ubiquitous learning (m-learning); (3) Use of serious games (n=11, f=10.85), which take into account the learner's mastery level, learning styles, gender and context; (4) Intelligent tutoring system [ITS] (n=9, f=8.8%), both to provide learning materials and explanations, exercises, examples, diagrams, images, movies, interactive and/or conversational tutorial material, as well as complement the normal school curriculum; and finally, (5) Use of robots (n=3, f=2.9%), linked to creating humanoid experiences with different behaviors, access to 24/7 tutoring or devices capable of changing roles to support learning. Some authors are Garcia-Cabot et al. (2015); Sampayo-Vargas et al. (2013) and Thompson & McGill (2017).

3.2.3 Driver #3: Assessment personalization

This driver (n=61, f=59.8%) focuses on providing continuous support to each student during their learning process, through assessment. It seeks to provide real-time feedback to motivate, identify difficulties, provide improvement opportunities, and encourage conscious self-assessment. These strategies go beyond a focus on student success or failure (Narciss *et al.*, 2014). Four subcategories were identified within this driver: (1) Handling student difficulties (n=50, f=49%), whose most reported strategies are suggestions for educational interventions (for example, elaborate comments, and support through an animated agent) and student performance diagnostics; (2) Quality feedback (n=49, f=48%), where the findings include real-time feedback, aligned with both the learning process and the products generated by the student, clearly described, assisted and supported by both technology and human peers; (3) Student progress (n=34, f=33.3%), through automated monitoring available to teachers and students and self-assessment processes and finally, (4) Assessment approaches (n=21, f=20.6%), where the most mentioned were formative assessment, flexible assessment approach, and competency-based learning. Some of the mentioned cases are found in Fırat et al. (2021), Gamrat et al. (2014) and McKenzie et al. (2013).

3.2.4 Driver #4: Personalization of the user-machine interface/environment

The literature shows different presentations and attributes of personalized learning environments (n=67, f=65.7%), mostly technology-mediated. This driver is based on the idea that learning environments should be attractive and support student retention in academic activities. The results related to this driver are presented grouped into six subcategories: (1) Structural design (n=49, f=48%), some of the key aspects are data interfaces, multimedia elements, collaborative environments, user customization, timely support and flexible learning environments; (2) Navigation (n=27, f=26.5%), which can improve the user's personal experience through adequate cognitive load and navigation panels on the home page; (3) Recommendations for customized educational games (n=12, f=11.8%), which mention the use of casual games and puzzles according to learning style, appropriate level of challenge, fun, role-playing games [RPG] with narrative elements, context-aware mobile role-playing games [CAMEG], high interactivity, learning objects [LO] associated with varied topics and formats; (4) Additional components (n=8, f=7.8%), such as attention regulation strategies, annotation module, stimuli, initial skill estimation and response prediction; (5) Use of language (n=7, f=6.9%), where the use of natural or conversational language, technologies such as robots, forums and chatbots replicating humanized conversations stand out and finally, (6) Human factors (n=6, f=5.9%), where collaborative work and humor in instruction were most relevant to promote social presence and trust. Some of the studies addressing the above are Chiu & Mok (2017); Ennouamani et al. (2020); Khenissi et al. (2016).

3.2.5 Driver #5: Use of Artificial Intelligence and other technological developments

Most of the analyzed articles (n=84, f=82.3%) highlight the technologies used, allowing the differentiation of at least two types of personalized learning systems: adaptive and intelligent systems. Adaptive systems adjust to student differences, although they are not necessarily intelligent since they can use simple algorithms to achieve such adaptation. On the other hand, intelligent systems use AI for data analysis and decision-making, thus offering more personalized learning support (Yang *et al.*, 2013). However, not all authors differentiate the underlying technology of the educational system. For example, the term "individualized learning environment" refers to the emergence and extension of Web-based Adaptive and Intelligent Educational Systems [AIWBES] (Özyurt *et al.*, 2014). In addition, the findings in this category allow for the identification of the elements that make up personalized learning systems, such as algorithms, architectures, and other tools used. This driver includes 5 subcategories: (1) AI techniques and algorithms (n=40, f=39.2%), which provide information on AI approaches used to analyze large volumes of data and provide personalized education. Techniques cited include data mining, analytics learning, and semantic recommendation systems. These techniques rely on algorithms like artificial neural networks, fuzzy logic, and item response theory; (2) Software, hardware, and other technical

complements (n=27, f=26.5%), which present various tools and platforms used to implement personalized learning systems with different levels of complexity and sophistication. Some examples include Media Wiki, imoodle, JavaScript, Microsoft VB.NET, and Textit. Advanced technologies including activity trackers, Affective Tutoring Systems for Built Environment Management [ATEN], biometrics, adaptive multimedia systems, and educational chatbots [EC] are also mentioned; (3) Serious game developments (n=19, f=18.6%), which highlight sequences of data reorganized based on student needs. Games that make use of context-aware mobile devices and 3D game design, among others, are also mentioned; (4) System architectures (n=17, f=16.7%), corresponding to each of the components that allow organizing the structure of the personalized learning system. Common modules include the student profile, generation of appropriate teaching materials, interface customization, and evaluation, and finally, (5) Cold start difficulties (n=3, f=2.9%), where some authors address the difficulty of lack of initial data from new students, for example, combining item response theory (IRT) and a trained regression tree to estimate cognitive abilities predict future student performance. Some of these studies are Chaloupský et al. (2021); Kay & Kummerfeld (2019) and Lin et al. (2013).

3.2.6 Driver #6: Literacy and other benefits for teachers

This driver (n=16, f=15.7%) recognizes the need to train pre-service and in-service teachers on the different possibilities of personalized learning. Personalization environments are also presented as an alternative for the design and execution of teacher development programs. Some of the studies mentioned are Kong & Song (2015), Kunze & Rutherford (2018) and Lee et al. (2018).

3.2.7 Driver #7: Frameworks or models used in personalized learning

This driver provides information on proposed approaches to developing different levels of personalized learning. Various studies (n=60, f=58.8%) explore student-centred pedagogies and technological advances for implementing personalized learning, for example, McKenzie et al. (2013), Schmid & Petko (2019) and Wanner & Palmer(2015). The combination of these approaches guides the design and implementation of personalization as a learning technique in various disciplines (Zou *et al.*, 2021), in addition to enabling the monitoring of processes and verification of their effectiveness. This driver includes 4 subcategories: (1) Conceptual frameworks for personalized learning design (n=52, f=51%), which aim to facilitate user interaction and understanding, focusing on personalized learning. They include cognitive load theory [CLT], instructional design [ADDIE], and flipped and blended learning approaches; (2) Learning style and cognitive style models (n=23, f=22.5%), where the Felder-Silverman learning style models and VARK are the most used. As for cognitive styles, the literature explored the learning orientation model and the field dependent/independent model; (3) Theoretical frameworks for establishing learning profiles (n=10, f=9.8%), among these, artificial neural network stands out. Others, such as feature analysis techniques (TFA) and the involvement load hypothesis (ILH), are mentioned infrequently, and finally, (4) Models for assessing student knowledge (n=6, f=5.9%), referring to the variation associated with achievements and prior knowledge. The most frequently used are the Bayesian model and Bloom's taxonomy of educational objectives. Some of the authors who addressed this category are El Aissaoui et al. (2019); Ramos de Melo et al. (2014) and Yousaf et al. (2023).

3.2.8 Driver #8: Public policies

Some authors (n=3, f=2.9%) provide insight into public policies in their countries that promote personalized learning, especially linked to improving the student experience and academic performance. Some examples are found in Lee et al. (2018) and Schmid & Petko (2019).

3.2.9 Driver #9: Studies by domain

This driver shows the disciplines studied in the literature in order of frequency. Demonstrating the interest of researchers from various disciplines to include personalized learning systems in response to the different ways in which human beings learn and the versatility of this student-centred approach.

Computer science is the most studied discipline (n=34, f=33.3%), followed by mathematics (n=11, f=10.8%), linguistics and/or vocabulary (n=7, f=6.8%), natural sciences (n=7, f=6.8%), English as a foreign language (n=6, f=5.9%), higher-order skills (n=4, f=3.9%), health sciences (n=4, f=3.9%), social sciences (n=3, f=2.9%).

3.2.10 Driver #10: Studies by level

This driver presents the training levels reported in studies on personalized learning. Studies were found at all training levels. The most frequent were undergraduate (n=54, f=52.9%), followed by secondary school and graduate studies (n=17, f=16.7%), and in-service teachers (n=16, f=15.7%). Studies were also found at the

primary education level and in free courses (n=11, f=10.8%) as well as in lifelong learners. However, it is striking that the preschool or early childhood level is the least explored, followed by pre-service teachers.

4. Discussion

The rapid advancement of artificial intelligence (AI) techniques presents intriguing possibilities to enhance personalized learning systems across multiple drivers identified in this review. As demonstrated by recent literature, AI-enabled solutions can play a pivotal role in the automated profiling of individual learners (Driver 1) by applying predictive analytics and machine learning algorithms to student interaction data (Tapalova and Zhiyenbayeva, 2022). The rich insights uncovered on knowledge levels, interests, and evolving needs can inform adaptive content sequencing and recommendation engines (Driver 2) to provide customized learning paths, intelligent tutoring, and conversational learning experiences (Castanha *et al.*, 2022).

For assessment personalization (Driver 3), AI shows promise in supplying real-time feedback, surfacing intervention needs, and tracking progress through analysis of students' work processes and responses (Feng, Magana and Kao, 2021). On the user interface front (Driver 4), AI-driven personalization can tailor navigation, structure, elements, and recommendations to enhance usability and engagement for each learner (Afini-Normadhi *et al.*, 2019). The aforementioned capabilities are enabled by employing advanced AI techniques such as machine learning, neural networks, natural language processing, and reinforcement learning that allow continuous improvement as more data is gathered (Driver 5) (Dhawan and Batra, 2020).

To fully harness the potential of AI in education, it is critical to develop teacher competencies (Driver 6) in interpreting analytics, implementing adaptive tools, and maintaining strong pedagogical foundations while protecting student privacy and preventing bias (Luckin and Holmes, 2016). Furthermore, human-centred design principles must be employed to develop intuitive interfaces and ensure transparency in AI systems' workings. Research is also needed to refine theoretical frameworks (Driver 7) underpinning personalized learning in light of the emerging affordances of AI (Bodily *et al.*, 2018). In summary, this discussion highlights the transformative yet balanced integration of AI to advance key drivers of personalized learning. More empirical studies are vital to unravel the full possibilities and pitfalls of this symbiosis.

This literature review shows that personalized learning holds vast potential across various disciplines and educational levels and modalities, including of course, e-learning. Furthermore, significant progress has been observed in the field of computer science, likely attributed to the rapid advancements in information technologies and artificial intelligence. These developments have drawn researchers' attention towards designing and implementing new computer-assisted learning strategies (Yang *et al.*, 2013).

It has been said that thoughtfully designed AI systems have immense potential to enhance data-driven, real-time personalization of instructional experiences to unlock the best in every student in the education 4.0 era. So, the next are some implications for education 4.0 and how AI can enhance the main drivers of personalized learning based on the literature review results.

Regarding the identification of learner characteristics, the ability of AI systems to rapidly process diverse student data opens new possibilities to build comprehensive learner profiles that capture academic abilities, conceptual misunderstandings, motivations, interests, and more. Also, advanced algorithms can identify patterns and relationships to model learner knowledge, skills, and needs in a sophisticated way. This enables the possibility of designing highly customized instructional strategies based on each student's profile (Liu, Primmer and Zhang, 2019).

Concerning personalizing content, with continually updated student models, AI systems can recommend the optimal content for each learner using machine learning techniques. As the system tracks their progress, the content can evolve in sync with the learner's demonstrated competencies, knowledge gaps, and interests. This creates a personalized content flow mapped to the learner's path that can be adjusted in terms of scope, complexity, modality, and pedagogical strategies based on the learner's evolving model (Ismail and Belkhouche, 2019).

Respecting personalizing assessments, AI has extensive potential to transform student assessment due to algorithms that can generate customized assessment items tailored to the skills and needs identified in each learner profile. Intelligent analysis of student responses and solution patterns can pinpoint knowledge gaps for targeted feedback and remediation, configuring on-demand assessments that can be tailored, enabling students to progress at their own pace.

Concerning personalizing interfaces, Mallik and Gangopadhyay (2023) indicate that with natural language processing and sentiment analysis capabilities, AI systems can interpret student voices, faces, and emotions to foster humanized interactions. In this sense, chatbots, virtual tutors, and gaming environments can dynamically adjust their interfaces, language, feedback, and motivational strategies to adapt to diverse learners and create connections, providing comfort and heightening engagement.

At last, but not least, it is interesting to consider leveraging emerging technologies, from smart devices to virtual reality, in which AI unlocks new modalities for personalized learning experiences.

Moving forward, further research is imperative, given that our comprehension of the optimal applications and consequences of AI in personalized learning is still evolving. Studies that encompass a diverse range of learner perspectives across various modalities, subjects, and extended durations are particularly significant.

One avenue for future research involves investigating AI techniques and algorithms. These studies should delve into identifying the most effective AI techniques and algorithms for modelling and responding to learner needs in real-time, aiming to enhance the intelligence and pedagogical effectiveness of AI adaptive systems.

Another vital area for exploration pertains to integration frameworks for AI and human instruction. It is crucial to explore frameworks that seamlessly integrate AI into personalization while preserving the roles of human educators, understanding how to harmonize AI and human instruction effectively is of utmost importance.

Besides the above, the development of a robust ethical framework is essential in the context of AI in education. Future research should delve into the ethics surrounding student data usage and privacy maintenance, especially with the increasing integration of AI in education. This issue has become a pressing challenge for educational policymakers and practitioners alike.

Another research approach that must be taken into consideration has to do with longitudinal studies comparing learning outcomes and engagement with AI-driven personalization versus traditional methods are essential. Concrete evidence gathered over an extended period is necessary to assess the true impact of AI in education.

Lastly, another valuable research branch to explore involves action research focused on effective change management strategies for the successful adoption of AI in educational institutions. Investigating how institutions can effectively implement AI-driven changes is crucial, and conducting comparative studies will help with this topic, assessing the limitations and best practices of human teacher personalization versus AI systems can provide valuable insights into the most effective approaches.

5. Conclusions

This systematic literature review thoroughly explores the fundamental drivers of personalized learning in the context of artificial intelligence (AI) and Education 4.0. The findings underscore critical factors such as identifying individual student characteristics, customizing content delivery and assessment methods, adapting user interfaces and learning environments, and harnessing advanced AI techniques and architectures. Significantly, AI emerges as a transformative catalyst, offering unprecedented capabilities in learner profiling, adaptive content delivery, real-time feedback, and intelligent interfaces. These AI-driven solutions hold great promise for enhancing personalized learning experiences, and addressing diverse learner needs, preferences, and competencies in a data-driven and dynamically responsive manner. This aligns with the vision of creating digital spaces or classrooms conducive to personalized learning, leveraging generative artificial intelligence to tailor instruction around core concepts, principles, and skills.

Regarding the above, achieving digital spaces (or even classrooms) that facilitate personalized learning has commonly been seen as an idealized and difficult scenario to attain. However, the rapid development of generative artificial intelligence may provide an appropriate response that allows for advancing opportunities for educators to carefully tailor instruction around the essential concepts, principles, and skills of each subject. This scenario provides a unique opportunity to advance the ideas promoted by Tomlinson (2017) regarding the design of differentiated classrooms. These classrooms are characterized by teachers who are attentive to student differences. In such settings, assessment and instruction are inseparable, and teachers can modify the content, process, and expected outcomes in the curriculum. Tomlinson's approach emphasizes the importance of adapting teaching strategies to meet the diverse needs of students, ensuring that each learner receives an education tailored to their abilities, interests, and learning levels.

Today's classrooms are typically characterized by a diverse population of students. This diversity can be attributed to various factors such as increased access to education at all levels, immigration trends, deepening

socioeconomic disparities within the general population, and the impact of the COVID-19 pandemic, which significantly affected student attendance at educational institutions. Addressing this scenario offers a unique opportunity to promote the creation of personalized learning programs. The current possibilities include utilizing different sources of information and developing new capacities for analyzing data with innovative strategies, such as data mining and machine learning, which can be enhanced by Artificial Intelligence (AI). These advancements prompt us to consider that we are at a juncture of transformation in our understanding of the teaching and learning processes. It is conceivable that future educators will need to be professionals who can adeptly interact with these new forms of information.

By way of closing these conclusions, it is worth mentioning that as the integration of AI in personalized learning continues to gain momentum, future research efforts must prioritize addressing the remaining challenges and unexplored opportunities. Longitudinal studies assessing the long-term impact of AI-driven personalization on learning outcomes, engagement, and skill development across diverse educational settings are crucial. Additionally, the development of robust ethical frameworks and governance models is imperative to ensure the responsible and equitable use of AI in education, safeguarding student privacy and mitigating potential biases. Furthermore, action research focused on effective change management strategies can provide valuable insights into the successful adoption of AI-enabled personalized learning systems within educational institutions. Ultimately, interdisciplinary collaboration among educators, technologists, policymakers, and stakeholders is vital to realizing the full transformative potential of AI in personalized learning and shaping the future of Education 4.0.

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Highlights

- AI systems holds vast potential to enhance data-driven, real-time personalization of learning.
- AI systems allow the creation of personalized content flow mapped to the learner's path
- AI has extensive potential to transform student customized assessment.
- Natural language processing facilitates the creation of connections, providing comfort and engagement.
- AI unlocks new modalities for personalized learning experiences

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Exploring the Characteristics and Attitudes of Electronic Textbook Users and Nonusers

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Abstract: A technological trend influencing society is the provision and adoption of digital books. Digital books are used in education in the form of electronic textbooks (e-textbooks). The research question examined in this manuscript is which students' characteristics and attitudes influence their adoption or non-adoption of e-textbooks? The study explores these characteristics and attitudes of students who have made the decision to become either an e-textbook user or nonuser. The empirical analysis is conducted using 1191 student responses to a questionnaire distributed in a mid-sized university in the western United States. Among these 1191 responses, 530 of the students had used an e-textbook and 661 had not used an e-textbook. The e-textbook user and nonuser groups are studied in three different ways. The first is by examining the counts and percentages for five respondent characteristics. The second way is through statistical tests (i.e., t-tests and multiple analysis of variance) on these characteristics across the groups. The results from these analyses did not identify any meaningful differences in characteristics across the user and nonuser groups. The third way was a content analysis performed on an open-ended question (i.e., What factors influenced you on whether to use an e-textbook?) on the questionnaire. The student e-textbook attitudes discovered from the content analysis showed that for e-textbook users, the cost or price of an e-textbook had a significant influence on e-textbook adoption. Two other attitudes influencing e-textbook users' adoption were usability, both positive and negative. The key attitude of nonusers regarding e-textbook adoption is negative e-textbook usability.

Keywords: e-Textbooks, Technology adoption, Characteristics of e-Textbook adoption

1. Introduction

Technological advances change society and individuals' lives. One example is the development and adoption of digital books. Adoption of digital books, or e-books, were initially slow to be accepted due to a lack of industry standards for the technology, transferability among technologies, and the lack of a clear, consistent business model (Dillon, 2001; Thomas, 2007). Another issue affecting acceptance is usability in the form of eye strain and fatigue on an electronic screen. On the other hand, reducing the cost of book production to an electronic format is advantageous to users, even if the readability is not ideal (Coleman, 2004; Liu, 2005; Baker-Eveleth, Miller, and Tucker, 2011). In a recent Pew Research Center report, around a third of the books read in the United States is of an electronic format (Faverio and Perrin, 2022). Digitized or electronic books have been used in education in the form of electronic textbooks (e-textbooks) for over twenty-years (Young, 2009; DeSantis, 2012; Daniel and Woody, 2013; Ji, Michaels, and Waterman 2014). An e-textbook is defined as a digitized version of a selected book assigned as part of the reading for a course (Dixon, 2020). E-textbooks can be web-based, digital replicas of print textbooks, or downloadable PDF's (Falc, 2013). With the variety of learning environments available to college students such as traditional face-to-face lectures, online, or blended method, e-textbooks can be beneficial for easy access to a written resource (Nouraey and Al-Badi, 2023; Chaw and Tang, 2023). E-textbooks are considered a learning object since they support learning, are reusable, and provide a building block for digital course content (Ritzhaupt, 2010). The structure of an e-textbook allows a student to interact with the discipline content in many ways. Examples include reference material, practice problems, or as a test environment depending on the needs of the student. A typical e-textbook can be used in different learning contexts making it reusable (Mogharreban and Guggenheim, 2008).

Although e-textbooks can provide quick interaction with the course content, several research studies have found that undergraduate students prefer learning with printed textbooks rather than digital (Noyes and Garland, 2005, Noyes and Garland, 2006, deNoyelles and Raible, 2017, Clinton-Lisell, Kelly and Clark, 2020). Users have expressed a willingness to use an e-textbook due to the digitized format making access easier and the ease of mobility although the usability issues of screen readability are a poor substitute for a print text (Bennett and

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Landoni, 2005; Buzzetto-More, Sweat-Guy and Elobaid, 2007; Dwyer and Davidson, 2013; Jardina and Chaparro, 2015). Liu (2005) found that 80% of students surveyed prefer print to digital textbooks to understand the text meaning. In this same study, these undergraduate students found digital or e-textbooks to be less interesting and the authors less credible. The University of California Libraries conducted a study and found that 58% of undergraduate students preferred print books (Falc, 2013) while a study at Northwest Missouri found a 40% reduction in studying because of the e-textbook format (Young, 2009).

Although there is a desire for reading print-based textbooks, increases in educational costs have college students considering ways to reduce their costs. The financial burden of education has escalated remarkably over the last 50 years due to a sharp rise in college tuition costs (Sauter, 2019). In addition to tuition, fees and room and board have increased 1,600%. Furthermore, data from the College Board indicates a continued upward trajectory beyond 2018, with the average costs of attending a private college reaching $60,420, and a public college at $46,730 during the 2022-2023 academic year. The average annual expenditure for ancillary academic materials such as textbooks and supplies are around $1,250; textbook costs have skyrocketed by 800% between 1978 and 2018. An additional impact to academic costs, is inflation, with the most significant increases since the late 1970s and early 1980s, causing additional strains to family budgets, compelling them to seek methods for reducing educational expenses (Staff Writers, 2022; Amadeo, 2023). One notable strategy to alleviate this financial pressure is the adoption of e-textbooks, which are generally 40-50% less expensive than traditional print textbooks (Staff Writers, 2022). In an era marked by economic challenges, every dollar saved on educational expenses is of paramount importance.

If the cost of textbooks is reduced by changing the display format, it would seem college students would be interested in switching to e-textbooks. Understanding if there is a difference between e-textbook and non e-textbook users, would be beneficial to faculty in developing courses. In addition, if there are other characteristics beyond the cost of the e-textbook influencing students' decisions and outcomes, that too would be important to understand.

2. The Literature

The prevalence of digital devices introduces a potential challenge for students: distractions. While e-textbooks and digital learning tools provide valuable interactive elements, they also open the door to various diversions such as social media, emails, and other applications (Jabr, 2013). These distractions can hinder a student's ability to maintain focused and concentrated study sessions.

Some students prefer the tactile experience of physical books and find it easier to highlight, annotate, and navigate through printed pages (Inie, Barkhuus and Brabrand, 2021). E-textbooks can be affected by technical glitches (Novak et al., 2022), compatibility issues (Casselden and Pears, 2020), ease of use issues (D'Ambra, Akter, and Mariani (2022), or Internet connectivity problems (Jaggars et al., 2021), which can disrupt the learning process. Not all students have access to devices capable of displaying e-textbooks (Carlson, 2005), which can create inequalities among students. Some students simply prefer the sensory experience of reading from a physical book and find it easier to engage with the material in that format (Johnston and Salaz, 2019). With physical textbooks, students can sell or share them after the course. E-textbooks might have limitations on reselling or sharing due to licensing and digital rights management (Millar and Schrier, 2015).

Despite the above problems with e-textbooks, there are a variety of advantages, such as lower costs, accessibility alternatives such as audio or video, and improved currency of content (Staff Writers, 2022; Amadeo, 2023; Cavanaugh, 2004). The cost advantage to students is reasonably clear since e-textbooks can be rented for half the price of a traditional textbook (Falc, 2013; Baker-Eveleth, Miller, & Tucker, 2011). Public school districts are also moving to e-textbooks as a cost saving mechanism (Tomassini, 2012); a recent higher education study showed the difference in savings between e-textbooks and traditional texts is insignificant considering a purchased textbook can be kept for longer or returned for cash (DeSantis, 2012). In addition, some states have proposed legislation for e-textbooks to ease costs by focusing on open educational resources (OER) (Scott and Shelly, 2023; deNoyelles and Raible, 2017, Hane, 2011). The goal of OER is to provide affordable college resources by sharing existing online sources thus reducing barriers for students regardless of economic status (Luo, Hostetler, Freeman and Stefaniak, 2020). The challenge may relate to certain disciplinary areas such as healthcare or technology due to rapid changes or the quality of the content.

E-textbooks provide convenience and accessibility for students but also have a positive environmental impact. The attraction stems from the realization that e-textbooks offer a significant reduction in carbon footprint compared to traditional printed textbooks. By embracing digital learning materials, students can actively

contribute to a more sustainable future by minimizing paper production, reducing transportation emissions, and conserving valuable natural resources (Kapuka, Shumba and Munthali, 2017). As ecological consciousness becomes a driving force among the younger generation, e-textbooks stand out as a practical and ecologically friendly choice, aligning education with environmental responsibility.

Students are increasingly gravitating towards the interactive nature of e-textbooks as a preference over traditional print media. The allure lies in the dynamic and engaging features that digital platforms offer, enabling students to delve deeper into their learning experience. Interactive elements such as multimedia content, hyperlinks, embedded quizzes, and simulations enhance comprehension and retention, catering to various learning styles (Spencer et al., 2020, Clinton-Lisell, Kelly and Clark, 2020). This interactivity not only fosters a more immersive educational journey but also empowers students to actively participate in their learning process. As technology continues to evolve, e-textbooks provide a glimpse into the future of education, where customization and engagement are seamlessly integrated into the academic landscape. Internet availability has created an opportunity for easy access to digital resources and e-textbooks. Electronic book readers and tablet devices have also affected the access to digital resources by providing portability, search-ability, and content tagging (Choi, 2012, Peek, 2012, Weisberg, 2011). Searching and tagging on a device mimics a traditional textbook with highlighting, page tagging, and writing comments in the margins (Lai and Chang, 2011). The improved currency of content is due to the ability of publishers to update content more frequently between print editions of a textbook. This is particularly advantageous in dynamic content areas (Cavanaugh, 2004).

Given the mix of advantages and disadvantages of students purchasing and using e-textbooks, not all students adopt, when a volitional decision, e-textbooks. This leads to the research question for this work, what are the student characteristics and attitudes which influence them to adopt or not to adopt e-textbooks? The research to address this question is presented in the following order. First, the data and a description of e-textbook users and nonusers groups are presented. These descriptions are followed by the analysis methods and results. The manuscript finishes with a discussion of the results and conclusions.

3. The Method

3.1 The Sample

The data to empirically examine e-textbook users' and nonusers' characteristics and attitudes were collected using a survey of students at a mid-sized university in the western United States. The questionnaire was web-based and developed and distributed using Qualtrics. A university listserv of students provided the email addresses to which the questionnaire was distributed. A total of 11,957 students received an email invitation to complete the questionnaire and 1382 responses were received producing a 11.56% response rate. Among these 1382 responses, 191 were incomplete and excluded from the study. The remaining 1191 responses had 530 or 45% reporting prior or current e-textbook use and 661 respondents or 55% who had not used an e-textbook. The analysis presented here is based upon these 1191 questionnaire responses, grouped as either an e-textbook user or nonuser. The questionnaire was developed from pre-existing measures related to technology acceptance and expectation-confirmation theory and was pre-tested with graduate students (Stone and Baker-Eveleth, 2013, 2013a).

The target population of respondents for the questionnaire were the students enrolled at the university as they would be included on the student Listserv. To examine the possible presence of nonresponse bias in the sample, two sample demographics were compared to the corresponding university demographics. Females appear to be slightly overrepresented in the sample at 57.36% compared to the student population at 45.70%. Students from the College of Business & Economics were overrepresented in the sample at 22.17%, while in the university population this percentage was 10.53. The greater percentage of business and economics majors in the sample may be because faculty from this college distributed the questionnaire. The gender percentage difference may be the result of a slightly greater percentage of female business and economics majors compared to males in these majors.

3.2 Respondent Characteristics

The study begins by comparing the characteristics of e-textbook users and nonusers. In Table 1, Panel A, the numbers, and percentages of respondents in total and for e-textbook users and nonusers are shown for respondent gender, whether they worked fulltime while in college, and whether they received parental and family support while in college. The overall sample was composed of 41% males and 59% female. These percentages where consistent for e-textbook users at 42% male and 58% female and for nonusers of e-textbooks at 41% male and 59% female. As for working full-time while in college, the overall sample showed 18% did so,

while 16% of e-textbook users worked full-time while 19% of nonusers also worked. In the full sample, 52% of the respondents received support from their parents and family, while 54% of e-textbook users and 51% of nonusers reported this same source of support.

Panel B in Table 1 illustrates the distributions for the two continuous characteristics, percent of expenses paid by the student and the student's grade point average (GPA). Regarding the percentage of expenses paid by the student, the only statistics which varied across all three groups (i.e., all respondents, e-textbook users and nonusers) were the means, standard deviations, and medians. All respondents, on average, paid 66% of their expenses while e-textbook users and nonusers paid 64% and 67% of their expenses, respectively. Similar results are observed for the medians with the all-respondent sample median at 80%, e-textbook users at 79%, and nonusers at 85%. The standard deviation varied slightly across the three groups of respondents with the differences being less than one. For the distribution of GPA, the means ranged from 3.36 to 3.37 and the median values ranged from 3.44 to 3.46. The standard deviations for these three groups differed by only 0.01.

Table 1: The Characteristics of All Respondents, E-Textbook Users and Nonusers

Panel A

Gender	All Respondents	E-Textbook Users	E-Textbook Nonusers
Male	493 (41.39%)	222 (41.89%)	271 (41.00%)
Female	698 (58.61%)	308 (58.11%)	390 (59.00%)
Totals	1191 (100.00%)	530 (100.00%)	661 (100.00%)

Work Fulltime While in College	All Respondents	E-Textbook Users	E-Textbook Nonusers
Yes	191 (17.77%)	77 (15.88%)	114 (19.32%)
No	884 (82.23%)	408 (84.12%)	476 (80.68%)
Totals	1075 (100.00%)	485 (100.00%)	590 (100.00%)

Parental & Family Support While in College	All Respondents	E-Textbook Users	E-Textbook Nonusers
Yes	549 (52.19%)	258 (54.09%)	291 (50.61%)
No	503 (47.81%)	219 (45.91%)	284 (49.39%)
Totals	1052 (100.00%)	477 (100.00%)	575 (100.00%)

Panel B

Percent of Expenses Paid by Student	Measure	All Respondents	E-Textbook Users	E-Textbook Nonusers
	Number of Respondents	1150	513	637
	Mean	65.86%	64.00%	67.35%
	Standard Deviation	37.13	37.59	36.72
	Maximum	100%	100%	100%
	Upper Quartile	100%	100%	100%
	Median	80%	79%	85%
	Lower Quartile	30%	30%	30%
	Minimum	0%	0%	0%

The Characteristics of All Respondents, E-Textbook Users and Nonusers

Grade Point Average	Measure	All Respondents	E-Textbook Users	E-Textbook Nonusers
	Number of Respondents	1167	518	637
	Mean	3.36	3.36	3.37
	Standard Deviation	0.52	0.53	0.52
	Maximum	4.00	4.00	4.00
	Upper Quartile	3.79	3.78	3.79
	Median	3.44	3.44	3.46
	Lower Quartile	3.02	3.02	3.02
	Minimum	0.00	0.00	0.00

All in all, the statistics shown in Table 1 do not indicate, at least to the naked eye, meaningful differences across these three groups. Most importantly for this study, no differences appear to exist between e-textbook users and nonusers. To further study any potential differences in these students' characteristics, statistical tests were also performed. The results of these tests are presented below.

3.3 Statistical Tests

To formally confirm the lack of apparent differences shown from the examination of the values in Table 1, statistical tests of differences were performed. The results from these tests are shown in Table 2. All the tests were performed using PC SAS 9.4. The first set of tests performed were t-tests for mean differences between e-textbook users and nonusers on respondent characteristics. In each test, the equality of the group variances, user and nonuser, was tested. In all these tests, no evidence was found for unequal variances across these groups. As a result, all the reported t-values are computed for equal variances. For each t-test, no significant differences were found between e-textbook users and nonusers for all the examined characteristics. These t-test results support the conclusions reached from an inspection of the values in Table 1.

Table 2: Comparing the Characteristics of E-Textbook Users and Nonusers t-Test Results

Gender

	Number	Mean	Standard Deviation	Standard Error	Minimum	Maximum
User	530	1.58	0.49	0.022	1.00	2.00
Nonuser	661	1.59	0.49	0.019	1.00	2.00

Equality of Variances

Method	Numerator DF	Denominator DF	F	Pr>F
Folded F	529	660	1.01	0.93

t-Test

Method	Variances	Degrees of Freedom	t-Value	Pr>|t|
Pooled	Equal	1189	-0.31	0.76

Work Fulltime While in College

	Number	Mean	Standard Deviation	Standard Error	Minimum	Maximum
User	485	1.84	0.37	0.017	1.00	2.00
Nonuser	59	1.81	0.40	0.016	1.00	2.00

Equality of Variances

Method	Numerator DF	Denominator DF	F	Pr>F
Folded F	589	484	1.17	0.08

t-Test

Method	Variances	Degrees of Freedom	t-Value	Pr>|t|
Pooled	Equal	1073	1.47	0.14

Parental & Family Support While in College

	Number	Mean	Standard Deviation	Standard Error	Minimum	Maximum
User	477	1.46	0.50	0.023	1.00	2.00
Nonuser	575	1.49	0.50	0.021	1.00	2.00

Equality of Variances

Method	Numerator DF	Denominator DF	F	Pr>F
Folded F	574	476	1.01	0.95

t-Test

Method	Variances	Degrees of Freedom	t-Value	Pr>|t|
Pooled	Equal	1050	-1.12	0.26

Percent of College Expenses Paid by Student

	Number	Mean	Standard Deviation	Standard Error	Minimum	Maximum
User	513	64.00%	37.59	1.66	0.00	100.00
Nonuser	637	67.35%	36.72	1.45	0.00	100.00

Equality of Variances

Method	Numerator DF	Denominator DF	F	Pr>F
Folded F	512	636	1.05	0.57

t-Test

Method	Variances	Degrees of Freedom	t-Value	Pr>|t|
Pooled	Equal	1148	-1.52	0.13

Grade Point Average

	Number	Mean	Standard Deviation	Standard Error	Minimum	Maximum
User	518	3.36	0.53	0.023	0.00	4.00
Nonuser	647	3.37	0.52	0.020	0.00	4.00

Equality of Variances

Method	Numerator DF	Denominator DF	F	Pr>F
Folded F	517	648	1.05	0.57

t-Test

Method	Variances	Degrees of Freedom	t-Value	Pr>|t|
Pooled	Equal	1165	-0.43	0.66

Because performing several t-tests on a series of related variables, such as these student characteristics, may distort the probabilities of Type I and Type II errors, multiple analysis of variance (MANOVA) was also performed. The MANOVA was also performed using PC SAS version 9.4. The results show no meaningful differences for the respondent characteristics individually between e-textbook users and nonusers. Additionally, based on the group MANOVA test, no differences were observed across the user and nonuser samples as a group. These results are shown in Table 3.

Table 3: Comparing the Characteristics of E-Textbook Users and Nonusers

Multiple Analysis of Variance Results

Gender

Source	DF	Sum of Squares	Mean Square	F-Value	Pr>F
Model	1	0.004	0.004	0.02	0.89
Error	968	235.90	0.24		
Corrected Total	969	235.90			

Work Fulltime While in College

Source	DF	Sum of Squares	Mean Square	F-Value	Pr>F
Model	1	0.23	0.23	1.95	0.16
Error	968	112.35	0.12		
Corrected Total	969	112.58			

Parental & Family Support Paying for College

Source	DF	Sum of Squares	Mean Square	F-Value	Pr>F
Model	1	0.55	0.55	2.20	0.14
Error	968	241.95	0.25		
Corrected Total	969	242.50			

Percent of College Expenses Paid by Student

Source	DF	Sum of Squares	Mean Square	F-Value	Pr>F
Model	1	2119.68	2119.68	1.53	0.22
Error	968	1,345,296.22	1389.77		
Corrected Total	969	1,347,415.91			

Grade Point Average

Source	DF	Sum of Squares	Mean Square	F-Value	Pr>F
Model	1	0.21	0.21	0.72	0.40
Error	968	274.29	0.28		
Corrected Total	969	274.50			

No Overall E-Textbook User/Nonuser Effect

Statistic	Value	F-Value	Numerator DF	Denominator DF	Pr>F
Wilks' Lambda	0.9956	0.84	5	964	0.52
Pillai's Trace	0.0044	0.84	5	964	0.52

Statistic	Value	F-Value	Numerator DF	Denominator DF	Pr>F
Hotelling-Lawley Trace	0.0044	0.84	5	964	0.52
Roy's Greatest Root	0.0043	0.84	5	964	0.52

3.4 Content Analysis

Intuitively, we expected to observe differences between e-textbook users and nonusers on at least some of the student characteristics. Based upon the literature presented earlier and the lower cost of e-textbooks, it was expected to see some differences in the college expense-related characteristics (i.e., working full-time, parental and family support, percent of student paid expenses). The lack of meaningful differences in these characteristics lead us to investigate the attitudes of e-textbook users and nonusers for differences. To examine the respondents' attitudes, content analysis was performed on student responses to the open-ended question "What factors influenced you on whether or not to use an e-textbook?".

The content analysis was performed by two of the authors who acted as raters for the responses on the open-ended question. Independently, the two raters identified themes and subthemes from both e-textbook users' and nonusers' responses in the open-ended question. If a respondent mentioned a concept or concern, the raters included it in the analysis. The raters did not screen any respondents' answers. After the raters developed their individual themes and subthemes, they agreed to a unified set of themes and subthemes. These final themes and subthemes were used in the analysis discussed below and shown in Table 4. In Table 4, the themes and subthemes are categorized by e-textbook users and e-textbook nonusers. Also displayed in Table 4 are the number of respondents who mentioned the theme or subtheme in their response to the open-ended question. Among the 1191 responding students, 973 left meaningful answers to the open-ended question, which equates to an 81.70% rate. Although there were 973 responses, components of the responses were extracted and may not equal 973.

Table 4: The Content Analysis Results for E-textbook Users and Nonusers

E-Textbook Users

Themes & Subthemes	Number of Responses
Price/Cost	**281**
Usability: Positive	**149**
Portability, Size, Weight	59
Features	39
Ease of Use	26
Convenience	25
Usability: Negative (e.g., Eye Fatigue; Don't Like to Read Online)	**103**
Type of Class (e.g., Subject, Major, Professor, Online)	**78**
Ownership	**66**
Available After Course Over	49
Resale	17
Accessibility (e.g., IT Platform, Device, Mobility, Availability, Internet Access)	**55**
Learning Impacts	**11**
Less Effective	6
More Effective	5
Immediate Delivery	**8**
Better for the Environment	**7**

E-textbook Nonusers

Themes & Subthemes	Number of Responses
Usability: Negative	**132**
Ease of Use	70
Eye Fatigue/ Don't Like to Read Online	62
Price/Cost	**77**
Accessibility (e.g., IT Platform, Device, Mobility, Availability, Internet Access)	**52**
Ownership	**35**
Availability After Course Over	21
Resale	14
Usability: Positive (e.g., Portability, Size, Weight, Convenience)	**32**
Type of Class (e.g., Subject, Major, Professor, Online)	**20**
Learning Impacts (e.g., Less Effective, Preference, Distracting)	**17**
Better for the Environment	**2**

A cutoff of 100 for the number of times a theme was mentioned was used to determine which themes are seen as key issues for the respondents. Using this cutoff, e-textbook users identified three key issues influencing their adoption decision. These key issues, in rank order, were price or cost, usability in a positive sense (e.g., portability, features, ease of use, and convenience), and usability in a negative sense (e.g., eye fatigue, don't like to read online). Only one theme for e-textbook nonusers satisfied this 100-response cutoff. This theme is usability in a negative sense, meaning these respondents do not like to read online or experience eye fatigue when they do.

4. Discussion

The data displayed in Table 1 and the statistical tests indicated e-textbook users and nonusers did not differ on their characteristics studied. The content analysis indicated that e-textbook users and nonusers displayed attitude differences regarding the adoption or potential adoption of e-textbooks. E-textbook users displayed positive attitudes toward the price or costs of adopting e-textbooks and the usability of e-textbooks. However, these users also acknowledged the negative aspects of usability, eye strain and having to read online, of using e-textbooks. These attitudes are consistent with the literature presented earlier. Specifically, e-textbooks are lower cost, quicker access to start reading, and a better delivery method, but not a better way to read. E-textbook nonusers, on the other hand, most frequently commented on the negative aspects of e-textbook usability. Their second most frequent comment was the price or cost of e-textbooks. It may well be that for these students the negative usability aspects of an e-textbook such as eye strain are so significant that these dominate any potential cost savings from adopting an e-textbook when making the adoption decision.

The content analysis results indicate that students' adoption or non-adoption of e-textbooks is very much a matter of personal preference, tempered by economic or cost considerations. The student population characteristics (e.g., economic circumstances) at a particular university or in a particular major or program could significantly influence e-textbook adoption rates. Given current concerns regarding higher education costs, in general, e-textbook use could be an important factor for universities and instructors to consider when performing instructional design.

Overall, the results do provide some insights into students' attitudes regarding the use or nonuse of e-textbooks. Most surprising and interesting in these results is the lack of needed financial support or self-funded educational expenses (i.e., percent of college expenses paid by the student, whether the student received parental or family support while in college) influencing a student's use or nonuse of e-textbooks. One often cited motivation for students to use an e-textbook is the reduced cost of e-textbooks. The statistical results do not support this motivation, but the content analysis indicated this was one motivation for e-textbook users. Confounding this result is that the content analysis for nonusers showed that price or cost was the second most frequently commented attitude. The question which comes to mind is "Do e-textbook nonusers perceive the negative usability of e-textbooks to be so negative as to make their lower costs insufficient to warrant using e-textbooks?

Another interesting result was identified for the attitudes of usability, both positive and negative. E-textbook users listed the themes of positive usability and negative usability as the second and third most mentioned comment. E-textbook users appear to acknowledge both the positive and negative aspects of e-textbooks. Possibly when balancing both positive and negative usability aspects of using an e-textbook with the lower costs, e-textbook users evaluate the benefits from e-textbook use to be greater than these negative usability aspects. Hence, they adopted the e-textbook. In the case of e-textbook nonusers, they appear to evaluate the negative usability aspects of e-textbooks as so great that these overwhelm any price or cost advantages.

5. Conclusions

Given the growing trend of e-textbooks in education, and the expansion of course delivery methods, it is worthwhile to understand the characteristics and attitudes which influence students' willingness to adopt electronic textbooks. The entirety of these results provides mixed findings regarding the adoption motivations of e-textbook users and nonusers. Additional research is needed to understand students' attitudes and motivations toward adopting or not adopting e-textbooks. The interplay of the positive and negative aspects of usability balanced with the cost or price factor is of particular interest. The course subject (e.g. business, mathematics, biology) may also influence users and nonusers motivation to read e-textbooks but limited research has been conducted identifying courses; this could provide valuable feedback to faculty when adopting e-textbooks.

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A Robust Examination of Cheating on Unproctored Online Exams

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Abstract: The rapid growth of online education, especially since the pandemic, is presenting educators with numerous challenges. Chief among these is concern about academic dishonesty, especially on unproctored online exams. Students cheating on exams is not a new phenomenon. The topic has been discussed and debated within institutions of higher learning, and significant levels of cheating have been reported in the academic literature for over sixty years. Much of this literature, however, has focused on student behavior in a classroom utilizing proctored, in-class exams. Grades on exams usually determine most of a student's final grade in a course, and GPAs are used by employers and graduate schools to indicate a student's subject matter mastery. As more conventional colleges and universities expand their online course offerings it is natural to wonder if academic dishonesty is more prevalent in online classes than in face-to-face classes. In particular, are students more likely to cheat when no one is watching (i.e., on unproctored assessment assignments) than they do when someone is watching (i.e., on proctored assessment assignments)? The purpose of this study is to investigate whether students cheat more on unproctored online exams than they do on proctored in-classroom exams, and if so, is there any pattern to their cheating behavior. Our findings are derived from careful empirical analysis of 741 undergraduate students who completed three unproctored online exams, several collaboration-encouraged assignments, and a proctored in-class comprehensive final exam in the same course with the same instructor. Additionally, we collected demographic and human capital data for every student. Using bivariate and regression analysis, we find significant evidence of more cheating on unproctored online exams than on proctored in-class exams even though students were given stern honor code violation warnings. Moreover, we discover that student cheating increased with each unproctored online exam, implying that students learn how to cheat as they become more familiar with taking online assessment assignments. Finally, we find that students with certain demographic and human capital characteristics tend to cheat more than others. This research strongly supports the use of proctoring for all evaluation assignments in online classes to ensure that grades in these classes properly reflect student aptitude as opposed to merely reflecting their ability to cheat.

Keywords: Academic dishonesty, Cheating, Online education, Unproctored online exams, Proctored in-class exams

1. Introduction

Academic dishonesty, especially on exams which often determine the most significant part of a student's grade, is a major concern for higher education. When a student receives a grade that exaggerates their actual knowledge of subject matter or ability to critically think, employers who hire or graduate schools that admit the student soon realize they have been deceived. This realization not only tarnishes the reputation of the school, but it also imperils the core of the institution. Once a "cheating culture" is established, academic dishonesty flourishes (Tolman, 2017). This can lead to a perception by students that everyone is cheating and that the only way to get ahead is to cheat (Crittenden, Hanna and Peterson, 2009). Such malignant behavior must be recognized and addressed before it snowballs. Academic faculty, researchers and institutions need to study academic dishonesty not only to protect the reputation of their universities and the core of their institutions but also to protect honest students from believing that they must cheat to compete.

Much academic research (Simkin and McLeod, 2010; McCabe, Butterfield and Trevino, 2012) reports that student cheating on exams in college is rampant, and for some students cheating has become habitual (Clarke and Lancaster, 2006). Most of this research, however, has focused on traditional face-to-face (F2F) education where exams are proctored. The rapid growth in online education (Morris, et al., 2020; Guppy, et al., 2022) raises the question of whether students are more apt to cheat on unproctored online exams than on proctored in-class exams.

Interestingly, the literature concerning online exam cheating is mixed. Some of these studies use survey data (King, Guyette and Piotrowski, 2009; King and Case, 2014) where students are anonymously asked whether they would tend to cheat more on unproctored online exams or on proctored in-class exams. The most common answer to this question is "yes." Caution, however, should be exercised in strictly interpreting survey data concerning cheating. After all, surveys ask dishonest people (i.e., cheaters) to honestly report whether or not

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they engaged in a dishonest activity. Since they are already dishonest, their answers may be less than forthright. Some students may fear being truthful, despite promises of anonymity; others may exaggerate their behaviors as a form of bragging, misusing the promise of anonymity as a protective shield. Indeed, information can be gleaned from student surveys about cheating, but the possibility of bias must be considered. Other studies (Harmon and Lambrinos, 2008; Beck, 2014; Dendir and Maxwell, 2020) use empirical techniques to examine unproctored versus proctored exam cheating behavior. Although many of these studies confirm that cheating on unproctored online exams is a problem, most suffer from poor "after-the-fact" design or small sample size.

The purpose of this study is to empirically investigate whether students are more likely to cheat on unproctored online exams than on proctored in-class exams and, if so, whether there is any pattern to their cheating behavior. This research is unique because the study was purposefully designed beforehand. All students in the study took the same online course taught by the same instructor. Students took multiple unproctored online exams in the class which allows observation of behavior through time. They also took a proctored in-class comprehensive final exam which allows for comparison between the two settings. Additionally, students completed several assignments (e.g., quizzes and problem sets) where they were encouraged to work in groups. This allows empirical comparison of cheating behavior on exams to assignments where collaboration was permitted. Finally, demographic and human capital data was collected for all participants to evaluate if some groups cheat more than others.

This research contributes to the literature by investigating whether the suspicions and anecdotal claims that online exams are more prone to cheating are supported by empirical evidence. It also offers a carefully designed methodology to examine online assessment assignment cheating that can be replicated by researchers in other settings. Finally, the dataset analyzed contains 741 observations, making it one of the most comprehensive studies to date devoted to examining this critically important topic.

2. Literature Review

Academic dishonesty among college students is well documented in the education literature. According to Hendershott, Drinan and Cross (2000) the practice is widespread. Clarke and Landcaster (2006) describe the cheating they find in their data as "habitual." In a survey of 144 students, Simkin and McLeod (2010) report that 60% of business students and 64% of non-business students admitted that they cheated in college. In a study involving thousands of student surveys from 31 different schools conducted over decades, McCabe, Butterfield and Trevino (2012) report that more than 66% of college students claim that they engaged in academic dishonesty in the prior year.

Not only does the literature demonstrate that cheating is pervasive, but researchers have also found that cheating has become more prevalent over time. Vandehey, Diekhoff and LaBeff (2007) document that student academic dishonesty has linearly increased over the past 50 years. McCabe, Trevino and Butterfield (2001) find that, from 1964 to 1994, student cheating on exams increased from 39% to 64%.

Prior to COVID, online course offerings at colleges and universities were rapidly growing in popularity. Allen and Seaman (2008) document a 46% increase in college students taking at least one online course between 2002 to 2007. During this same period, the authors find that enrollment in online courses was growing five times faster than in traditional courses. Allen and Seaman (2013) report that 32% of higher education students in the U.S. were taking at least one online course in 2012.

Since the COVID pandemic, the number of online offerings at colleges and universities has exploded. The Digest of Education Statistics (2021) reports that in 2020, over 74% of all college students in the U.S. took at least one class online. Morris, et al. (2020) argue that online education will continue to grow in importance because university chief financial officers see e-education as a path to generate additional revenue as well as a means to widen access to traditionally underserved socio-economic groups. Guppy, et al. (2022) report that approximately 70 percent of the over 4500 college-level educators, students, administrators, and instructional designers surveyed envision fully online offerings will maintain a strong growth trajectory into the future.

This rapid growth in online education naturally raises the question of whether the amount of cheating that might occur on unproctored online assessment assignments is greater than, equal to, or less than the amount that occurs on proctored in-class assignments. On the one hand, there is the logical belief that if students are cheating when they are being watched, they will cheat even more when no one is looking. Moten, et al. (2013) argue that because exam performance in an online environment can be affected by accessing textbooks and notes, communicating with others via texting or group social networks, group test-taking, and impersonation, it is impossible to validate the results of unproctored online assessment assignments. Adzima (2020) notes that

students taking an unproctored online exam can and most likely will cheat and/or plagiarize from the Internet precisely because they are free from exam supervision. Another view is that cheating is just as likely to happen in a classroom as it is in an online environment. According to this view, exam design can be effectively used to minimize cheating on unproctored online exams. For example, password protecting exams (Rovai, 2000), randomly drawing exam questions from a pool of test questions (Shuey, 2002), and limiting the time for viewing/answering questions (Taylor, 2002) are anti-cheating techniques that can be used for online tests. Indeed, Beebe, Vonderwell and Boboc (2010) argue that educators who mechanically transfer assessment strategies they use in F2F classes to an online class are inviting students to cheat. Finally, some contend that online classes may be less prone to cheating due to the flexible schedule which mitigates "panic cheating" by students in F2F classes (Stuber-McEwen, Wiseley and Hoggatt, 2009).

Recent scholarly work reports various dimensions of academic dishonesty in unproctored online university exams. Noorbehbahani, Mohammadi and Aminazadeh (2022) systematically reviewed 58 studies on online test cheating published from 2010-2021. They categorized these articles into four themes: causal factors, cheating methods, detection techniques, and deterrence strategies. Key findings include that the leading publications are journal articles, cheating prevention and detection are the most studied themes, and the main cheating reasons involve the teacher, institution, student's internal motivations, and social/environmental factors.

Other empirical studies evaluate specific interventions aimed at reducing cheating rates. Golden and Kohlbeck (2020) tested whether paraphrasing test bank questions limits cheating compared to verbatim questions. Across undergraduate auditing classes, students performed significantly worse on paraphrased items, even with honor codes or proctoring. This implies students leveraged the internet to search answers for identical test bank content. The authors conclude that subtly modifying test banks questions can enhance academic integrity in unmonitored online exams.

Complementary experimental research by Vazquez, Chiang and Sarmiento-Barbieri (2021) examined impacts of proctoring on student achievement in university economics courses. Their findings reveal students scored over 11% higher on average when assessments were not monitored, regardless of using a live proctor versus automated software. While test anxiety or distraction at home may play a role, patterns imply collaboration amongst students represents the primary form of cheating.

Dench and Joyce (2022) conduct a field experiment to test whether informing students about the ability to detect plagiarism deters cheating in online college courses. Across four introductory business classes, students were randomly warned that software could identify copied work. Whereas warnings had little effect, notifying caught cheaters that they were now on a "watch list" dramatically reduced cheating rates by over 65% in subsequent assignments. Bilen and Matro (2021) present cases where students appeared to type out answers to complex questions in under 30 seconds. The authors interpret these results to indicate cheating will remain widespread in unproctored online assessments unless credible monitoring is implemented. Studies examining student academic dishonesty on unproctored online exams either use data derived from surveys or they attempt to extract evidence of cheating from bivariate and regression analysis of online assignment scores. Using surveys collected from 121 undergraduate business majors, King, Guyette and Piotrowski (2009) find that 73.6% of respondents believed that it is easier to cheat in an online course than to cheat in a F2F course. Watson and Sottile (2010), analyzing surveys collected from 635 undergraduate and graduate students, report that students disclosed that they engaged in academic dishonesty more in F2F classes than in online courses. King and Case (2014) collected survey data from 1817 students over a five-year period to examine possible changes in cheating behavior over time. The authors claim that, in 2013, 74% of students believed that cheating on an online exam was very easy or somewhat easy.

Though such evidence is compelling, the accuracy of anonymous survey responses has been questioned in the literature, particularly when the surveys relate to analyzing potentially sensitive behaviors. Psychologists call this phenomenon "social desirability bias" (Nederhof, 1985). Asking students if they cheated on an assessment assignment, something they are often told violates the school's honor code and could result in suspension, qualifies under this heading. Another concern about surveys is that the term "cheating" has flexible definitions (Wei, et al., 2014). For example, in a study exploring why students cheat, Perry (2010) reports that for first year undergraduates, only about one in four thought that copying word-for-word without citing the original author constituted plagiarism. If the definition of cheating is vague in students' minds, asking them if they cheated on a survey will produce vague results.

In response to these limitations, researchers are increasingly applying empirical techniques to analyze the relationship between grades on proctored versus unproctored assessment assignments to identify potential

cheating. D'Souza and Siegfeldt (2017) provide an excellent survey of this literature. The simplest approach is to compare differences between proctored and unproctored exam scores. If the difference is statistically significant for otherwise similar groups and assignments, cheating may be the cause. Boxplots and scatterplots can also be used to visualize similarities and differences between the distribution of grades in the different settings.

To more formally examine possible cheating behavior, Harmon and Lambrinos (2008) propose a regression methodology that is based on the coefficient of determination (the R^2 statistic). Beck (2014) and Dendir and Maxwell (2020) use this same model in their studies of online cheating. The procedure regresses exam grade on student characteristics that have been previously shown in the literature to be correlated with performance. Separate regressions are run for unproctored assignment grades and for proctored assignment grades. The proctored exam R^2 value shows the proportion of the variance in the dependent variable that is explained by the independent variables in the absence of cheating. Thus, it is the standard. If, for the same students, the R^2 value of an unproctored assignment regression is similar to that of the proctored exam regression, then cheating did not occur. However, if the R^2 value is significantly less for the unproctored exam, Harmon and Lambrinos (2008) argue that cheating is likely the explanation.

The authors applied this technique to two different summer sections of a principal of macroeconomics course. The two sections were entirely online and identical in every respect, except for the final exam. In one section (N = 24), the exam was in person and proctored. In the other section (N = 38), it was online and unproctored. The dependent variable in their model is exam grade and the independent variables are age, grade level, major and grade point average (GPA). The R^2 value for the proctored final exam was 0.497 and the average R^2 value of the unproctored final exam was 0.081. These results suggest that cheating took place in the online class.

Beck (2014) uses the Harmon and Lambrinos model to test for cheating on monitored (N = 80) versus unmonitored examinations (N = 19). The dependent variables are grades on the mid-term exam and the final exam, and the independent variables are GPA, credit hours and major. GPA is the only significant variable in all regressions. The R^2 values for the monitored mid-term exams are higher than those for the unmonitored mid-terms exams, but this relationship is reversed for the final exam. The author concludes that these contradictory findings reject the conclusion that there is more cheating on unproctored online exams than on proctored exams.

Both of these studies suffer from small sample size and a limited number of explanatory variables. Dendir and Maxwell (2020) apply the same technique to a much larger dataset (421 unproctored exams and 227 proctored exams). Additionally, the authors recommend the Goldfeld-Quandt test and the Chow test to formally examine if a difference in the R^2 values between the different settings is significant. Their results strongly suggest that excessive cheating occurs on unproctored exams.

This research study is very similar to Dendir and Maxwell (2020), but with several important distinctions that address limitations noted by these authors. First, Dendir and Maxwell (2020) examine student data from similar sections of two different courses (principles of microeconomics and geography of North America) taught over several semesters (Fall 2014 through Spring 2019). Our study examines student behavior in a single course over multiple semesters.

Second, in Dendir and Maxwell (2020), for approximately half of the time period, all exams (three midterm exams and a final exam) in both courses were unproctored, and then starting in Spring 2019 all exams were proctored. Thus, they compare the results of proctored exams for one time period to the results of unproctored exams for a different group of students from another time period. Although the authors claim that they believe student characteristics were similar between the periods, the two populations are not the same. In our study, we examine the behavior of the same student completing unproctored and proctored assignments in the same semester.

Third, Dendir and Maxwell (2020) use only two independent variables in their regressions: age and GPA. Our regressions have ten independent variables, all of which have been validated in the academic literature as determinants of student performance in similar courses.

Finally, in Dendir and Maxwell (2020) proctoring is achieved using Respondus Lockdown Browser plus Webcam. Although studies have shown that monitoring software can effectively reduce online cheating (Hylton, Levy and Dringus, 2016), there are concerns about student online exam performance being negatively impacted because they may feel nervous about being filmed (Butler-Henderson and Crawford, 2020). In our study, in-class proctoring (i.e., the "gold standard") is used.

Using the existing empirical research literature to create a carefully predesigned research approach with 741 observations, this study answers the following research questions:

RQ1: Does empirical evidence suggest that students are more likely to cheat on unproctored online exams than they are to cheat on carefully proctored in-class exams, where in both settings students are specifically told that cheating violates the school's honor code?

RQ2: Does cheating behavior increase as the semester progresses?

RQ3: Is there a relationship between student demographic or human capital characteristics and the propensity to cheat?

3. Study Design

The 15-week course used for this study was specifically designed to answer the research questions listed above. All aspects of the course were conducted online, except for the final exam. Although the course was asynchronous, it had a specific weekly schedule. For every week, students were assigned textbook chapters to read, video lectures to view, and graded assignments to complete. Any assignments not completed by midnight on Sunday of the due week received a grade of 0. The course had 15 quizzes (one per week), five takehome problem set (THPS) assignments (due at midnight on Sunday of weeks 3, 6, 9, 12 and 15), three unproctored online midterm exams (in weeks 5, 9 and 14), and an in-class proctored comprehensive final exam.

The course used for this study was an undergraduate principles of corporate finance course. Corporate finance is a math-oriented subject in which answers to questions used in assessment assignments are either right or wrong. In such a course, it is possible to create a very large databank of questions that can either be multiple choice with random ordering of answer choices or open-ended problems. The question databank for this course was created by the course instructor over several years and it contains over 600 distinct multiple-choice questions and over 200 open-ended problems. Approximately one-third of all the questions in the databank cover the course material associated with each midterm exam. All multiple-choice questions have 5 answer choices. For open ended problems, one of more numbers in the problem changes every time the question is used such that each iteration of the problem has a unique correct answer.

The unproctored online midterm exams in the class were given over a weekend. Students were allowed to take the exam during any 150-minute period while the exam was open. Each exam had 40 total questions, 30 were multiple choice and 10 were open ended problems. To minimize cheating opportunities, the instructor employed techniques suggested by Moten et al. (2013) and Flom, Green and Wallace (2023). Questions on exams were randomly selected from the corresponding section of the question databank, questions appeared one at a time, and students had to complete a question before moving to the next. The Learning Management System used for online exams includes a countdown timer that showed students how much of the 150-minute time limit remained. Once the counter hit zero, the exam was automatically closed. Prior to each exam, students were instructed to carefully monitor the timer to be sure to answer all questions before the exam closed.

The first question on each midterm exam, that students had to certify they agreed to, stated that academic dishonesty of any form was a violation of the university honor code and that if the instructor found any evidence of cheating, the student(s) involved would be fully prosecuted. Nonetheless, because the midterm exams were unproctored, there was no way of telling whether students were using their book or notes, looking up questions or solution processes on the internet, collaborating with other students, engaging in contract cheating, or other. No students were prosecuted for cheating during the study period.

The comprehensive final exam for the class was given to all students on the same day at the same time in a single large lecture hall. The final exam had 40 questions and a strict 150-minute time limit. Students were seated such that there was an empty chair between each student and multiple versions of the exam were distributed before students entered the room so that no students seated next to each other had the same version of the exam. Fendler, Godbey and Yates (2018) show that these techniques can significantly reduce student cheating on proctored exams. Student IDs were verified before students were allowed to enter the exam room, students had to put away cellphones, and multiple proctors actively roamed the room during the exam. Finally, students had to sign that they read and understood the university honor code before they were allowed to begin their exam. Other than being in a classroom, the substance (i.e., the final exam covered the same material as the midterm exams in approximately equal amounts) and format (i.e., time limit, number of questions, etc.) of the proctored final exam was designed to be as similar as possible to the three unproctored online midterm exams.

For weekly quizzes, students were allowed to retake these as many times as they wanted and only the highest grade counted. Additionally, students were encouraged to collaborate with others in the class if they encountered any questions or problems that they could not correctly answer on their own. Students were given two weeks to complete THPS assignments. They were also encouraged to work in groups on these assignments. At the end of the semester, an average quiz grade and an average THPS grade were computed for each student.

During the first week of class, all students took an online algebra math quiz. Students also took an online risk tolerance quiz (pfp.missouri.edu, n.d.) that scored their attitude about investment risk. To collect the necessary demographic data, students were asked to complete a pre-course and a post-course survey quiz. Those who properly completed both survey quizzes were given extra credit points towards their final course grade. Students who did not wish to participate were offered an alternative assignment to receive the same number of bonus points. The university provided student GPA and gender data.

The instructor in charge of the class received IRB approval to collect and use the data analyzed in this study. Once collected and merged, all student identifier data was removed to protect the identity of all participants.

Data was collected for students taking the course over six consecutive semesters (spring 2017, fall 2017, spring 2018, fall 2018, spring 2019 and fall 2019). For each of these semesters, all aspects of the course were conducted as described above. A total of 741 students completed all assignments in the classes, the two survey quizzes, the math quiz, and the risk tolerance quiz. T-tests were conducted on all variables for each semester to confirm that all semester samples were derived from the same population. Thus, compiling all data into one large dataset is appropriate.

4. Data

Descriptive statistics for the entire sample are provided in Table 1.

Table 1: Descriptive Statistics for All Sample Variables

Variable	Mean	S.D.	Min.	Max.	# Obs.
Proctored Assessment Assignment					
Comprehensive Final Exam	63.6%	19.6	20.0	100	741
Unproctored Assessment Assignments					
Exam 1	71.7%	16.7	23.0	100	741
Exam 2	75.9%	13.9	36.3	100	741
Exam 3	80.2%	10.8	46.5	100	741
Unproctored Collaboration Encouraged Assessment Assignments					
Quiz-Avg	95.1%	6.3	52.3	100	741
THPS-Avg	84.9%	11.5	19.6	100	741
Demographic and Personal Characteristic Variables					
Math Quiz	66.4%	21.7	6.0	100	741
Age	24.0	4.9	18.0	61.0	741
GPA	3.18	0.43	2.0	4.19	741
TrmHrs	12.8	3.5	3.0	24.0	741
Gender (F = 1)	56.3%	-	0	1	741
Major (Fin/Acct =1)	33.9%	4.96	0	1	741
Risk Score	27.2	5.3	13.0	50.0	741
MathAnx(HiAnx = 5)	3.1	1.4	1	5	741
#Online	3.5	2.2	0	14	741
Job-SptsHrs	23.0	14.1	0	40.0	741

In addition to the variables described in the prior section:

- TrmHrs is the total number of course hours that the student was taking in the same semester that they took this course.

- Major indicates whether a student is a finance or accounting major (basically, "sister" subjects) or some other major.
- MathAnx is a Likert scale variable for the student answer to the question: "Which of the following BEST describes how much you agree (or disagree) with the following statement: I get nervous and/or anxious when taking a class that covers or uses math." For this variable a value of 1 indicates the student strongly disagrees with the statement and a value of 5 indicates strong agreement with the statement.
- #Online is the total number of online classes that the student took prior to this class.
- Job-SptsHrs are the self-reported number of hours per week that the student spends working in a job and/or participating in a university sports activity.

5. Results

5.1 Bivariate Analysis

The first step in examining whether the data indicates cheating may have occurred on the unproctored exams in the class is to compare the descriptive statistics of the grade on each unproctored exam with the proctored exam grade. The proctored final exam in the class was comprehensive and similarly structured to the midterm exams in the number of questions and degree of difficulty. If the grades on each successive exam, including the final exam, improved, then the data may be reflecting student learning, a highly desired outcome. If, however, the score on the proctored final exam is significantly lower than the scores on the unproctored midterm exams, cheating is a possible explanation.

Table 2 shows the mean and standard deviation of each of the unproctored assessment assignments compared to the same statistics for the proctored exam. The last two columns in Table 2 list the results of a two-sample t-test for the equality of means between each of the unproctored vs. proctored exam pairings.

Table 2: Mean Comparisons Between Unproctored and Proctored Exams

Assessment Assignment	N	Mean	St. Dev.	T	P > t
Unproctored Exam 1	741	71.7	16.7	11.21	0.00
Proctored Final Exam	741	63.6	19.6		
Unproctored Exam 2	741	75.9	13.9	16.01	0.00
Proctored Final Exam	741	63.6	19.6		
Unproctored Exam 3	741	80.2	10.8	23.27	0.00
Proctored Final Exam	741	63.6	19.6		

The average grades on all of the unproctored exams are significantly higher than the average grade on the proctored exam. A possible non-cheating explanation for a lower final exam average is that students fear final exams, especially in a classroom with proctors, more than they do online exams. This fear could cause students to perform poorer on the final exam. However, although course subject matter tends to increase in difficulty as the course progresses, the average grade on the unproctored exams increases with each successive exam. Additionally, the standard deviation of grades is less for the unproctored exams versus the proctored exams, and the standard deviation of grades decreases with each successive unproctored exam. These relationships are consistent with the conclusion that cheating did occur on the unproctored exams, and that the degree of cheating may have increased with each successive unproctored event.

Figure 1 shows boxplot comparisons between each unproctored exam and the proctored final exam. The median of each unproctored exam is greater than the median of the proctored exam, and both the range and dispersion of the unproctored exams are less than those of the proctored exam. Additionally, the range decreases, the median grade increases and the dispersion of grades decreases with each successive unproctored exam taken. These relationships correspond with the trends noted above.

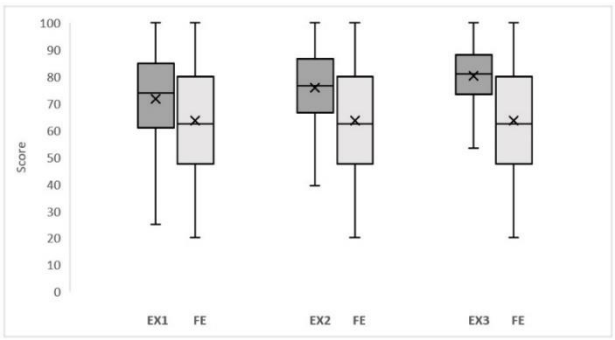
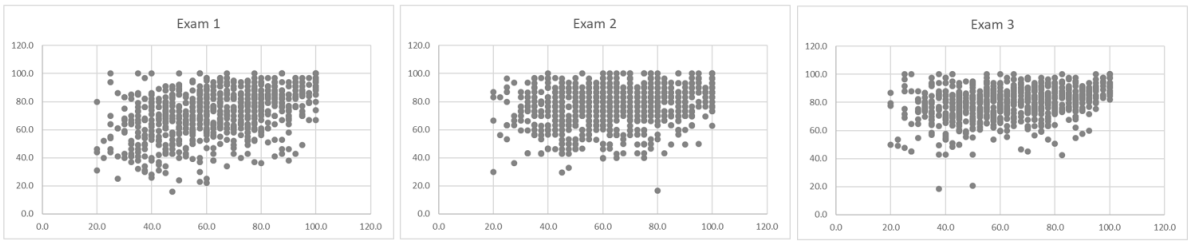


Figure 1: Boxplot Comparisons of Unproctored and Proctored Exams

Scatterplots showing the relationship for all observations between each unproctored exam and the proctored exam are shown in Figure 2. As one would expect there is a large number of plots in the upper, right hand corner (students who did well on the midterm exams and had equivalent performance on the final exam). Though a trend exists, the correlation coefficients for Exam 2 and Exam 3 relative to Final Exam are very low (0.2488 and 0.2940, respectively). However, the curious take away from the scatterplots is that the data points become more compact with each successive unproctored exam, with a large number of plots in the upper left quadrant of each graph (students who did very well on the unproctored midterm exams and performed very poorly on the proctored final exam). This pattern is consistent with students cheating on the unproctored exams. Although cheaters achieved high grades on the midterm exams, because they did not actually learn the course material, these students performed very poorly on the carefully proctored comprehensive final exam.



Correl. Coeff. = 0.4199 Correl. Coeff. = 0.2488 Correl. Coeff. = 0.2940

Figure 2: Scatterplots for Unproctored and Proctored Exams

5.2 Regression Analysis: Comparing Unproctored to Proctored Assessment Assignments

A more formal analysis of the data involves regressing exams scores on appropriate independent variables. All the independent variables used in this study (i.e., the Demographic and Personal Characteristic Variables listed in Table 1) have been validated in the academic literature as factors that impact exam performance in a finance course. Borde, Byrd and Modani (1998) report that age, GPA, gender, declared major, number of course hours, and outside distractions (i.e., work or sports hours) influence performance in finance courses. Ross and Wright (2020) find that quantitative skill is a significant determinant of success in finance. We use two similar, yet unique, variables to capture quantitative ability: score on the pre-course algebra quiz and the answer to a survey question that quantifies a student's level of anxiety towards math. The algebra math quiz that students took at the beginning of each semester did not count towards the final grade in the course, so it was a "no pressure" assignment. The MathAnx variable is the same measure used by Pekrun, et al. (2017) who find that negative emotions about math (i.e., a high MathAnx value) significantly negatively impact student performance on test scores in math-based subjects. Fendler and Bredthauer (2016) show that the number of previously taken online courses is an additional important determinant of grades for students taking an online finance course. Sarmiento and Manaloto (2018) find that students with a high level of risk tolerance are more likely to cheat. We surmise that if a student is more likely to cheat, their grade on unproctored exams will be higher, but on a comprehensive proctored final exam it will be lower (because they did not actually learn the course material).

The specific regression model that we estimate is:

$$\text{Grade}_i = a_{0,i} + a_{1,i}\,(\text{Math Quiz}) + a_{2,i}\,(\text{Age}) + a_{3,i}\,(\text{GPA}) + a_{4,i}\,(\text{TrmHrs}) + a_{5,i}\,(\text{Gender}) + a_{6,i}\,(\text{Major}) + a_{7,i}\,(\text{Risk Score})$$
$$+ a_{8,i}\,(\text{MathAnx}) + a_{9,i}\,(\#\text{Online}) + a_{10,i}\,(\text{Job-SptsHrs}) + \varepsilon_i$$

where $Grade_i$ is score on an assessment assignment and ε_i is the regression error.

Regression coefficients for the Procotored Final Exam, Unproctored Exam 1, Unproctored Exam 2, Unproctored Exam 3, collaboration allowed Average Quiz and collaboration allowed Average THPS models are presented in Table 3.

Table 3: Regressions for Proctored ($Grade_p$) and Unproctored ($Grade_{up}$) Exams

	Proctored	Unproctored			Collaboration Allowed	
Variable	**Final Exam**	**Exam 1**	**Exam 2**	**Exam 3**	**Quiz-Avg**	**THPS-Avg**
Constant	35.12***	28.18***	32.12***	57.27***	79.86***	71.33***
	(4.666)	(3.892)	(5.133)	(11.561)	(27.859)	(13.048)
Math Quiz	0.14***	0.08***	0.06***	0.03	0.00	0.00
	(5.027)	(2.823)	(2.575)	(1.593)	(0.411)	(0.227)
Age	0.01	-0.01	-0.09	-0.08	0.10***	-0.11
	(0.100)	(0.034)	(0.881)	(0.984)	(2.096)	(1.254)
GPA	16.96***	12.32***	10.53***	5.30***	4.24***	5.67***
	(11.852)	(8.943)	(8.851)	(5.628)	(7.771)	(5.451)
TrmHrs	-0.83***	-0.25	-0.17	-0.21*	-0.05	-0.12
	(4.803)	(1.512)	(1.178)	(1.881)	(0.696)	(0.933)
Gender (F=1)	-5.20***	-0.18	-1.66*	1.23	0.14	0.20
	(4.492)	(0.162)	(1.725)	(1.619)	(0.326)	(0.233)
Fin-Acc=1	4.07***	2.92***	-1.02	1.80***	1.20***	1.26
	(3.289)	(2.454)	(0.991)	(2.213)	(2.555)	(1.397)
RiskScore	-0.64***	0.30***	0.38***	0.32***	0.03	0.11
	(5.858)	(2.846)	(4.209)	(4.397)	(0.790)	(1.373)
MathAnx (HiAnx=5)	-1.31***	-0.71*	0.42	-0.35	-0.28*	-0.40
	(3.015)	(1.686)	(1.153)	(1.223)	(1.706)	(1.266)
#ONLINE	0.37	0.19	0.56***	0.63***	0.13	0.02
	(1.416)	(0.736)	(2.572)	(3.632)	(1.229)	(0.102)
JOB-SPTS-HRS	-0.13***	-0.21***	-0.07***	-0.10***	-0.05***	-0.10***
	(2.965)	(5.098)	(2.031)	(3.371)	(3.296)	(3.077)
R square	0.4001	0.2311	0.1707	0.1407	0.1481	0.0889
F ratio	48.70	21.94	15.03	11.95	12.69	7.122
N	741	741	741	741	741	741

Note. |t| ratios are shown in parentheses below each parameter estimate; *** shows significance at $p < 0.01$; ** shows significance at $p < 0.05$; * shows significance at $p < 0.10$.

As shown in Table 3, the R^2 value for the Proctored Final Exam is 0.4001, for Unproctored Exam 1 is 0.2311, for Unproctored Exam 2 is 0.1707, and for Unproctored Exam 3 is 0.1407. And the R^2 value for the collaboration allowed quiz and THPS assignments are 0.1481 and 0.0889, respectively.

To examine whether the R^2 values for these regression equation differences are significant, Dendir and Maxwell (2020) propose using the Goldfeld-Quandt (GQ) test. The GQ test checks for heteroscedasticity in regression analysis by comparing the variance of the error term for two regressions to check whether they both derive from the same population. For this study, if the GQ test suggests that heteroscedasticity is present between the proctored exam regression and an unproctored exam regression, then cheating most likely occurred on the unproctored exam.

The Goldfeld-Quandt F-ratio statistic for each exam pairing is shown in Table 4. The GQ test indicates that the error variances are significantly different between the proctored Final Exam and the unproctored Exam 2

regressions and between the proctored Final Exam and the unproctored Exam 3 regressions, suggesting that cheating occurred on both of these unproctored exams. Additionally, the larger F-ratio statistic for Exam 3 versus Exam 2 suggests that the amount of cheating increased as students took additional exams in the class.

Table 4: Formal Tests of Unproctored versus Proctored Exam Regressions

	Unproctored Exam 1 versus Proctored Final Exam	**Unproctored Exam 2 versus Proctored Final Exam**	**Unproctored Exam 3 versus Proctored Final Exam**
Goldfeld-Quandt Test F(730, 730)	1.08	1.45***	2.31***
Chow Test F(10,1472)	19.33***	84.25***	392.13***

Note. *** indicates significance at $p < 0.01$.

Dendir and Maxwell (2020) also suggest using a Chow test. The Chow test can be used to determine whether one regression line or two separate regression lines best fit a split set of data. For this study, if the Chow F-statistic is significant, then the estimated coefficients in the unproctored exam regression, as a group, are statistically different from those in the proctored exam regression. Cheating is a plausible explanation for this difference. The Chow test statistics shown in Table 4 are highly statistically significant ($p < .01$) for each unproctored exam, and the statistic increases with each successive exam. These results support the conclusion that cheating occurred on the unproctored exams and that the degree of cheating increased as students took additional exams in the class.

5.3 Regression Analysis: Comparison of Significant Parameters

Trends in the size and significance levels of the coefficients in the Table 3 regressions lend further support to a conclusion that the amount of cheating most likely increased as the semester progressed. For nearly every significant variable, the size of the regression coefficients decreased with each successive exam. And for most of these, the impact of the Exam 3 regression on grade is more closely related to the "collaboration allowed" assessments assignments than to the proctored Final Exam.

Similarly, for GPA the |t| ratio follows the same pattern. The |t| ratio for GPA decreases from 11.852 for the Final Exam to 8.943 for Exam 1, 8.851 for Exam 2, and 5.628 for Exam 3. In fact, the impact of GPA on grade for the "collaboration allowed" THPS assignments is essentially the same as the impact of GPA on Exam 3.

The most interesting coefficient relationship trends, however, are for #Online, Math Quiz, MathAnx and RiskScore. #Online is insignificant for the proctored Final Exam, but highly positively significant for Exam 2 and Exam 3. This trend implies that students with more experience taking online classes may be more likely to cheat on exams. For this class, the warning against cheating may have prevented these students from cheating on Exam 1, but when they discovered that the warning was mostly hollow, they were more emboldened to cheat on Exam 2 and Exam 3.

Whereas both Math Quiz and MathAnx are, as expected, highly significant for the proctored exam equation, they are insignificant for unproctored Exam 3. One possible reason for this change might be that students with poorer math skills and those with math phobia felt more compelled, or perhaps justified, to cheat by the third unproctored exam in the class. As these students experienced the importance of math in finance, they may have chosen to cheat to overcome their weakness(es) in this area.

The trend in RiskScore is perhaps the most compelling evidence that cheating occurred on the unproctored exams in the class. As previously noted, Sarmiento and Manaloto (2018) report that students with a high degree of risk tolerance are more apt to cheat. Thus, on unproctored exams, these students would be expected to get a higher grade. But because this grade derives from cheating instead of from learning, when they are tested on this same material on a comprehensive final exam where they cannot cheat, they perform significantly worse. In fact, that is exactly what the regressions in Table 3 show. Whereas RiskScore is significantly positively related to grade on all three unproctored exams, it is significantly negatively related to the grade on the proctored comprehensive Final Exam.

5.4 Answers to Research Questions

The bivariate and regression analysis presented above provides answers to the three research questions. Specifically, students are more likely to cheat on unproctored online exams than they are to cheat on carefully proctored in-class exams, where in both settings students are specifically told that cheating violates the school's

honor code. As experience taking unproctored online exams increases, the likelihood of student cheating also increases. In fact, the degree of cheating on the third unproctored exam in the class was so extensive that the relationship between grade and mastery of subject matter was essentially the same as what would be expected for a collaboration encouraged assignment. Finally, students with more experience taking online classes seem to cheat more, students who are weak or believe they are weak in a topic necessary to succeed in the class tend to cheat more, and students who considered themselves to be risktakers tend to cheat more.

6. Discussion and Conclusion

Academic dishonesty, especially on exams which are used in most courses for assessment, is a major concern for higher education. Students who cheat on exams often receive a grade for a class that does not reflect their knowledge or understanding. Improper evaluation of student ability can tarnish a school's reputation. Even more concerning, left unchecked, cheating can become established as part of an institution's culture, causing honest students to consider cheating as necessary to maintain their position. The rapid growth in online education, especially since COVID, raises the question of whether students are more apt to cheat on unproctored online exams than they do on proctored in-class exams.

Finding the answer to this question is important because as experience with e-education grows, both faculty and students are discovering significant benefits with online testing. Students prefer taking online exams because they like the immediate feedback, they are confident that computer grading is more equitable and transparent than instructor hand grading, and they prefer the flexibility of being able to take an exam when it is best for them as opposed to when the course is scheduled by the university (Baleni, 2015). Indeed, in a survey of 220 students, Baleni (2015) reports that an overwhelming majority (83%) of respondents indicated a strong preference for taking online exams, with "only a few students declaring a preference for traditional assessments" (p 232). Dreher, Reiners and Dreher (2011) report that faculty also like giving online exams because they eliminate time spent printing, distributing and collecting paper exams, and they eliminate the tedium of grading the same question numerous times which frees faculty to provide more meaningful feedback to students.

The purpose of this study is to investigate whether students cheat more on unproctored online exams than on proctored in-class exams in order to help educators protect their institutions as well as to defend honest students. Data was collected from a 15-week long, online undergraduate course that was specifically designed for this project. The dataset consists of student grades on three unproctored mid-term exams (given in weeks 5, 9 and 14), several collaboration-encouraged assessments assignments, a proctored in-class comprehensive final exam, human capital data, and demographic information. The study ran for 6 consecutive semesters from spring 2017 to fall 2019. Course design, delivery, assignments, directions given, and instructor were consistent across all semesters. The final dataset includes 741 observations.

To determine whether student cheating behavior differs between exam settings (i.e., unproctored versus proctored), we estimate regressions using the grade on each of the three unproctored exams (where cheating is possible), the grade on the class collaboration-encouraged assignments (where "cheating" is expected to be observed), and the grade on the proctored final exam (where cheating is not highly unlikely due to exam design) as the dependent variable. We use independent variables of student characteristics that are identified in the literature as affecting performance. As discussed in Harmon and Lambrinos (2008), comparing the R^2 values of these regressions can provide insights into academic dishonesty. The R^2 value of the proctored exam is considered to be the standard for acceptable honest behavior. The R^2 values of the collaboration-encouraged assignments should reflect open cooperation (i.e., the expected value when cheating is rampant).

We find a significant amount of cheating on each of the unproctored online exams. The R^2 values for each of these regression equations is significantly lower than the model for the proctored final exam. We also find that as the semester progresses, online students learn how to cheat more effectively. The R^2 value for each successive exam decreases. In fact, by the third unproctored online exam in the class, the R^2 value is essentially the same as the R^2 value for the collaboration-encouraged assessment assignments.

This study offers several contributions for academics in higher education. First, we provide compelling empirical evidence from a purposefully designed study showing that students will cheat more on unproctored online exams compared to proctored in-class exams. This confirms suspicions and anecdotal claims that online exams are more prone to cheating. Second, this study demonstrates through quantitative analysis that student cheating actually increases on successive unproctored online exams, implying that students learn how to cheat more effectively as they take more online classes. Thus, cheating is a progressive threat, not a static one. Third,

we identify specific demographics and human capital factors, such as more online experience, poorer math skills, and higher risk tolerance, to be associated with more cheating. These are concrete student characteristics possibly associated with cheating of which academics should be aware. Fourth, our study makes a forceful case, through a dataset of over 700 students, that all online assessments should be proctored to safeguard integrity. Finally, we offer a model methodology for other researchers to copy and hopefully improve. In summary, this study makes both an empirical and methodological contribution to the literature, providing compelling evidence to justify proctored online exams and a framework for further research on this important topic.

Limitations of this study that represent areas for future research include the following. The proctoring used for this study was in-class, human proctors. Requiring online students to come to a classroom to take an exam may be impractical. The study should be replicated with software-proctored exams. This study examines student behavior in a single course (principles of corporate finance). Analyzing multiple courses could reveal whether our findings generalize across disciplines. Some of the variables used in the study are self-reported (e.g., job/sports hours). More objective measures may improve reliability. Additional student characteristics, such as family income level, citizenship status, or instructor rating, could be incorporated into the study. Finally, the emergence of other technical tools, such as ChatGPT, and their impact on student cheating need to be carefully studied.

Overall, the accumulating evidence makes clear that without credible oversight, cheating is likely to remain extensive on unproctored online university exams. Multiple detection approaches and deterrence strategies show promise in helping to ensure integrity. Further research is warranted to better understand student behavior in digital environments as well as to determine how to best evaluate student learning in this evolving academic arena.

Declarations of interest*:* none

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Exploring the Impact of Online Teaching Environment on EFL Teachers' Professional Identity

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Abstract: The impact of COVID-19 on the higher education sector has extended beyond using alternative technological methods. It has also influenced the professional identities of instructors themselves. This study aims to investigate EFL instructors' perceptions of the impact of online teaching on identity transformation during the COVID-19 lockdown. It also investigates how online teaching has affected teachers' professional identity in relevant aspects. The study was conducted during the first academic semester of 2022/ 2023. The researchers adopted a mixed research methodology that involved both quantitative and qualitative research techniques. A questionnaire was distributed to (44) EFL instructors, and semi-structured interviews were conducted with (8) EFL instructors at the Department of Languages and Translation at a Palestinian University, Palestine. Appropriate quantitative and qualitative analyses were utilized to figure out participants' responses to the questionnaire and the interviews. The results of the survey revealed that online teaching positively influenced instructors' social relations with their colleagues and students, enhanced the teaching process, and promoted instructors' self-esteem. As for the interviews, the findings showed the substantial impact of online teaching on EFL instructors' identity in terms of their professional needs, self-awareness and self-esteem, relationships with learners, relationships with colleagues, and their perspectives towards their institution. Hence, some recommendations were suggested.

Key words: EFL instructors' identity, Online teaching, COVID-19, Professional identity transformation

1. Introduction

Despite its substantial importance, EFL teachers' identity transformation during COVID-19 has received less attention compared to the plethora of research conducted on technological transformation in teaching methods in the higher education sector. Over the past few years, significant developments have taken place in teaching English as a foreign language (EFL), particularly with the shift towards online teaching. Many studies have met such development and started addressing the usage of technology-based tools in EFL teaching. Tarteer, Badah, & Khlaif's (2021) study examined, for example, the usage of Google Classroom as a technology-enhanced tool in teaching English during the COVID-19 outbreak. The shift to the usage of such applications and tools have also affected the way EFL teachers perceive their own identity. These changes have reconstructed teachers' basic roles, their needs, their relationships with students, their self-esteem, and their progress at both personal and professional levels.

Teachers' identities fundamentally shape how teachers perceive their profession (Buchanan, 2015). This issue has received great attention in previous literature (Sachs, 2005; Freese, 2006). However, it has never been stable. A teacher's identity is dynamic and changeable over time, influenced by many factors (Beauchamp and Thomas, 2009). These factors include internal to the individual, for example, emotional or external to the individual, such as life experience and job conditions (Rodgers and Scott, 2008). Beijaard, Meijer, and Verloop (2004) noted that person and context shape a teacher's identity. Teachers integrate contextual attributes in unique ways that align with the achievement of their ultimate educational goals in the profession. The same study found that there are sub-identities within the teacher's professional identity that differ in their centrality, but work in harmony to avoid any conflict among them.

Among the various significant changes that took place within the context was the transformation to online teaching with the COVID-19 outbreak. EFL teachers at schools and universities, similar to their counterparts in other disciplines, have suddenly found themselves transitioning entirely to online teaching after the pandemic outbreak. This has been considered a new change in the digital age that has never been expected by teachers or researchers (Zimmer, McTigue, & Matsuda; Kwon et al., 2021). This sudden shift in the educational sector included conducting lectures online, communicating with students remotely, assessing students online, and using many apps like Moodle, Google Meet, and Zoom to achieve the aforementioned activities. Computers

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have been used in language education as an assisted tool in language learning (CALL), but they were not as dominant as they became after the COVID-19 crisis (Farrah and Al-Bakri, 2020). A great number of higher education institutions have started depending totally on online teaching. This substantial shift in the educational landscape, coupled with the consequent interaction between teachers and the new dynamic context, has affected teachers' perceptions of their profession, teaching practices, and relations with their students and colleagues.

Switching to online teaching is inseparable from changes in teachers' self-perspectives and teacher's identities. Understanding teachers' perceptions of the impact of these significant changes on EFL instructors' identity and relating this to their professional needs, self-esteem and self-awareness, relations with learners, and perspectives towards their institution is crucial to the online educational landscape. As Palestinian EFL instructors have started adopting the evolving landscape of higher education, characterized by the shift towards online teaching, a gap has emerged in understanding how these dynamics contribute to transforming their professional identities. Thus, this study explores teachers' perceptions of the impact of online teaching on their professional identity and how online teaching has affected their professional identity in relevant aspects.

In the subsequent sections of this paper, we will survey the existing literature related to the study's subject matter in order to establish the study context. Then, a detailed methodology will be outlined in the research design, instruments, and data analysis. The findings and discussions are presented in the subsequent section, shedding light on the most significant findings from the two research instruments. Finally, we will draw a conclusion, where a focus will be on the pedagogical implications as well as future studies.

2. Literature Review

Although there has been an increasing significance of professional identity transformation in the educational landscape due to the break of COVID-19, it could be argued that there is a dearth of research focusing on the experiences of EFL instructors. This review of literature aims to analyze and synthesize relevant literature thematically, providing a comprehensive overview of the current state of knowledge.

2.1 Teacher's Professional Identity

Vokatis and Zhang (2016) defined teacher's professional identity as "how teachers identify themselves as teachers, including who they are as professionals, and who they strive and are empowered to become in a constant process of reflecting on their practices and experiences" (p. 59).. It combines social, cultural, political, institutional, and personal interactions in various work scenarios (Day, 2013).

In the existing literature, a teacher's professional identity has been characterized by dynamicity and instability. Teachers engage extensively with their surrounding environment. They are affected by their relations with their colleagues in educational work contexts, their administrative staff, their students, and other people in their work communities (Beijaard et al., 2004). Burn (2007) defined a teacher's professional identity as being related to what teachers should be and their professional roles as teachers. According to Smagorinsky et al. (2004)teacher's identity is reconstructed by interacting with others within cultural activities. Zembylas (2003) asserted the importance of teachers' emotions status in teachers' identity transformation. Canrinus et al. (2011) assured the importance of how teachers perceive their significance in shaping their professional identity when they deal with others in their professional environment. Teachers' professional identity is also impacted by the professional circumstances surrounding them, including educational policies, the curriculum, and the physical and logistical teaching environment (Vokatis and Zhang, 2016). In this regard, Song (2016) argues that teachers' identities shift due to teaching context changes. Therefore, social relations with peers and students and the surrounding physical and logistical environment are fundamental in modeling how teachers perceive themselves and their profession.

Another perspective of a teacher's identity highlights the sociocultural dimension, which perceives a teacher's identity as both a product of different effects on the teacher, and a process that is influenced by continuous changes and interactions within the teacher's professional development. A teacher's identity is viewed as a collection of influences, structures, and social contexts, which are constantly dynamic and mingled, and in which the teacher interacts and negotiates in the given contexts (Olsen, 2008). In this context, a teacher's identity is ever-changing and undergoes continued transformation based on the surrounding environment and changes in the professional landscape. These changes impose changes in the ways teachers perceive themselves within their profession.

Canrinus et al., (2011) confirm that there are many factors that contribute to shaping a teacher's professional identity. Among these are job satisfaction, self-efficacy, commitment to work, and the level of motivation as teachers. On the other hand, Nias (1989) and Day (2002) argued that a teacher's professional identity is highly relevant to how and degree teachers respond to professional and educational rehabilitation and reform. In this sense, new reforms in the professional and educational contexts should be studied in relation to teachers' identity. Similarly, any attempts to raise the quality of education and increase the efficacy and efficiency of teachers' work and their positive impacts on their students should be active and true assistance for teachers to maintain their enthusiasm for work and better investments in their emotional and cognitive selves (Day, 2000b).

Braun, Maguire, & Ball (2010) asserts that any change in the professional context of teaching is inseparable from teacher's professional lives. This includes educational changes carried out by educational institutions to enhance different teaching practices. This implies the importance of studying teacher's identity transformation in the period of educational change. In a similar sense, Canrinus et al. (2011) confirms that a teacher's professional identity can be formed and impacted by multidimensional elements including the way teachers perceive themselves, job motivation, self-esteem, and how they perceive teaching. Hence, teachers' cognition, which involves their beliefs, knowledge, and reflective practices, is related to their professional identity (Brog, 2003). William (2010) also confirmed the importance of socialization in forming teachers' professional identity, which demands collaboration and communication among teachers in the professional context.

2.2 Previous Studies on EFL Instructors' Identity Transformation

Examining the transformation of EFL instructors' identities as a result of the usage of technology-integrated tools has gained limited attention across educational research. This could be attributed to the fact that this aspect of EFL research has emerged as a result of the COVID-19 outbreak in 2019. Nonetheless, researchers have addressed other aspects of EFL instructors' professional identity. Reis (2011), for instance, explored the development of teacher's professional identity of non-native English-speaking teachers (NNESTs) and their attitudes towards themselves in comparison to the myth of native English-speaking teachers and its relation to professional identity and instructional practices. The study was based on interviews with a non-native speaker English teacher, classroom observations, and a dialogue journal. The study revealed the native-speaker English teacher myth as a professional, qualified, and competent than the non-native ESL teacher blindly adopted. The study concluded that the non-native teacher's attitudes and beliefs towards the native-speaker English teacher had impacts on his professional identity.

On the other hand, Song (2016) explored how transforming the context of teaching through globalization can create demands for English language teachers. The study also discusses teachers' emotional responses to this shift. The study was conducted by interviewing five English secondary school teachers from South Korea. Attentiveness to individual students and a lived curriculum for teachers and students were encouraged by the open vulnerability of other teachers with their confidence in personal skills. Thus, the subjectivity of English language teachers was traced in its social and institutional contexts.

As for the studies addressing the influence of online teaching on EFL instructors after the COVID-19 outbreak, many researchers have tackled this aspect from various lenses and in different educational settings. For example, Yuan & Liu (2021) examined how the identities of EFL university instructors developed during an online semester. Following the case study approach, the study targeted three Chinese EFL instructors, where all experienced nervousness in the online teaching mode. The findings demonstrated that EFL instructors lacked structured identities and roles when shifted to the online environment. The researchers recommended providing both pedagogical as well psychological support to the EFL instructors when teaching online. In a later study, El-Soussi (2022) investigated the experiences of EFL instructors at four UAE universities regarding their professional identity through semi-structured interviews. The results are somewhat similar to those of the previous study, where the EFL instructors reported instability when viewing themselves and beliefs regarding the online teaching mode. The primary challenges were associated with the instructors' pedagogical, managerial, and social practices.

Following a mixed-method approach, Celebi and Eraldemir-Tuyan (2020) examined the experiences of EFL Turkish lecturers' professional identity in online teaching. The study found that those instructors were not fully prepared for this kind of teaching mode as many challenges associated with instructional and technological aspects emerged. The study concluded by recommending implementing explanatory action research to gain more valuable insights. In a more recent study, Zhang & Hwang (2023) explored the reconstruction of the identity of eighteen Chinese university instructors and two high school teachers during the COVID-19 outbreak. The authors interviewed those instructors who did not have previous experience online before COVID-19. The

findings revealed that the EFL instructors' identities have been challenged and further influenced after the shifts to online teaching due to the changes in teaching practices and roles. Interviews reported some educational and technological difficulties that emerged after the COVID-19 pandemic, through which their identity was affected.

Research Questions

This study aims to answer the following research questions:

RQ1. What are EFL instructors' perceptions towards identity transformation in online teaching during the Covid-19 pandemic?

RQ2. How has switching to online teaching during the COVID-19 pandemic affected EFL instructors' professional identity according to instructors' perceptions?

3. Methodology

3.1 Integrated Research Approach

To gain a more comprehensive understanding of the study problem, the current study followed the mixed method approach, where a combination of both quantitative and qualitative methods was used. Creswell & Clark 2018 argue that quantitative data offer a broader understanding, while qualitative data provide an in-depth insight into the research problem. To this end, the researchers adopted a descriptive-analytical approach to explore instructors' perceptions of their professional identity transformation. Semi-structured interviews were also conducted with (8) of those instructors to find out the impact of online teaching on their professional identity.

3.2 Participants

The study population consisted of all instructors in the Department of Languages and Translation at a Palestinian university, totaling (51) individuals with different academic ranks. According to Krejcie & Morgan (1970), the minimum sample size is (44). As such, an available sample of (44) instructors participated in the study. Of (44), 75.1% were females, and 47.7% had less than ten years of experience.

3.3 Research Instruments

3.3.1 The quantitative tool (questionnaire)

A 35-item questionnaire was distributed to the participants employing a four-point Likert scale. The questionnaire was derived from a previous study conducted by Zimmer et al. in 2021, where it was referred to as "The Digital Learning Identity Survey". The response options ranged from strongly agree (4), agree (3), disagree (2), and strongly disagree (1). The questionnaire covered four main domains: personal satisfaction toward professional and technical skills during online teaching, the effectiveness of online teaching, the impact of online teaching on professional self-awareness and self-esteem, and the impact of online teaching on social relations with colleagues and learners. Ranges of agreement with the item on the questionnaire were investigated based on the means by using the following rubric: from 1 to less than 2 showed a lower level of agreement, from 2 to less than 3 showed a medium level of agreement, and from 3 to 5 showed a high level of agreement.

Three educational and research experts were asked to read and review the appropriateness of the study instruments. Their feedback and recommendations were taken into consideration. Hence, the study instruments' validity was established

To verify the internal consistency of the performance of the study sample members on the questionnaire items, the questionnaire was piloted to a sample of (15) participants (excluded from the study sample) and re-administered after two weeks. Then, the Pearson correlation coefficient between the item and its domain, and the corrected item-total correlation between the item and its domain was extracted.

3.3.2 The qualitative tools (interviews)

The researchers composed a set of interview questions designed for the semi-structured interviews with EFL instructors at the Department of Languages and Translation at the target University. These questions were crafted in alignment with the research's primary questions. The interview consisted of six questions (Appendix 1) that all aimed to elicit in-depth qualitative responses on the EFL instructors' ideas towards professional identity transition. Following data collection, the qualitative data obtained from the interviews underwent a

thorough analysis process aimed to extract meaningful insights and patterns from the participants' responses. The analysis adhered to established qualitative research principles.

To establish the validity of the interview questions, the researchers shared them with EFL educational experts from the same university. In addition, pilot interviews were conducted with a group of volunteers to ensure clarity and uncover potential ambiguities. To ensure the reliability of the interviews, the researchers ensured that all the interviewees participated willingly in the research interviews and that the interviewees fully understood all questions. Moreover, after the interviews were conducted, the researchers summarized the interviewees' responses, and these summaries were reviewed and approved by the interviewees themselves. As for the interview questions, they included the following:

- To what extent were you ready professionally to deal with the sudden switch to online teaching during the pandemic outbreak?
- Were you satisfied with your professional abilities and skills in online teaching as an EFL instructor?
- Has shifting to online teaching impacted your self-awareness and self-esteem as an instructor of English language? In what ways?
- Has shifting to online teaching impacted your relations with learners? In what ways?
- Has shifting to online teaching impacted your relations with other colleagues? In what ways?
- To what extent has your institution responded to the sudden shift to online learning?

3.4 Data Analysis

The data collected by the questionnaire were analyzed using SPPS software, where statistical analysis was conducted to identify patterns and trends related to the study questions. Specifically, mean scores, standard deviations, and levels of agreement were computed to compare the participants' responses to the questionnaire items. On the other hand, the qualitative data generated from the interview responses were treated differently. The themes of interview questions were listed and the participants' responses were quoted and carefully discussed. The analysis involved several key steps, including data coding, thematic analysis, and interpretation. Coding involved systematically categorizing segments of the interview transcripts based on recurring themes and or ideas. Thematic analysis then included identifying overarching themes within the coded data, allowing for a deeper understanding of the participants' views on professional identity transition. The interpretation, on the other hand, involved synthesizing these themes and drawing meaningful conclusions that contribute to the overall research objectives. Such an approach allowed the researchers to investigate the participants' perspectives and experiences in-depth, contributing to a comprehensive exploration of the study's subject matter

4. Results

4.1 Results of the First Research Question

RQ1. What are EFL Instructors' perceptions towards identity transformation during online teaching?

The means, standard deviations, rank, and level of agreement for the EFL instructors' perceptions about their identity transformation during online teaching were extracted to answer this question. The results are presented in Table 1.

Table 1: Means and Standard Deviations of Instructors' Perceptions of the Impact of Online Teaching on Professional Identity Transformation

Domain	Mean	Std	Rank	Level of Agreement
The impact of online teaching on social relations with colleagues and learners.	3.14	.40	1	High
Effectiveness of online teaching.	3.04	.34	2	High
The impact of online teaching on professional self-awareness and self-esteem.	3.00	.42	3	High
Personal satisfaction toward professional and technical skills during online teaching.	2.90	.39	4	Medium
Overall	**3.00**	**.29**		**High**

Table 1 shows that Instructors' perceptions about EFL instructors' identity transformation during online teaching in the four domains ranged between (2.90–3.14), with medium to high levels of agreement (Figure 1). The domain related to the impact of online teaching on social relations with colleagues and learners ranked first, with a mean of (3.14) and a high level of agreement. However, the domain referring to personal satisfaction toward professional and technical skills during the online teaching domain ranked fourth, with a mean of (2.90) and a medium level of agreement. The average score of overall instructors" perceptions is (3.00), with a high level of agreement as depicted in Figure 1.

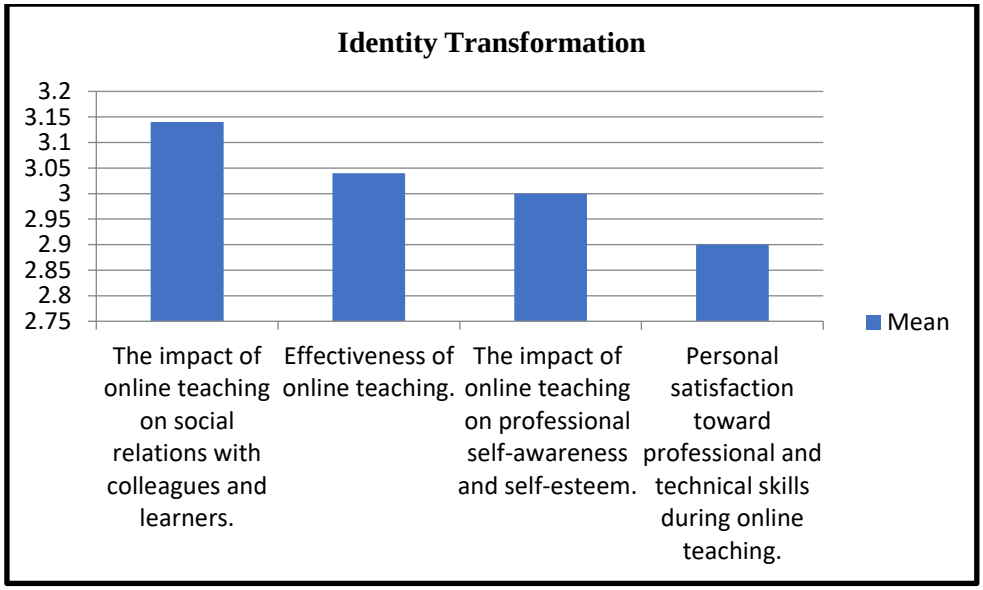

Figure 1: Means of Instructors' Perceptions on the Impact of Online Teaching on Professional Identity Transformation

Furthermore, the researchers computed the means, standard deviations, rank, and level of agreement for the instructors' perceptions concerning professional identity transformation during online teaching within the four domains. The results are presented in Tables (2-5). It is worth mentioning that the sequence of the four domains' results corresponds to the original order in which they are presented in the questionnaire.

Table 2: Means and Standard Deviations along "The impact of online teaching on social relations with colleagues and learners" domain

No.	Item	Mean	Std	Rank	Level of Agreement
35	I tried to actively engage myself with the technology I was using for online teaching	3.50	.51	1	High
33	I used technology to communicate with my colleagues better	3.14	.55	2	High
32	I used technology to understand my students better	3.00	.53	3	High
34	I used technology to help me better understand other people	2.91	.74	4	Medium
	Overall	**3.14**	**.40**		**High**

Table 2 shows that the mean scores of instructors' perceptions along the "The impact of online teaching on social relations with colleagues and learners" domain ranged between (2.91- 3.50) with medium to high level of agreement. Moreover, instructors reported the highest level of perceptions (Mean=3.50) on the item "I tried to actively engage myself with the technology I was using for online teaching". In contrast, they reported the lowest level of perceptions (2.91) on the item "I used technology to help me better understand other people." The participants showed a high level of agreement on the item with numbers (32, 33, 35), while they showed a medium level of agreement on the item (34) as presented in Figure 2.

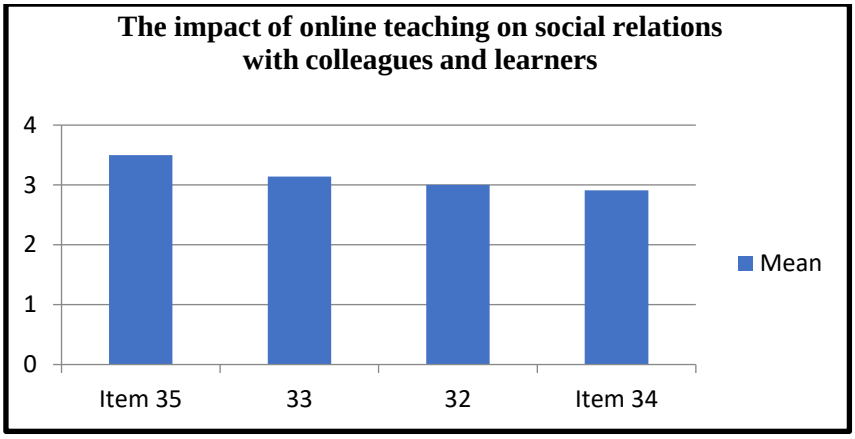

Figure 2: Means of Instructor's Perceptions along "The impact of online teaching on social relations with colleagues and learners" Domain

Table 3: Means and Standard Deviations along "Effectiveness of online teaching" Domain

No.	Item	Mean	Std	Rank	Level of Agreement
21	I used technology to gain new knowledge for online teaching	3.31	.46	1	High
22	Teaching online transformed my teaching practices	3.29	.55	2	High
16	Teaching online often caused me to be personally reflective	3.25	.53	3	High
15	Some of my character was shaped by the ways I started to follow in online teaching	3.16	.37	4	High
17	Teaching online made me carefully consider changes I had to make in my teaching practices	3.11	.32	5	High
14	Using technology to teach online was stimulating	3.07	.50	6	High
25	Technology often made me want to make personal changes in the way I used to teach	3.07	.50	6	High
19	I used technology for valuable reasons	3.02	.55	8	High
20	I had a high interest in using technology to teach online	2.93	.70	9	Medium
24	I felt that teaching online with technology was exciting	2.89	.90	10	Medium
26	Now, teaching online with technology has become an important part of my life	2.89	.75	10	Medium
18	Teaching online transformed my teaching values	2.89	.58	10	Medium
23	I used technology to improve my understanding of life	2.68	.67	13	Medium
	Overall	**3.04**	**.34**		**High**

Table 3 shows that the mean scores of instructors' perceptions along the "Effectiveness of online teaching" domain ranged between (2.68-3.31) with a medium to high level of agreement. Moreover, instructors' reported the highest level of perceptions (Mean=3.31) on the item "I used technology to gain new knowledge for online teaching", while they reported the lowest level of perceptions (2.68) on the item "I used technology to improve my understanding of life" The participants showed a high level of agreement on the item with numbers (14, 15, 16, 17, 19, 21, 22, 25), while they showed a medium level of agreement on the items (18, 20, 23, 24, 26) as shown in Figure 3.

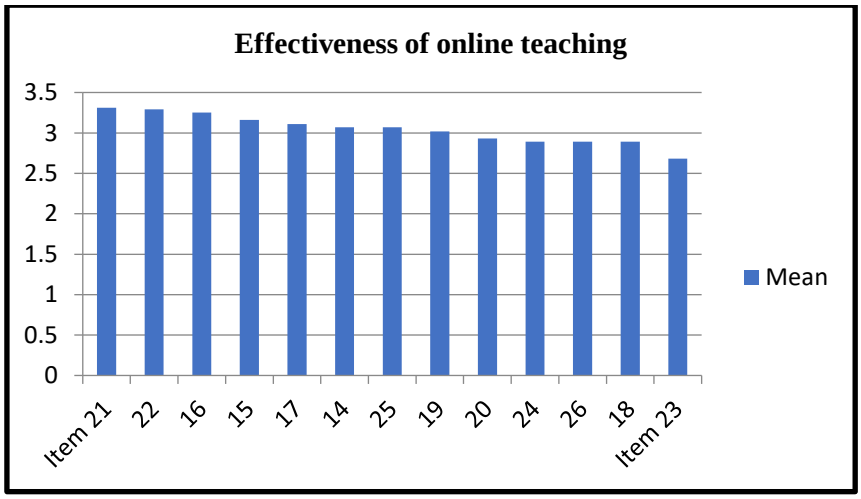

Figure 3: Means of Instructors' Perceptions of "Effectiveness of Online Teaching" Domain

Table 4: Means and Standard Deviations along "The impact of online teaching on professional self-awareness and self-esteem" Domain

No.	Item	Mean	Std	Rank	Level of Agreement
31	Technology often helped me change my perspective about things	3.16	.48	1	High
27	Teaching online transformed the way I used to perceive myself as a teacher	3.14	.55	2	High
29	I can recall instances in which I have been personally transformed from things I taught online using technology	3.00	.49	3	High
30	Teaching online made me carefully consider changes I should make in my life	3.00	.49	3	High
28	Teaching online with technology transformed my thinking	2.93	.40	5	Medium
	Overall	**3.00**	**.42**		**High**

Table 4 shows that the mean scores of instructors' perceptions along the "The impact of online teaching on professional self-awareness and self-esteem" domain ranged between (2.93-3.16) with medium to high levels of agreement. Moreover, instructors reported the highest level of perceptions (Mean=3.16) on the item "Technology often helped me change my perspective about things". In contrast, they reported the lowest level of perceptions (2.93) on the item "Teaching online with technology transformed my thinking." The participants showed a high level of agreement on the item with numbers (27, 29, 30, 31), while they showed a medium level of agreement on the item (28) as presented in Figure 4.

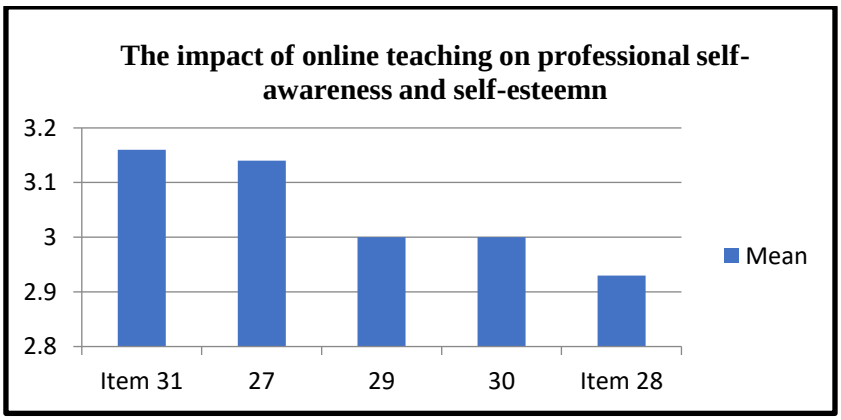

Figure 4: Means of Instructors' Perceptions of "The impact of online teaching on professional self-awareness and self-esteem" Domain

Table 5: Means and standard deviations along "personal satisfaction toward professional and technical skills during online teaching" domain

No.	Item	Mean	Std	Rank	Level of Agreement
13	Now, I frequently use technology to teach online when it is needed	3.32	.47	1	High
12	Now, I am interested in many aspects of using technology for teaching online	3.20	.59	2	High
11	Now, I use technology extensively to teach about different skills in English	3.16	.57	3	High
7	I didn't mind demonstrating technology I used in online teaching for others	3.05	.68	4	High
6	If my technological abilities were assessed, I would show good basic technological ability	2.98	.63	5	Medium
4	I used many different types of technology for online teaching	2.98	.66	5	Medium
10	I enjoyed using technology to teach online	2.95	.81	7	Medium
2	At first, I faced many technical problems	2.89	.78	8	Medium
9	I used technology proficiently while teaching online	2.82	.54	9	Medium
5	I was comfortable with my technological ability in teaching online	2.68	.60	10	Medium
8	I felt like I used technology efficiently when I started to teach online	2.68	.67	10	Medium
3	I was fluent in using technology for online teaching purposes	2.57	.66	12	Medium
1	At first, I was ready for the switch to online teaching	2.48	.63	13	Medium
	Overall	**2.90**	**.39**		**Medium**

Table 5 shows that the mean scores of instructors' perceptions along the "Personal satisfaction toward professional and technical skills during online teaching" domain ranged between (2.48-3.32) with medium to high levels of agreement. Moreover, instructors reported the highest level of perceptions (Mean=3.32) on the item "Now, I frequently use technology to teach online when it is needed", while they reported the lowest level of perceptions (2.48) on the item "At first, I was ready for the switch to online teaching." The participants showed a high level of agreement on the item with numbers (7, 11, 12, 13), while they showed a medium level of agreement on the items (1, 2, 3, 4, 5, 6, 8, 9, 10) as shown in Figure 5.

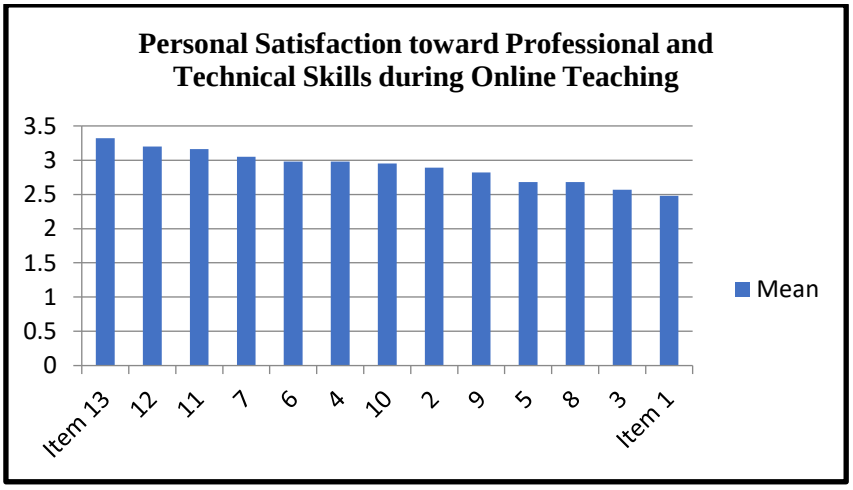

Figure 5: Means of Instructors' Perceptions of "Personal Satisfaction toward Professional and Technical Skills during Online Teaching" Domain

4.2 Results of the Second Study Question

RQ2. How has switching to online teaching affected EFL instructors' professional identity according to instructors' perceptions*?*

To enhance readability, we present the theme of each interview question along with the results, quoting some participants' responses.

4.2.1 The degree of professional readiness to online teaching

Most respondents asserted that they were not ready at all for the sudden shift caused by the COVID-19 outbreak. However, they started learning once the switch took place. The majority confirmed that their previous knowledge about online teaching was mainly theoretical and shallow. They had no practical knowledge of designing or delivering online teaching material. One of the interviewees said, "*To be honest, I had a lot of theoretical background based on many readings related to online teaching. Nevertheless, I had minimal experience in doing real teaching online*". However, only one instructor indicated her readiness to do online teaching based on her previous work, which was basically online in nature. She said, "*Given my previous experience with online teaching, the sudden transition to distance learning platforms didn't affect my career. I was already using online platforms such as Google Meets, Zoom, Kahoot, etc.*"

4.2.2 Personal satisfaction with personal professional and technical skills to deal with online teaching as an EFL instructor

Most of the interviewees confirmed that during the initial stage of the virus outbreak, they experienced a lack of satisfaction with their professional skills in dealing with the sudden shift to online teaching. They thought that their technical skills were insufficient to adapt fully to the sudden shift to online teaching. One instructor stated, "*we had to start from scratch, finding an application that fills the need for online classes and grants access to audio and visual aids*". Another instructor observed, "*I did my best to be well prepared to deal with all obstacles to be able to deliver a satisfactory lecture. However, I met many challenges*". Nonetheless, this abrupt condition has caused them to work harder to adapt to the requirements of the new circumstances.

4.2.3 The impact of online teaching on self-awareness and self-esteem

The majority of the interviewees asserted the impact of shifting to online teaching on their self-esteem and self-awareness in different ways. On the one hand, they confessed that the new condition has made them more aware of their technical and professional needs. They realized their imperious deficiency in most technical and e-learning skills. One instructor reflected "*It was a very challenging experience that made me want to learn more, achieve more and be able to deliver the content in an interesting and professional way. It surely affected me as I was doubtful whether my students were actually understanding and benefiting from this experience. I was an ongoing state of "doubt" whether I was doing the right thing the way it should be done*". On the other hand, having to working hard to improve their technical skills and acquainting new methods of online teaching have impacted their self-esteem positively. One instructor stated "*the sudden move to online teaching did actually affect my self-esteem as an EFL instructor because I was able to develop different methods that I could implement in my classroom whether online or face-to-face. I have also encouraged myself to research more and find out about successful teaching methods online. I could use different programs that I have never used before*". Another instructor added, "*I learn new things after every class I teach, whether online or in person. Online teaching has significantly contributed to my career and helped me maintain a good and effective teaching process with the students*". Another instructor reflected on the positive impact of online teaching on teaching English as a foreign language by stating, "*I am constantly aware of the fact that I teach English as a non-native speaker. That is why I continually try to improve my delivery and skills. I would say that the teaching material I found online has aided my presentation and complimented the content of my classes. This integration of sources gave me a boost of confidence in the way I handle the material delivery*".

4.2.4 The impact of online teaching on social relations with learners

There was a consensus among the interviewees that the period of online teaching has negatively affected personal relationships, honesty, and trust between students and their instructors. Most instructors confirmed that their students preferred to keep their cameras off, which made the term 'remote' very applicable in this situation. One instructor reflected "*It was challenging to create a relationship with my students. Students were not required to open cameras, meaning I spoke to black Zoom boxes. Many students did not present original*

work, so it was challenging to know their level and assess their learning experiences. When we returned to face-to-face learning, I was shocked at how difficult it was to recollect a student's name or remember that they took a class with me. I had a difficult time synthesizing names with faces. Moments of sadness and confusion colored my first weeks of being back on campus after two years of online teaching!". Another instructor observed, "*when we returned back to the conventional mode of teaching (face-to- face), I started to cherish the emotional factor of teaching more (i.e., student's facial expressions, laughter, jokes, group-work…etc.), which was a bit missed during the remote teaching, especially when students resisted opening their cameras*". However, two instructors reflected on the unexpected positive impact of online period on their relations with learners. The first one said enthusiastically "*Online teaching and learning impacted our learning environment positively. Students gained more self-confidence. In online classes, they participated more often and express themselves more comfortably*". The other instructor confirmed that "*E- learning period impacted my relations with my students in a very positive way as we were reflecting all the time to make sure that I am able to reach out to them despite the challenges they encountered during Covid period*".

4.2.5 The impact of online teaching on social relations with other colleagues

Most EFL instructors reflected on the negative part of not being able to meet their colleagues and see them as often as they used to, particularly during the early stages of the pandemic. They would not meet physically as before, which might have negatively impacted some social relations. On the other hand, this period of time has contributed significantly to flourishing cooperative and supportive working groups. Many instructors asserted that this was an excellent opportunity to create a community of learners and practitioners. For most of them, this was a time of bonding and sharing experience. One instructor said, "*we shared insights about different issues and tried to help tackle the problems we faced*". Another instructor added, "*it was an inspiring period to think of and develop new projects and exchange experiences*". Interestingly, one instructor reflected on the social ethics during online teaching "*it has not always been a smooth ride as online teaching blurred the already eroded lines between personal life and work in academia. I had moments when I felt my privacy was violated, and colleagues could send me work emails without respect for breaks or time limits!*".

4.2.6 How the institution responded to the sudden shift of online teaching and learning

The interviewees showed general positive attitudes about their institution's reaction and response to the sudden shift to online teaching and learning. They indicated that their university was among the first Palestinian and Arab universities to react actively to the lockdown and the eventual distant teaching and learning as it invited all its staff members to attend free sessions and training workshops to get them acquainted with the technological needs of online teaching mode. The university also made its IT staff always ready to support the instructors. One instructor said "*I would say that we were very lucky to have dedicated support from our IT team at the university who did an amazing task of helping and solving all the technical issues that hindered our progress. We had exceptional support from our department in organizing and managing the course content to meet our students' needs without affecting their progress*". Another instructor reflected "*The university and the IT department have done the best they can to assure that classes and exams could go according to plan*". Some instructors thought that the university should have provided more support during that time. One of these instructors observed "*I noticed that the university tried to be prompt in its response to the shift to the online realm and dedicated sources to accomplish this task. However, the lack of orientation and mentorship meant a gap in fully utilizing the sources and keeping up with updates. Not all instructors are tech-savvy, and not all of them know how to use the ITC and other online platforms. The university did not offer hotlines for inquiries or technical aid*". The way the university has responded to instructors' professional needs during the crisis was also critical for teachers and instructors. In fact, it has impacted how they perceived it. The positive attitudes most instructors have had towards their institution have created a strong sense of belonging which is an essential component of their professional identity. The critical conditions the university went through, yet its support to its staff, the dedication it showed to solve any technical issues and the help it provided to instructors to manage their courses well and meet students' needs without affecting their progress, all this have contributed to creating a robust connection with their institution.

5. Discussion

The first study question examined EFL instructors' perceptions toward the impact of online teaching on the transformation of their professional identity in terms of the four domains: the impact of online teaching on social relations with colleagues and learners, the effectiveness of online teaching, the impact of online teaching on professional self-awareness and self-esteem, and personal satisfaction toward professional and technical skills

during online teaching. The significant changes in the way EFL instructors had to deliver the learned material, the new way of communicating with each other and with learners, the new professional and technological needs that appeared with the new style of teaching and learning, and the impact of online teaching on their professional self-awareness and self-esteem, all of these have contributed significantly to changes in their perceptions on the effectiveness online teaching has had on their professional identity.

The most prominent finding of the current study is that the new experience in online teaching has impacted EFL instructors' social relations with colleagues and learners. This domain ranked the highest among other aspects. Being in the same boat and facing the same professional and technical challenges had positively impacted EFL instructors' relations and emotional feelings towards their colleagues. They had to learn to be more cooperative and attentive. Although they were not able to meet physically as before, they were able to create a new virtual working environment where they shared their teaching experience, resources, and even some funny stories. As for their social relations with learners, EFL instructors' relations were also affected during online teaching, impacting their professional identity in this regard. They realized how important it was to establish rapport with learners. Maintaining a good relationship with learners was really essential, and it might be even more fundamental in online classes. Such a result contradicts what El-Soussi (2022) found, where EFL instructors reported that online has negatively affected their social roles. The participants claimed that the virtual environment limited the human interaction between the instructors and students. A similar pattern of results was obtained in Cain and colleagues' (2023) study, where instructors reported negative feedback toward online teaching due to a lack of body language and nonverbal cues. One study participant clearly declared that teaching is about building relationships, and such connections can not be established virtually. Likewise, Algrani's (2023) study concluded that lack of in-person interaction is among the three disadvantages of online teaching as perceived by most EFL instructors. Zhang & Hwang (2023) found that communicating with students is also the greatest difficulty for language teachers in virtual classes.

The sudden shift to online teaching and learning and the subsequent change in how instructors delivered the study material had many implications. Instructors suddenly found themselves in front of a new reform in their profession. They had to start learning and adopting new strategies to teach, to communicate, and to assess. For instructors, this was not a smooth shift or an easy change. It has made them aware of their professional needs in terms of dealing with technology and integrating it to a wide extent in their virtual classrooms. Furthermore, they had to capture any opportunity that might help them prove their abilities as instructors who can adapt to the new changes in the context of their profession. This shift to online teaching has undoubtedly made instructors think about the "effectiveness of online teaching" and to what extent this new mode can have long-term effects on their professional identity.

EFL instructors' identities also transformed in terms of their self-esteem and self-awareness as they had to develop different methods to be implemented in their virtual classes. They had to encourage themselves to research more and find out more about successful online teaching methods. They found themselves stimulated to try and use different programs they had never utilized before. This made them more acquainted with strategies, software programs, and online applications to get students excited about virtual meetings and classes. This in return has affected their motivation and passion for online teaching. Hence, it has also improved their self-awareness and self-esteem.

Unsurprisingly, EFL instructors rated their personal satisfaction toward professional and technical skills during online teaching at the lowest level compared with other aspects, although this aspect was assessed at a medium level. This can be attributed to the challenges instructors face at the beginning of the online endeavor. Most instructors expressed how challenging the beginning was. Most instructors were not well-acquainted with the new ways of online teaching and essential technical skills. Further, the rabid shift to online teaching left EFL university instructors feeling less confident in those skills. This result confirms Cain et al.'s (2022) study, where the authors state that teachers' lack of readiness to instruct through digital tools has been a dominant concern in the existing literature. This finding is directly in line with Cain and colleagues' (2023) study, where technological challenges emerged as a major theme in the participants' qualitative responses. Participants showed high concerns toward the passivity and unfamiliarity of the technology-based mediums in the online environment.

6. Conclusion

6.1 Conclusions

This study aimed to investigate Palestinian EFL instructors' perceptions of the impact of online teaching on professional identity transformation. It also investigated how online teaching affected instructors' professional identity in some aspects. Thus, it contributed to a nuanced understanding of the intelligible impact of online teaching on instructors' professional identity. As it was shown, the study revealed that EFL instructors' perceptions of the impact of online teaching on their professional identity ranged between high and medium ranks. It also revealed how EFL instructors' professional identity was influenced in terms of professional needs, self-awareness and self-esteem, social relations with colleagues and learners, and instructors' perspectives towards their institution.

6.2 Pedagogical Implications

Some important implications can be drawn based on what was revealed in this study. As it was found, the shift to online teaching has impacted the way EFL instructors perceived their professional needs, their social relations in the context of their career, how they perceived themselves, and their perspectives towards their institution. Hence, it is essential to be aware of these changes in the professional context by adapting to new transformations and creating a professional environment where EFL instructors can learn new technical skills. It is also recommended that educational institutions foster a virtual social network in such cases to intensify the positive outcomes of professional groups in a social and friendly mold, where EFL instructors can circulate their expertise and success stories in online teaching. Finally, educational institutions are also recommended to adapt their educational policies and teaching requirements in the light of any educational change, which can help EFL instructors cope with new changes in the professional context successfully. This can include allowing EFL instructors more flexibility in how they deliver their classes and evaluate their students.

6.3 Study Limitations and Future Studies

Although the study has successfully met its objectives and contributed to the existing body of literature in the field, two limitations might be acknowledged in this study. First, the research was limited to a specific context which is mainly related to one Palestinian university with certain participants. This may limit the generalizability of the results to other educational settings. Secondly, the current study mainly relied on self-reported responses for the quantitative and qualitative data which can cause potential bias, particularly given the resemblance between the aspects of the questionnaire and the themes of the interview questions.

Future studies may follow the same methodology and apply it to other educational institutions where a more in-depth understanding of how online teaching impacts EFL instructors' professional identities could be achieved. Besides, researchers are encouraged to conduct similar studies in hybrid learning environments in the higher education sector. It would be interesting to observe how the professional identity of EFL instructors might be shaped in such a context.

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Data availability: Data will be made available upon request.

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The Impact of the Online Learning Readiness Self-Check Survey with Australian Tertiary Enabling Students

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Abstract*:* This study reports on two key aspects relating to the use of the Online Learning Readiness Self-Check (OLRSC) survey, which has been proposed as identifying non-traditional students' readiness for online learning, and their strengths and weaknesses in six key areas. The first aspect validates the use of the instrument based on data from 199 students engaged in an online tertiary enabling course at a regional university in Australia. Factor analysis verified the scale structure of the instrument; however, two items were removed prior to the final analysis due to low communality and/or high cross loading with other items. This is followed by an examination of whether the instrument might be useful for the early identification of students who are at risk of disengagement from the enabling program. While it was hypothesised that the instrument, which measured factors such as the quality of interaction with peers and instructors, their capacity to manage technology and how well they managed learning, should have been a useful tool to identify early disengagement, the hypothesis was not supported. No significant associations were identified between any of the instrument's scales and early withdrawal from the course or completion of the first unit of study. Future recommendations for educators are made with a view to improving student engagement.

Keywords: Tertiary enabling education, Online learning, Predicting engagement in enabling education, Transition

1. Introduction

Students who enter university enabling programs demonstrate a wide range of learning readiness. Irrespective of age, there are a variety of reasons why students may be challenged in their attempt to re-engage with education, including having a limited educational background, personal and/or environmental barriers, competing opportunities, being challenged by previous educational experiences, or being absent from formal education for an extended period of time that they have limited confidence in their ability to be able to successfully engage with a tertiary enabling course. For these reasons, an underpinning characteristic of tertiary enabling programs is that they have a focus on student support to ensure that each student has the opportunity to succeed to their potential (Crawford, Kift & Jarvis, 2019; Motta & Bennett, 2018). This paper describes one attempt at an Australian regional university to identify non-traditional online students in a tertiary enabling program, who may be at higher risk of disengaging with their study, so that targeted interventions could take place.

2. Background

A key goal for tertiary enabling education is to "assist academically underprepared learners to acquire the necessary knowledge, skills and confidence to transition to and succeed in higher education" (Willans & Seary, 2018, p. 48). Strategies identified to help increase the likelihood of success in enabling programs include building appropriate supportive relationships with university, academic staff and peers (Lisciandro & Gibbs, 2016; Pham, 2022), developing an appropriate learning environment in which to study (Shah et al., 2014) and providing students with the ability to maintain commitment, motivation and self-belief related to their study and learning goals (Syme et al., 2022; Whannell & Whannell, 2015). One of the key challenges in enabling education, in addition to managing the diversity of students in such programs, is the challenge of retaining them (Willans & Seary, 2018).

Students who enrol in enabling education programs in Australia have been frequently reported at being as a high risk of attrition. For example, Li and Carroll (2017) found that students from equity groups were at greater risk of university attrition. Nelson, Duncan & Clarke, (2009) reported similar findings for equity students at regional universities. Further, they found that for students belonging to multiple equity groups, as may be the case with many enabling students, factors compounded resulting in additional impact on completions.

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Accordingly for higher education in general, and enabling education in particular, there has been substantial research that has attempted to identify students who are at a high risk of attrition (e.g. Chai & Gibson, 2015; Whannell & Whannell, 2014, Willans & Seary, 2018). This study adds to this literature by exploring the utility of the Online Learning Readiness Self-Check (OLRSC) (Cheon, Cheng & Cho, 2021) to equity students at a regional Australia university.

2.1 The Online Learning Resources Self-Check Survey

The OLRSC survey was developed and validated by Cheon, Cheng & Cho, (2021). The items in the unit and the factor structure are shown in Appendix 1. The validation was completed using a dataset comprising "505 prospective online learners with diverse background[s]" (p. 599) and was completed using both exploratory and confirmatory factor analysis. The instrument, comprising of 23 items, was identified to have a structure made up of six factors as summarised in Table 1 below.

Table 1: OLRSC factor structure (Cheon, Cheng & Cho, 2021)

Factor	Items	Item Description	Cronbach's α
Learning Management (LM)	6	Relating to planning and monitoring learning tasks	0.87
Interaction with Peers (IP)	3	Relating to seeking and providing help with peers	0.87
Technology Management (TM)	4	Relating to the use of various digital applications and basic troubleshooting skills	0.78
Space Management (SM)	4	Relating to creation of a learning environment to focus on tasks	0.88
Interaction with Instructors (II)	3	Relating to necessary communication with instructors	0.84
Motivation Management (MM)	3	Relating to the motivational strategies when learning online	0.76

The Cronbach's alpha values indicate a high level of internal consistency in each of the scales (Ho, 2006).

Cheon, Cheng & Cho (2021) proposed a number of opportunities that were available in the use of the OLRSC with non-traditional students, including that these learners would be able to "recognize their strengths and weaknesses in regard to online learning" (p. 614). They also argued that that student with lower online readiness scores as identified by the OLRSC, might abandon online learning, and that the use of the instrument was appropriate to "evaluate current readiness levels and provide online learning tips or guidelines to improve factors with low scores" (p. 614). The provision of customised resources for students was also recommended.

Of particular interest to the researchers in this study was that although Cheon, Cheng & Cho (2021) proposed that the OLRSC was suitable for use with non-traditional students, they stated that the "majority of the participants (79%) had a postsecondary degree. In particular, 33.3% of the participants had a graduate degree" (p. 606). This contrasts greatly with the demographics of students who enrol in tertiary enabling courses in Australia, including at the institution where this study was conducted, where few have any form of post-secondary school qualifications. This brought into question whether the instrument was valid for use with enabling students in the Australian context. Despite the difference in the background of the cohort targeted in this study, the scales were considered appropriate for use for this study.

Method

The research questions that guided the project were:

- How valid is the Online Learning Readiness Self-Check survey for use with students enrolled in a tertiary pathways enabling course?
- What capacity does the early use of the Online Learning Readiness Self-Check survey in a tertiary pathways enabling course have for predicting student attrition/retention?

2.2 Unit Content

The OLRSC as developed by Cheon, Cheng & Cho (2021) includes six scales, namely Learning Management, Space Management, Technology Management, Interaction with Instructors, Interaction with Peers and Motivation Management. Content was developed to support each of the areas addressed by these scales and was included in a module in the Moodle LMS. The existing Moodle material also included content to specifically target the enhancement of students' academic skills relating to writing, numeracy, information technology and how to

interact with academic staff and peers. The study plan for the module required students to complete the survey which was available in Qualtrics. On completion, the result for each scale was provided, and the student was advised to continue to the supporting content in the LMS, particularly those areas where the students' scale result was considered low. The additional content was expected to take approximately one week to complete.

2.3 Participants

Potential participants were students enrolled in the two foundation units located in the enabling course for the Trimester 2 and 3 sessions in 2022. Students were notified of the research in week 2 of the trimester by an announcement in the Moodle LMS used by the institution, which also generated an email to each student. The survey was available for completion up to the end of week 5 of the trimester via the online survey tool Qualtrics. At the completion of the study and following cleaning of the dataset where incomplete responses were removed, 199 surveys were available for analysis from a total population of 480 students, representing a 41.5% response rate. Of the students who responded, over 82% identified as female, indicating a strong gender bias in the participants. A similar gender bias is seen in the total enrolments in the pathways program for these trimesters, where 74% of all students are female. Participant ages ranged from 17 to 72, with a mean of 29.4.

At the conclusion of the survey, participants were presented with their summative scores on each of the six scales available. They were also provided with a link to the customised resources in the teaching materials in Moodle that could be used to understand the meaning of the result, and how they might develop their capacities in each area.

At the completion of the project, the data was downloaded, and the researchers were provided with the email address for each of the participants to allow matching of survey results with engagement in the enabling unit. This process was in accordance with the ethics approval for the project.

2.4 Analysis

The data available was examined and partial responses were removed prior to analysis. Considering that the six-factor structure of the OLRSC was validated by Cheon, Cheng & Cho (2021), the initial analysis to confirm this was done using Principal Components Analysis (PCA) using Direct Oblimin rotation to allow for correlation between the factors was conducted using all 23 items (Ho, 2006). Factors were considered suitable for use if the eigenvalue for the factor was greater than one and the Scree Test indicated suitability (Ford, MacCallum & Tait, 1986). Individual items were considered appropriate for inclusion in a factor if the item communality was 0.5 or greater (Child, 2006) and the item loaded on the factor with a value of greater than 0.5 with cross-loadings of less than 0.2 (Ho, 2006).

To allow testing of the capacity for the OLRSC to be used as a tool to predict outcomes in the enabling unit, student engagement was operationalised using two variables. The first variable, called Engagement, was calculated by an examination of the Moodle logs. Students had access to Moodle for a period of 14 weeks from when it was available for access, to the date of the submission of the final assessment task for the unit. Students who completed all assessment tasks, irrespective of whether a pass grade was achieved, were given a result on the Engagement variable of 14. Students who did not complete all assessments were allocated a value for Engagement, depending on the week at which the Moodle activity logs indicated that they had no longer accessed the unit content. Thus, a student whose final access to Moodle was in week 7, was allocated an Engagement value of 8. Due to a high incidence of student attrition early in the trimester, the resultant negative skewing of the Engagement variable indicated that the non-parametric Spearman's rho correlation was appropriate for use (Field, 2013).

It was hypothesised that there should be statistically significant differences in one or more of the OLRSC scales based on unit completion. The second nominal variable, Completion, was operationalised by examining if students had completed and submitted all assessment tasks for the unit. Due to non-normal distributions in some of the OLRSC scales, the Mann-Whitney *U*-test was used to determine if there were any significant differences in any of the OLRSC scales based on Completion (Field, 2013).

3. Findings

3.1 Validation of the Online Learning Readiness Self-Check Survey

The 199 valid responses to the survey were entered into SPSS version 27. The initial PCA using Direct Oblimin rotation to allow for correlation between the factors was conducted using all 23 items in the OLRSC (Ho, 2006). An examination of the scree plot and factor eigenvalues greater than one indicated that the six-factor solution

was supported, with a Kaiser-Meyer-Olkin Measure of Sampling Adequacy of 0.839 and 73.4% of the variance in the items accounted for (Dziuban & Shirkey, 1974). However, item LM1 demonstrated a relatively low communality at 0.434, and also demonstrated a high cross loading on the Motivation Management factor (0.294). Item LM5 demonstrated a high cross loading on the Interaction with Peers factor (0.362). These items were removed from the analysis and it was repeated.

The final PCA using the remaining 21 items demonstrated a Kaiser-Meyer-Olkin Measure of Sampling Adequacy of 0.822 with item communalities ranging from 0.519 to 0.946. Six factors were identified accounting for 76.1% of the variation in the items. The Scree plot is shown in Figure 1.

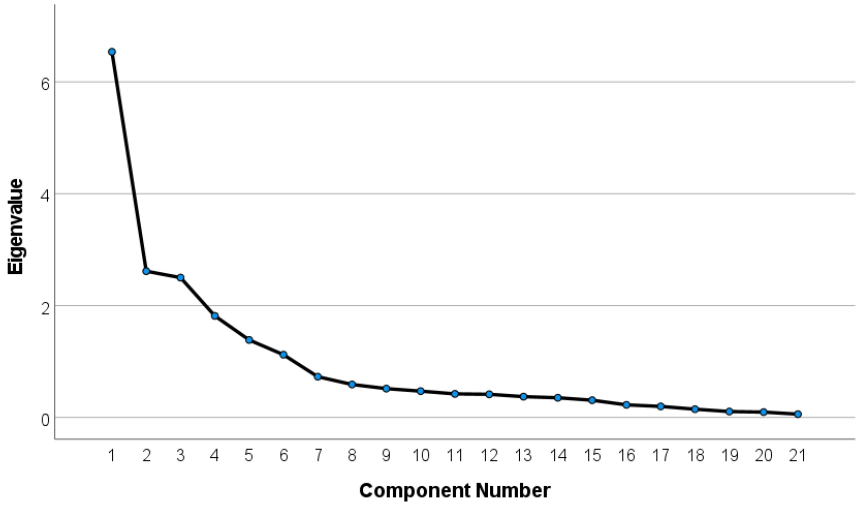

Figure 1: Principal Components Analysis Scree Plot

The factor loadings for the PCA are shown below in Table 2.

Table 2: Pattern matrix for PCA using Direct Oblimin rotation

	Factor					
Item	**1**	**2**	**3**	**4**	**5**	**6**
II3	**0.958**	0.017	-0.043	0.003	-0.019	-0.009
II2	**0.922**	-0.008	-0.006	-0.043	0.050	0.038
II1	**0.913**	0.013	0.019	0.003	0.004	0.093
TM3	-0.063	**0.852**	0.030	0.041	-0.019	-0.046
TM1	0.134	**0.834**	0.132	0.062	0.060	-0.024
TM2	0.010	**0.821**	-0.016	-0.086	0.038	0.018
TM4	-0.055	**0.769**	-0.154	-0.079	-0.058	0.078
MM1	0.025	-0.009	**-0.914**	0.004	-0.025	-0.026
MM2	0.047	-0.008	**-0.878**	-0.031	0.087	0.000
MM3	-0.025	-0.008	**-0.860**	0.016	0.031	0.028
SM2	-0.052	-0.016	0.073	**-0.952**	0.055	0.014
SM3	-0.057	0.022	0.090	**-0.938**	0.029	0.020
SM1	0.126	-0.038	-0.057	**-0.727**	-0.042	-0.011
SM4	0.037	0.093	-0.174	**-0.693**	0.007	0.023
LM2	-0.001	-0.114	0.063	-0.032	**0.801**	0.021
LM3	0.159	-0.023	-0.073	-0.049	**0.746**	-0.094
LM4	-0.018	0.093	-0.057	-0.067	**0.732**	-0.034
LM6	-0.058	0.088	-0.054	0.071	**0.680**	0.126

	Factor					
Item	**1**	**2**	**3**	**4**	**5**	**6**
IP1	0.052	0.051	-0.017	0.039	-0.089	**0.907**
IP2	-0.018	-0.062	-0.003	-0.064	0.052	**0.891**
IP3	0.065	0.005	0.028	-0.006	0.071	**0.876**

The Cronbach's alpha for each of the final scales was between 0.761 and 0.963, indicating a sound to high level of internal consistency for all scales: Learning Management – 0.761; Interaction with Peers – 0.899; Technology Management – 0.838; Space Management – 0.872; Interaction with Instructors – 0.963; Motivation Management – 0.885 (Buckingham & Saunders, 2004).

Table 3 provides the descriptive statistics for each of the scales. It is evident that all scales demonstrated a wide spread of scores, with some students reporting very low results.

Table 3: Descriptive statistics – OLRSC scales

Scale	Possible Score	X_{Min}	X_{Max}	$\bar{X}$	Cronbach's alpha	Count
Learning Management	4 – 28	8	28	21.7	0.761	199
Interaction with Peers	3 – 21	3	21	12.8	0.899	199
Technology Management	4 – 28	6	28	21.5	0.838	199
Space Management	4 – 28	8	28	22.7	0.872	199
Interaction with Instructors	3 – 21	3	21	15.9	0.963	199
Motivation Management	3 – 21	3	21	16.0	0.885	199

An examination of the histograms and box plots indicated a negative skewing of the data in some scales. This analysis indicated that the 21-item version of the OLRSC would be appropriate for use with the non-traditional students enrolled in the pathways enabling program, however the decision was made that further data analysis would be done using non-parametric techniques (Field, 2013).

3.2 Predictive Capacity of the OLRSC

Based on the reviewed literature, it was hypothesised that students who scored higher on the scales of the OLRSC should demonstrate a higher level of engagement and completion in the enabling unit. The Spearman correlations of Engagement with the OLRSC scales are shown in Table 4. The second variable, Completion, was a nominal variable indicating whether the student had completed all assessment in the unit. The Mann-Whitney *U*-test results for each of the scales based on Completion are shown in Table 5.

Table 4: Spearman correlations: Engagement with OLRSC scales

Scale	Learning Management	Interaction with Peers	Technology Management	Space Management	Interaction with Instructors	Motivation Management
Correlation	0.044	-0.083	0.085	0.007	0.037	0.092
p	0.541	0.251	0.241	0.928	0.606	0.203

Table 5: Mann-Whitney *U*-test: OLRSC scales based on unit completion

Scale	Learning Management	Interaction with Peers	Technology Management	Space Management	Interaction with Instructors	Motivation Management
U	3512	3484.5	3635	3842.5	3752	3512
p	0.214	0.188	0.372	0.976	0.568	0.214

4. Discussion

It was hypothesised that the OLRSC scales would be a useful indicator of a non-traditional online student's capacity to successfully engage with their online study in the tertiary enabling course and, as a consequence, would be useful in identifying at-risk students. While the OLRSC appears to be a robust survey for use with Australian enabling students, its usefulness as a tool to be able to assist with the early identification of at-risk students was not supported in this study.

The lack of a significant correlation between the Engagement variable and any of the OLRSC scales, and the lack of statistically significant differences based on unit completion, is contrary to what was expected based on the literature. By way of example, a study by Farr-Wharton et al. (2017) of first- and second-year undergraduates at a similar Australian regional university to that where this study was conducted, found "compelling evidence regarding the role of lecturer-student relationships in enhancing student outcomes" (p. 167). Studies with tertiary enabling students have also supported this view (e.g. Cavanagh et al., 2012; Bunn, 2019). Syme et al. (2022) argue that in the tertiary enabling context, high quality outcomes require "a trusting and open student-teacher relationship" (p. 2428). In this study, there was little association between the Engagement variable and the nature of the interaction with instructors (ρ = 0.037, p = 0.606). Similarly, there was little evidence of a difference in the variable based on unit completion (U = 3752, p = 0.568). When the items of the Interaction with Instructors scale of the OLRSC are considered, it appears that the items are quite limited in scope, with a focus on practical actions that are required to access content via the instructor e.g. II1: I ask the instructor questions when needed; II2: I seek assistance from the instructor when needed. These items do not look to the question of the quality or nature of the relationship with instructors, and may therefore not be addressing those aspects that may be predictive of overall outcome.

When the rationale provided by Cheon, Cheng & Cho (2021) for the items included in the OLRSC is considered, it appears appropriate and based on the extant literature. The items appear to address aspects of the tertiary study environment that non-traditional students would need to develop in order to succeed at university. For this reason, the instrument and associated support materials that were developed to support this study are still included in the unit content. The introduction to the survey and the support materials are presented as tools to assist in understanding the level of development of specific skills and how they might be enhanced.

5. Conclusion

This research project investigated the validity of the OLRSC survey for use with two cohorts of Australian tertiary enabling students. With the exception of two items in the Learning Management scale which were excluded, the survey provided six scales that validated appropriately and demonstrated the same scale structure as that found by Cheon, Cheng & Cho (2021). However, the capacity of the instrument to be used for predictive purposes to identify an enabling student who may be more at risk of disengagement and early attrition is not supported. This finding does appear somewhat contrary to what was expected based on the literature and what the scales of the OLRSC appear to measure. When the nature of the items in the various scales of the instrument are considered, the lack of predictive capacity of the instrument is considered unusual. This appears as an area that warrants additional research efforts with a view to develop an instrument that is able to be used to identify students who are at risk of attrition so that appropriate intervention may be performed.

A limitation of this study is that it has used a quantitative approach based on engagement and unit completion. Future qualitative research would need to be undertaken to establish whether the completion of the OLRSC and engagement with the accompanying support materials were of use to students, either in terms of assisting them to develop the relevant skills addressed or to inform them of strategies that could be used to assist them in the transition into their tertiary study.

Disclosure Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Data availability statement

The data that supports the analysis and findings of this study are not available as the ethics approval does not allow sharing of data beyond the researchers involved.

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A Strategy Development Framework for Educational Technology: An integrated Design Science Research and Modified Delphi Approach

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Abstract: Emerging technologies are transforming educational practices, but successful integration requires improving the quality and efficiency of learning. New technology emerges in hype cycles but adoption and performance lag over time. A strategy development framework is needed for decision-makers to understand the complex interaction of all the factors to consider when making new technology investments. The research explores how strategy development occurs through the dynamic interaction of strategy with learning, and technology integration. It analyses the key elements of a strategy map for learning with technology and how they influence each other within the overall strategy map. The research design integrated the different cycles of Design Science Research (DSR) with a modified Delphi Technique in two phases of research. During the first research phase, Delphi panel members were interviewed to understand current challenges and practices in learning with technology. The results of the literature review and thematic data analysis from the interviews were used to create a hypothetical strategy map and a strategy development framework, as an artefact, as part of the DSR process. This framework was shared with Delphi members in the second phase of research, and they were requested to evaluate the framework for its fit and utility in similar contexts of learning with technology. The feedback contributed to the refinement of the artefact and highlighted the key operational focus areas for learning with technology. The key operational focus areas identified were the need to increase the basic technology literacy of students and educators, continuous professional development in terms of online pedagogy, and the need for principles in terms of multimedia design. Other focus areas were an online design blueprint and an improvement in learning and teaching experiences through efficiencies and productivity of ed-tech technologies. This study contributes a strategy development framework for educational technology which enhances theories around the analytical and conceptual processes when planning and implementing new emerging technologies in learning. Analytical processes include external and internal analysis and a SWOT analysis of aspects related to learning with technology. Other key outcomes of the study include a hypothetical strategy map for learning with technology which aligns business objectives to a financial, customer, internal business process and learning and growth perspective.

Keywords: Balanced scorecard, Educational technology, Emerging technology, Learning with technology, Strategy development, Strategy map

1. Introduction

Emerging technologies are a catalyst for educational innovation and can radically transform education. Technology innovations need to improve the productivity and efficiency of learning and the quality of learning (Serdyukov, 2017). The oversupply and proliferation of technological advances emerge in hype cycles but the adoption and performance of these technologies lag after a significant time lapse (Linden and Fenn, 2003). Technology adoption navigates through a cycle of initial over-enthusiasm, disillusionment and eventual productivity as described by the Gartner hype cycle (Linden and Fenn, 2003). An understanding of this cycle guides decision-making regarding the most relevant technological choices in terms of strategic goals. A strategy process enables decision-makers to make technology choices aligned with business goals. Chief Information Officers from institutional learning organisations indicated operational excellence through technology, as a primary goal of technology in their organisations (Gartner Inc., 2022). Organisations should guard against overinvestment in the early stages of the hype cycle but should also not ignore potential benefits in the long run (Linden and Fenn, 2003).

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Strategic choices in terms of technology investments require decision-makers to make trade-offs between short-term profitability and sustainable performance in times of uncertainty (Pelser and Prinsloo, 2014; Dong, 2021). EdTech decision-makers are often expected to select EdTech tools from a wide range of technologies that will ensure an improvement in student outcomes. Real-world implementations, defining the scope and context of the operationalization of educational technology is required and will provide valuable guidance in facilitating this decision-making process (Hollands and Escueta, 2017).

Digital innovation and transformation are multi-dimensional and complex and involve stakeholders and decision-makers at all levels in an organization, to facilitate the changes required. Alignment with strategic objectives has an impact on infrastructure, tools, processes, strategies, experiences, and skills development. It requires a technology roadmap and a sound theoretical approach to inform a pedagogy for technology-based learning (Serdyukov, 2017; Sousa and Rocha, 2019; Balakrishnan and Das, 2020; Torraco and Lundgren, 2020).

The balanced scorecard (BSC) is an effective strategic management tool in higher education on an institutional or business unit level and links a strategic vision to measurable objectives. It is congruent with the Baldridge Criteria for Performance Excellence in Education. It is effective for strategic management and also for day-to-day operational performance management (Karathanos and Karathanos, 2005; Chen, Yang and Shiau, 2006; Beard, 2009; Hladchenko, 2015). The most promising evidence for the integration of the analyze, design, develop, integrate and evaluate (ADDIE) model of learning design, with the BSC was however found in the *Learning Scorecard* of Cronje (2008). In this model, the perspectives of the BSC are superimposed on the ADDIE elements of learning, proposing a holistic approach to align and integrate learning with business processes through a clear business strategy.

This study aims to provide a strategy development framework that will highlight the multiple factors that contribute to the effective implementation of emerging technologies in learning on both a strategic and operational level. This framework outlines critical elements associated with operational business performance when learning with technology. The authors view a strategy as an outcome of a process, written up in a company document. This study proposes a strategy development framework, highlighting analytical and conceptual processes that can be used in a strategy development process to derive a unique company strategy.

The research explores how strategy development occurs through the dynamic interaction of strategy with learning, and technology integration. It analyses the key elements of a strategy map for learning with technology and how they influence each other within the overall strategy map. Learning with technology occurs in business environments and academic institutions. The audience for this study is ideally decision-makers in educational or training institutions. It will be equally informative for teachers or instructional designers embracing new technological advancements in their practice or operation.

2. Methodology

2.1 Abductive Theory Building

The study used models and concepts of an interdisciplinary nature to analyse findings in different phases of the research. Concepts related to strategic planning, business performance management, instructional design and educational technology were explored to understand the complex dynamics between strategy and learning with technology.

The theoretical underpinnings of the BSC and the (ADDIE) instructional design model, were integrated into an abductive structure for data analysis. The BSC was used to develop a strategy map that links strategy, technology, and learning. It was used to identify key dimensions of business performance and to contextualise these dimensions in terms of a "financial perspective, internal process perspective, learning and innovation perspective and a customer perspective" (Kaplan and Norton, 1993; Kaplan, 2009).

Learning interventions are designed systemically during the phases of the ADDIE paradigm (Gustafson and Branch, 1997). The design of learning material for online environments involves using many emerging technologies. The integration of elements of ADDIE and its underlying constructs with perspectives of the balanced scorecard was further enhanced through elements of design thinking. Iterative cycles of design thinking and principles of rapid prototyping enhanced the theoretical foundation for understanding learning with technology.

2.2 Research Design

The study was conducted in a multidimensional environment of external socio-technical dynamics as well as internal organisational dynamics. The iterative cycles of design thinking were central to the research design.

2.2.1 Integration of Design Science Research (DSR) and Delphi

Figure 1 illustrates how the different DSR cycles facilitated the research process. This study adopted the four different cycles of DSR as a guiding framework for research (Drechsler and Hevner, 2006). The integration of the different Delphi phases is illustrated at the bottom of the picture with the arrows. The change and impact cycle represents the contextual environment and links with the comprehensive literature review which analysed the internal and external dynamics impacting learning with technology. The literature provides insights regarding trends in the external environment, and capabilities in the internal environments, and integrates it on a conceptual level with a strengths, weaknesses, opportunities, and threats (SWOT) analysis to identify opportunities and threats in the environment.

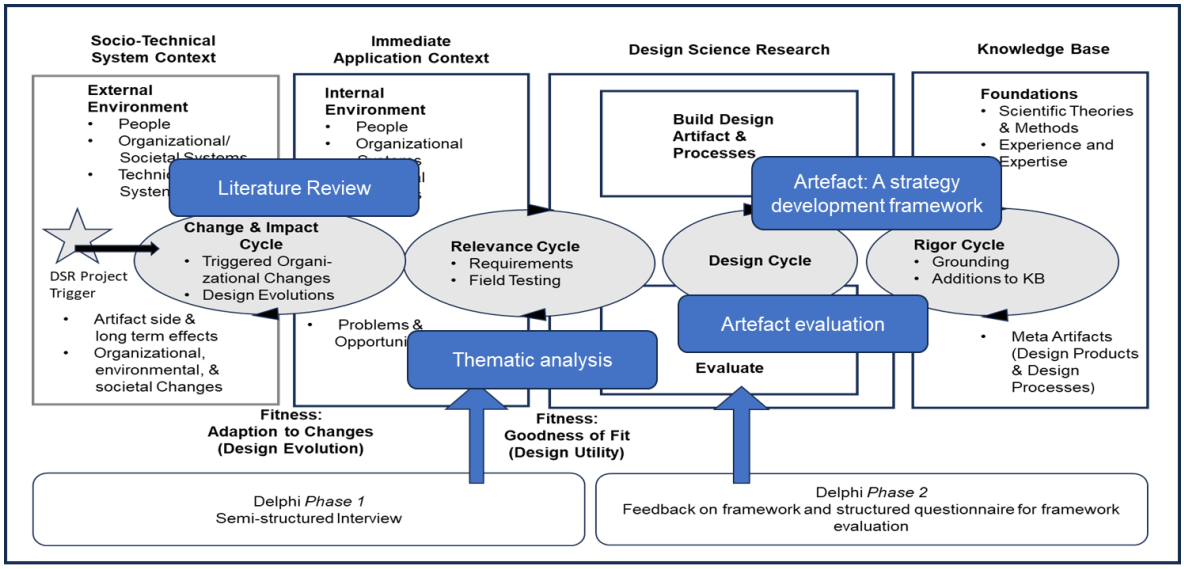
The relevance cycle facilitates problem identification and was integrated with the first phase of Delphi where participants were interviewed to determine their understanding and experiences in the contextual environment. Participants were asked to describe how emerging technologies are changing business operations from a learning perspective in terms of the different phases of ADDIE. The interviewer prompted responses in line with the dimensions of the BSC, namely financial, customer, internal process and learning and growth perspective. They also shared success stories, failures and measures of success. Interviews with Delphi participants in phase one were subsequently analysed through an abductive theory-building process to construct a hypothetical strategy map to highlight the different elements to be included in an overall strategy map.

The design cycle represents the development and testing of an artefact. The results from the thematic analysis of the interviews were combined with insights from the literature review to develop a hypothetical strategy map and to identify operational focus areas (Section 3). The environmental analysis, together with the hypothetical strategy map was presented to panel members in a video presentation as the draft artefact, in the second phase of Delphi. They were requested to evaluate the proposed strategy development framework for its fit and utility in a dynamic context and to rate the operational focus areas in terms of their importance to practice. They received a structured questionnaire through a web-based interface and were asked to rate the different operational focus areas on a 4-point Likert scale. The responses for each focus area were summated by allocating a numerical value to the responses (strongly disagree, 1; disagree, 2; agree, 3 and strongly agree, 4). The average values were then used to rank the focus areas in terms of importance. The artefact is documented as a strategy development framework in Sections 3 and 4 and was improved through iterative design methodology and contributed to the knowledge base which integrates with the rigour cycle.

2.2.2 Delphi

The Delphi technique is a group communication technique, structured to solicit the opinions from a group of experts regarding a specific complex problem (Linstone and Turoff, 1975). The technique has been developed to facilitate interaction and group dynamics while maintaining the anonymity of respondents. If respondents are known to each other, confrontation regarding a specific matter could lead to the risk of conforming to the opinions of others or withholding controversial opinions. The technique uses structured feedback to ensure that all participants get relevant and applicable information and reduces unnecessary “noise”. The structured feedback allows participants to reflect and revise their own opinions. The group responses are then analysed statistically (Dalkey and Helmer, 1963; Dalkey, 1969). The Delphi technique has evolved in terms of how it is applied in different fields and many variations exist (Linstone and Turoff, 1975).

The Delphi method is widely used in framework development and theory building. The iterative cycles of the Delphi technique provide experts with the opportunity to develop a collective understanding of a theory and to provide feedback on components thereof. This can enhance practice as well as theory and contributes to construct validity (Okoli and Pawlowski, 2004).



Note: Adapted from A four-cycle view of DSR (Dreschler and Hevner 2016: 5)

Figure 1: Integrated DSR and Delphi process

2.2.3 Types of artefacts and its evaluation in DSR

The different types of artefacts of DSR are broadly classified in terms of constructs, models, methods, and instantiations (March and Smith, 1995). Peffers et al., (2012) also added algorithms and conceptual frameworks or meta-models to the classification. The outcome of this study is presented in the format of a strategy development framework developed through iterative cycles of problem identification, analysis, design, and evaluation. In a study on evaluation methods for artefact types, Peffers et al., (2012) found that a framework can effectively be evaluated by a panel of experts through a Delphi study.

2.2.4 Panel selection criteria

Purposive sampling was used to identify seven participants to form part of the Delphi panel and to participate in two phases of panel processes remotely, via electronic platforms. Participants were selected based on their unique understanding of complex phenomena in context and were considered "information-rich" individuals (Patton in Onwuegbuzie and Leech, 2007). Table 1 highlights the selection criteria that were used to ensure that participants came from specialist clusters or managerial levels in the field of learning with technology. Participants were selected from business and higher educational organisations.

Table 1: Selection criteria for Delphi panel participants

Criteria	Where to find respondents
Strategic insight and futuristic mindset	Strategy specialist
Key decision-makers in shaping systems to drive change, new methods, and policies	Directors, divisional managers
Instructional design experts with knowledge of emerging technologies and applied technical expertise.	Senior instructional design specialists

Members were further selected based on their professional qualifications, academic rank, interest in the subject matter of the study, and willingness to participate. Some panel members were requested to participate based on their participation at other academic conferences or forums. Table 2 gives an anonymised description of the role and profile of the Delphi panel members. The researcher facilitated the debate through the research instruments and structured feedback. Participants remained anonymous to all other participants throughout the process. The names of participants were completely removed from the research report, and numbers alone were allocated to participants to maintain their privacy and anonymity in the study. The different perspectives of the panel members are integrated into the discussion section.

Table 2: Panel members of the Delphi panel

Nr	Institution	Role and profile	Academic rank/position
1	Distance education institution SA	Managing director/ instructional designer The company sells courses online. The courses are mainly focused on Accounting, HR, Occupational Health, and Safety. The focus is on courses that sell high volumes and have a high ROI. A small number of courses are custom-designed.	Managing director
2	Learning design and delivery company (International)	Managing director/ instructional designer All courses are designed based on client needs. Focus is on mobile learning and on-the job training initiatives as well as compliance training.	Dr
3	Private university in SA	Head: Instructional design The university has a clear strategy for student segmentation and online design blueprints for different online modalities.	Dr
4	Public university Africa	Coordinator: Institute of Distance Education The university is exploring alternative delivery channels. Focus is on providing guidelines for expanding online offerings and providing basic literacy programmes.	Dr/ Prof
5	Public university SA	Head: Instructional design A central design unit develops interactive and multimedia learning materials. The design unit works in multidisciplinary teams to facilitate design and implementation.	Dr
6	Government education department	Head of policy and implementation The participant is responsible for national guidelines and policies on infrastructure deployment in government schools. Responsible for change management and change agent training.	Dr
7	Private school UAE	Head of data management The participant is responsible for data management and facilitates technology infrastructure decisions at a private school in Dubai.	Senior manager

3. Analysis and Discussion

This section will first describe the environmental analysis and will then continue to discuss the hypothetical strategy map in the form of a BSC. It will also unpack the detailed components of the BSC and will highlight the operational focus areas which emerged from the analysis.

3.1 Environmental Analysis

3.1.1 External analysis

A literature review on key trends in terms of emerging technologies and operational learning design practices highlighted major themes in learning with educational technology. Key elements associated with each theme are discussed below.

Generative AI

The recent boom in generative AI made educators acutely aware of the need for new competency frameworks to prepare learners to thrive in an AI-powered world. Professional capacity building is required to provide teachers with the skill to use AI in instructional activities and assessment practices that will improve student learning (Pedró, 2019; Baidoo-Anu and Owusu Ansah, 2023)

Blended learning / hybrid integration

Blended learning has emerged as a dominant theme when designing learning environments and includes theories, methods, and technologies in synchronous and asynchronous environments (Cronje, 2020; Joosten et al., 2020; Singh, 2021;).

Technology-supported collaborative learning

A collaborative learning environment, facilitating interaction among peers and tutors needs to consider design elements to integrate "cognitive presence, social presence, and teaching presence" effectively in a virtual learning environment. Online collaboration and support contribute to a sense of closeness and belonging in an online environment (Garrison, Anderson and Archer, 1999; Berry, 2019; Vlachopoulos and Makri, 2019; Ferri, Grifoni and Guzzo, 2020; Mishra, Gupta and Shree, 2020; Rasheed, Kamsin and Abdullah, 2020)

Immersive learning experiences (Virtual reality (VR), Simulation, Game-based learning)

Immersive learning environments such as VR and gamification can have high entertainment value but require technical competence and engineering skills. Further research is required to determine the effectiveness of such learning environments (Baker, Bujak and Demillo, 2012; Vlachopoulos and Makri, 2019; Joosten et al., 2020; Hamilton et al., 2021)

Adaptive learning/ Educational analytics

Adaptive learning puts the student and his/her unique characteristics, abilities, knowledge competencies and preferences at the centre of the learning experience (Muñoz et al., 2022). AI-powered adaptive learning systems collect data and analyse the behaviour of students. It will suggest an optimal learning route and learning material based on students' learning patterns and unique abilities (Alam, 2022). Adaptive learning technology requires a solid technology infrastructure which includes appropriate hardware, software, and internet connectivity for execution. The design of these systems needs to accommodate the complex requirements to be adaptable and responsive to individual learners. Real-time data challenges and the interoperability and integration complexity of LMSs remain significant challenges (Muñoz et al., 2022).

Digital assessment

There is a strong need to develop and enhance online assessment strategies to accommodate the requirements of learning styles, learning outcomes, pedagogy, and delivery to assure academic integrity and security. (Gaytan and McEwen, 2007; García-Morales, Garrido-Moreno and Martín-Rojas, 2021)

Micro-credentials

Discomfort about the implementation of micro-credentials is a global concern. It could provide a new income stream for short courses but major uncertainty around stackable components in curriculum design, and specifically standardization, validation, and accreditation in the context of a quality framework, remain at the centre of the debate (Kato, Galán-Muros and Weko, 2020; McGreal and Olcott, 2022)

3.1.2 Internal analysis

A strategic framework or roadmap for the deployment and integration of digital technologies needs to consider the core capabilities (Wu et al., 2008) required for learning with technology. Such a macro-level strategy for a digital eco-system incorporates all digital components such as hardware, software, applications, training modules, knowledge components and processes and must facilitate the integration and interoperability of emerging and legacy technology components (Uden, Wangsa and Damiani, 2007). Data protection and information security, system reliability and protection against viruses are important components of technical management and support (Almaiah, Al-Khasawneh and Althunibat, 2020).

Core capabilities to be included in the digital eco-system (based on the e-learning hypercube model) of Wu et al., (2008) include:

- Technology infrastructure for communication and delivery involves network infrastructure, applications platforms and devices.
- Technology for content development includes technology used for content creation, packaging, and delivery.
- Capabilities to design learning environments include learning and teaching theories; strategies, and methods for online learning; methods for collaborative learning; and new evaluation and assessment methods for online learning environments.
- Technology support to learners, instructors, and institutions.

3.1.3 SWOT analysis

Although the SWOT analysis is primarily a group activity involving representatives of different strategic and operational levels in an organisation (Pickton and Wright, 1998; Harrison, 2010), the researcher used it as a mechanism to plot the factors identified through the internal and external analysis in various categories of the SWOT matrix.

The SWOT analysis in Figure 2, indicates the relative position of the internal and external factors identified through this study in a generic SWOT matrix. Some internal factors can be strengths or weaknesses based on the current implementation of management control and rigour in a specific environment. The external dynamics can be a threat to existence or provide valuable opportunities for new technological innovations. Factors driving internal efficiencies are related to cost efficiencies and productivity, design excellence in terms of emerging online environments and the skills and capacity of learners and educators. External factors mainly concern factors related to technology infrastructure and access as well as innovations due to emerging technologies.

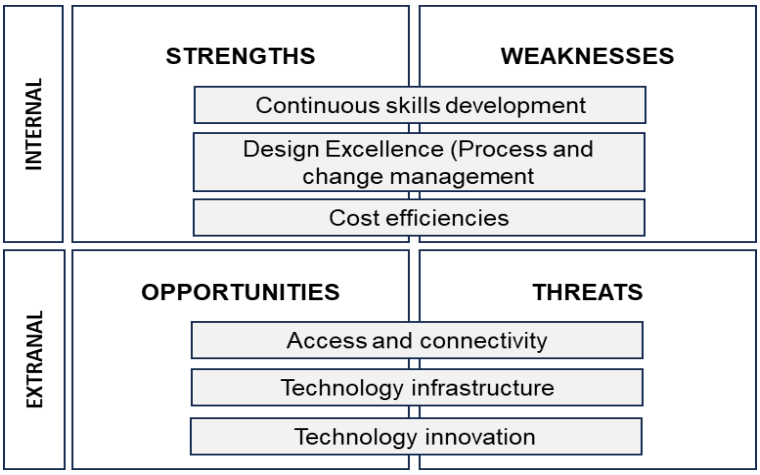


Figure 2: SWOT Analysis

3.2 The BSC for Learning With Technology

The balanced scorecard (BSC) provides a comprehensive framework of critical areas in the business and how it links to a company's strategic vision and objectives The overall objective of "Operational Excellence in Learning" was used as a strategic vision for this BSC. The "conceptual foundations" of the BSC and specifically the "guiding question for each perspective" were used to identify the activities and focus areas for each perspective in the context of the overall strategy map. The BSC was constructed based on the work of Kaplan (2009) and Kaplan and Norton (1993, 1996, 2004) from the thematic analysis of the interviews of Delphi panel participants.

Figure 3 is a visual presentation of the BSC for learning with technology. The financial perspective contains traditional financial measures and includes measures related to shareholder value. Improved learning and teaching experience and increased efficiency and productivity of learning have been added to the financial perspective due to the importance of these factors in a learning environment. The customer perspective includes measures that link directly to the portfolio of learning interventions offered to specific student groups based on unique learner profiles. The internal process perspective focuses on core capabilities and related internal processes in terms of learning design, delivery, and implementation. The learning and growth perspective builds capacity through continuous professional development initiatives and technology infrastructure that aim to improve performance in the financial, process and customer perspective.

The impact of elements in the learning and growth perspective on financial performance is not directly measurable. It does have a chain of causal relationships, indicated by the blue arrows, with critical aspects in the process and customer perspectives, that lead to financial performance. Core output measures such as profitability and increased efficiency and productivity in learning are lagging indicators, while the leading indicators relate to the uniqueness of the business in terms of activities that will lead to profitability and the optimal mix of courses associated with specific online business models.

The BSC model provides an aggregated view of how these different elements influence each other causally when linked to a single vision or strategic objective. In this strategy map the arrows indicate the direction of causal

influence. The colour of the bubbles indicates the intensity of the responses by participants who were interviewed. The light grey bubbles had the lowest number of mentions while the dark blue bubbles had the highest number of mentions.

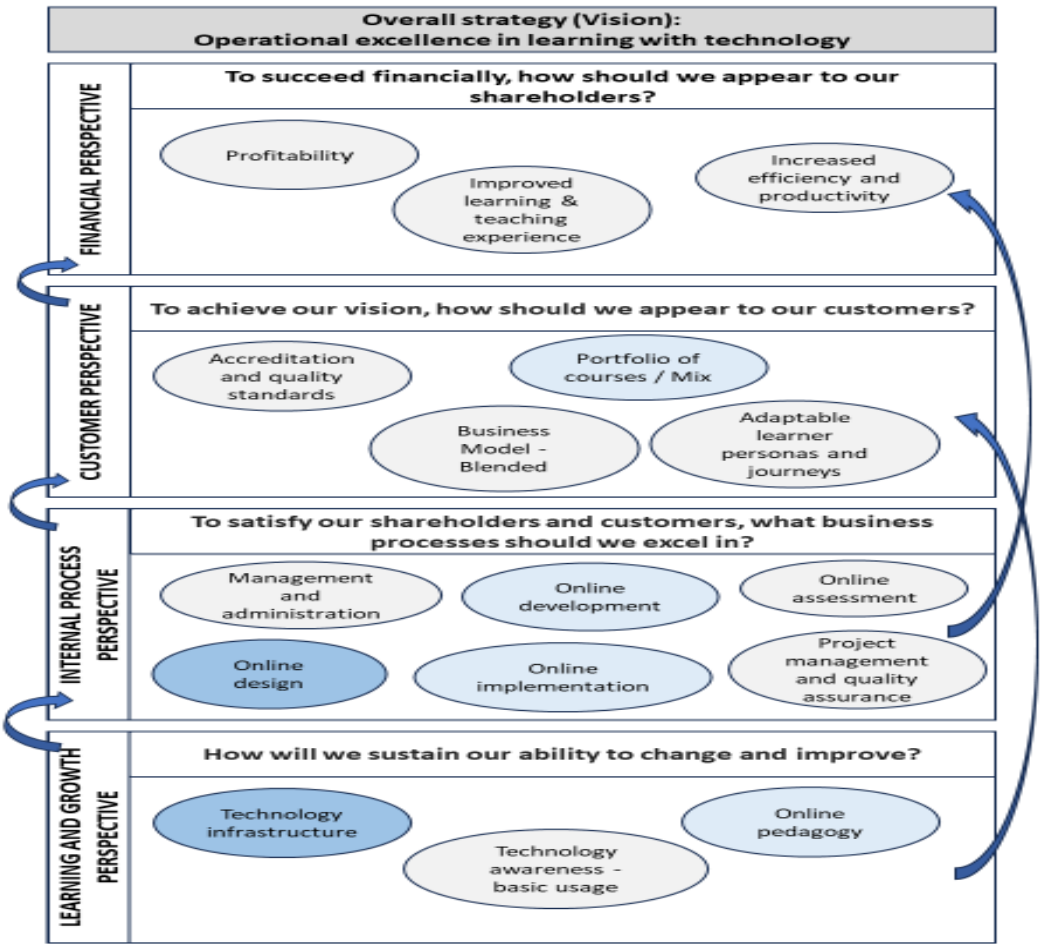


Figure 3: The BSC for learning with technology

3.3 The BSC Unpacked in Terms of Operational Components

In this section, every perspective of the BSC in Figure 3, is unpacked, based on the core themes and elements associated with the leading question in each perspective. We call this BSC a strategy map.

3.3.1 The financial perspective

"To succeed financially, how should we appear to our shareholders?" (Kaplan, 2009) In a business environment, profitability and other financial measures are the ultimate lag factor of good practices. However, in a learning environment, improved learning through effective technology use is the ultimate lag factor. Because improved learning and increased efficiency and productivity are primary goals of operational excellence, the author decided to allocate these themes to the financial perspective.

The role and function of the training unit will also determine if the unit will have financial objectives or not. In some organisations, the unit will have a service delivery function to support other units in the organization. The individual roles of the people participating in a strategy session will determine the lenses through which they interpret the utility of the strategy map. The financial decision-maker might want to include some parameters to measure activities related to learning with technology. Figure 4 highlights the elements allocated to the financial perspective as indicated with bubbles.

Profitability is mainly concerned with the cost of new technology and the diversification of income streams in an e-learning environment. Improved learning and teaching experience refers to satisfaction, engagement, and

user experience as well as completion ratios. Increased efficiency and productivity refer to the effective use of technology and the resultant increase in learning outcomes.

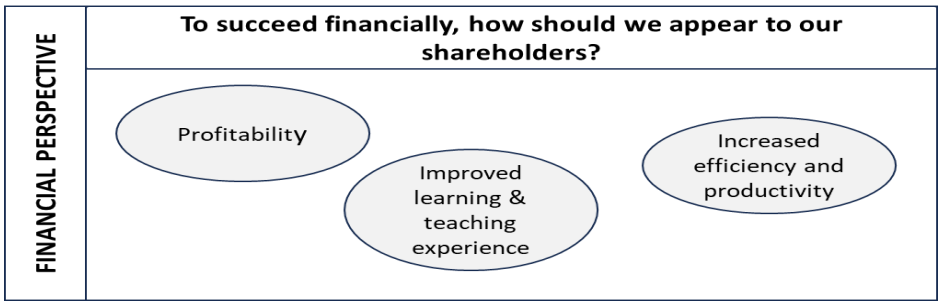


Figure 4: The financial perspective

3.3.2 The customer perspective

"To achieve our vision, how should we appear to our customers? "(Kaplan, 2009). Figure 5 highlights the elements allocated to the customer perspective as indicated by the bubbles. The customer perspective involves important decisions in terms of an online or face-to-face delivery model and its synchronous and asynchronous components. The types of courses can vary from accredited qualifications, compliance training, and industry-specific training courses to micro-credentials and short courses. Segmentation of learner personas involves adaptive learning approaches and student journeys while cognizant of generational differences in technology knowledge and usage patterns. Accreditation links to the required standards when providing courses.

Feedback from Delphi participants indicated that the customer perspective should be adaptive to individual contexts. The customer in educational settings differs from the customer in corporate environments and customer segmentation will depend on the unique characteristics of clients and customers. The customer requirements therefore must be interpreted for the unique contextual environment in which the strategy map will be applicable.

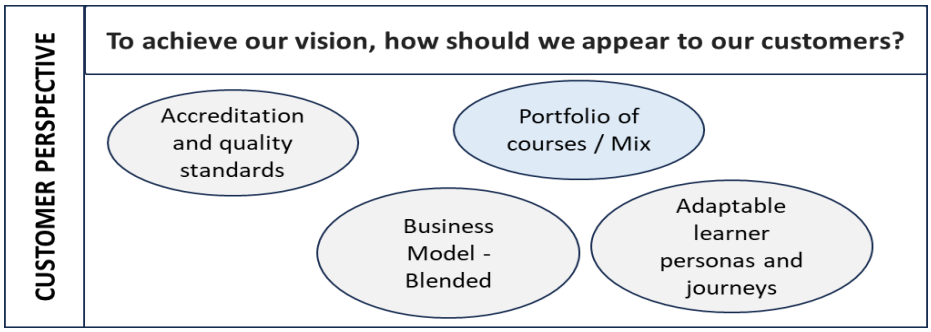


Figure 5: Customer perspective

3.3.3 Internal process perspective

"To satisfy our shareholders and customers, what business processes should we excel in?" (Kaplan, 2009) The categories correlate strongly with the ADDIE phases in an online environment. These categories are online design, online development, online implementation, and online assessment. Other themes such as management and administration, project management and quality assurance align with aspects of organisational management. Figure 6 highlights the elements allocated to the internal process perspective as indicated with the bubbles.

Online design is mainly concerned with an online design blueprint, highlighting different learning models and styles and their synchronous and asynchronous components. Design principles ensure constructive alignment between learning objectives, the use of digital media, activities, and assessment for optimal learning outcomes. It also provides for different instructional strategies such as game-based learning, augmented reality, on-the job shadowing or peripheral participation in a community of inquiry. Online development requires principles for multimedia development for different modalities, and specifications for different modes of learning delivery such as on-line, blended, face-to-face or mobile and is also concerned with different types of digital learning material. Online implementation is concerned with digital navigation standards for online delivery as well as on-

line help and technical support. Online communication and collaboration create a sense of belonging and WhatsApp groups can be an important tool to facilitate student support. It is also concerned with feedback, scaffolding and support in terms of learning methods and materials. Online assessment involves new policies and guidelines for authentic assessment as well as different types of online assessment, such as portfolios of evidence in the digital world. Guidelines are also required for assessment of work done with the help of AI.

The most important themes in this perspective are the need for design principles and guidelines in terms of instructional strategies, linked to a design blueprint; the need for principles and guidelines in terms of multimedia development; delivery on the learning platform through excellence in navigation, orientation, and support; and guidelines for assessment.

This perspective is also adaptable to the situational context. The elements to be included will vary if the design team is situated in an organization or institution with state-of-the-art design tools and an LMS infrastructure or if the instructional designer is a freelance consultant. A freelance consultant might prefer to work with available open-source technologies and design will be less governed through design principles and blueprints.

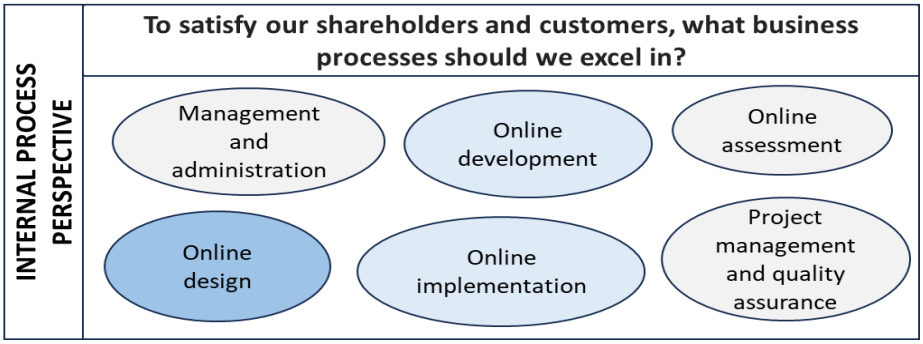


Figure 6: The internal process perspective

3.3.4 Learning and growth perspective

"How will we sustain our ability to change and improve?" (Kaplan, 2009: This cluster of themes deals primarily with building capacity for future growth and development. It focuses broadly on technology infrastructure and skills development. Once again, the elements to be included aim for a holistic and complete picture of what the strategy should incorporate. As with the other perspectives, the unique context of an organization in terms of infrastructure and skills development will determine the elements to include in the overall map. The technical complexities will vary in different organisations. Figure 7 highlights the elements allocated to the learning and growth perspective as indicated with the bubbles.

Technology infrastructure involves the full technology ecosystem and includes the hardware software and support. It included learning management systems, authoring tools, data management and strategic and operational support in terms of the technology infrastructure. An online pedagogy involves all aspects related to instructional design for online courses, AI literacy and online assessment literacy. Technology awareness and basic usage programmes need to support both learners and educators to effectively use digital educational tools.

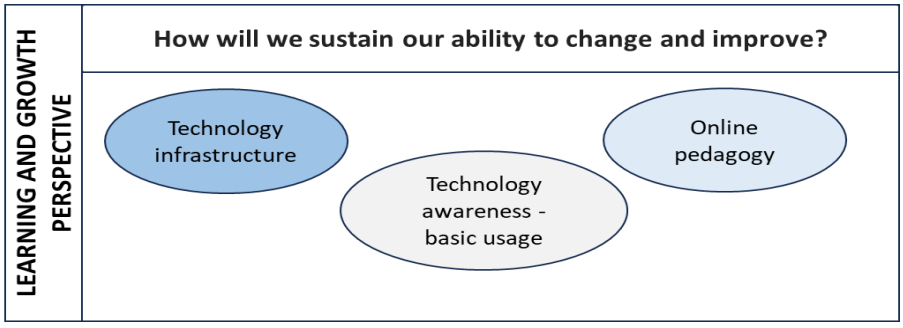


Figure 7: Learning and growth perspective

3.4 Operational Focus Areas

The leading questions for each perspective contributed to the identification of core themes and elements for each perspective. Table 3 highlights the operational focus areas which were identified for each perspective. This represents a tactical plan of action.

Table 3: Operational focus areas

Perspective	Operational focus areas
Financial perspective	Optimize profitability through the diversification of income streams and the management of infrastructure and operational costs. (Profitability) Improve the learning and teaching experience through efficiencies and productivity of ed-tech technologies (Efficiency)
Customer perspective	Provide an optimal basket of blended learning interventions (Blended mix). Understand student personas and journeys based on unique technology profiles and other student analytics (Customer personas).
Process perspective	Develop an online design blueprint, incorporating design principles, instructional strategies, and constructive alignment of learning objectives and outcomes with the use of ed-tech tools and instruments (Online design blueprint). Develop learning materials based on principles for multi-media development for optimal delivery across different modes (synchronous, asynchronous, online, face-to-face etc.) (Principles of multi-media design). Implement learning interfaces according to principles of navigation and support (learner, social and technical) (Oline navigation).
Learning and growth perspective	Plan for the optimal technology architecture (LSM and stand-alone tools and components) and ensure continuous support and management of the platform (Optimal technology architecture). Continuous professional development (CPD) in terms of online pedagogy which includes instructional design skills, writing skills, technical design skills, and curriculum design skills. AI literacy and AI assessment literacy as part of continuous professional development (CPD). Provide basic technology usage and skills programmes for learners and educators involved in learning with technology (Basic skills).

The ranking of the different focus areas is reflected in Figure 8. The areas where there were some disagreements were related to profitability, an optimal technology architecture roadmap and customer personas. This is a result of the unique circumstances in which participants were operating and their business objectives. The strongest agreement was in terms of the need to increase the basic technology literacy of students and educators, continuous professional development in terms of online pedagogy, and the need for principles in terms of multimedia design. Other focus areas were an online design blueprint and an improvement in learning and teaching experiences through efficiencies and productivity of ed-tech technologies.

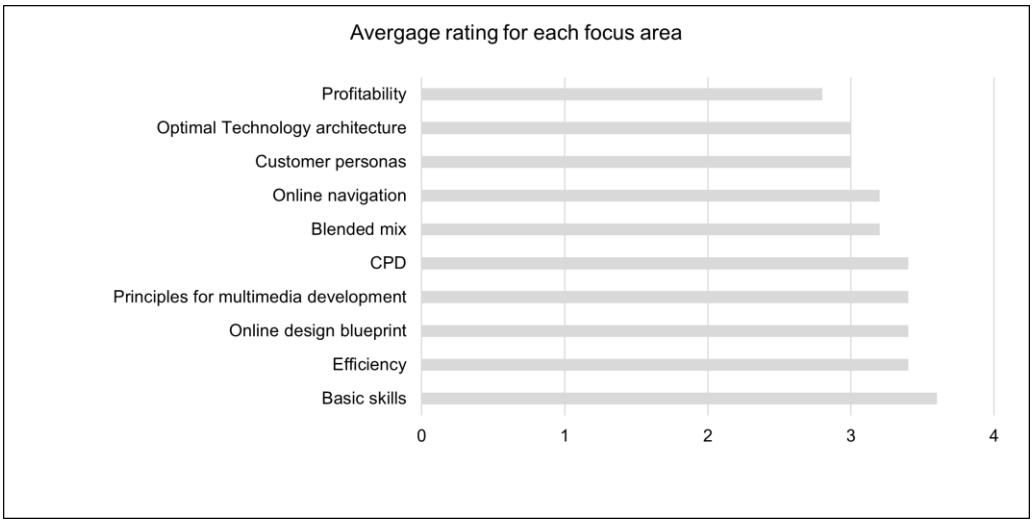


Figure 8: Average rating for each focus area

Analysis indicated further that most Delphi participants agreed that the conceptual framework has strategic importance and is adaptable to its context. Participants also agreed that the framework contributes to operational efficiencies and effectiveness and was sufficient in terms of the level of detail.

4. The Strategy Development Framework

Through the iterative processes of analysis and design, a strategy development framework emerged. Figure 9 highlights the analytical and conceptual processes in the strategy development framework. It starts with an analysis of the internal and external environment of learning with technology. The external analysis focuses on trends in emerging technologies and the operationalization thereof, while core capabilities in a technical ecosystem are used to analyse the internal environment. The SWOT analysis brings the internal and external environment together by identifying potential opportunities and threats for learning with technology. The elements identified in the internal and external environment are then mapped through a conceptual process in the categories of the balanced scorecard or strategy map. Operational excellence was chosen as the strategic objective guiding the development of the strategy map. The "guiding question for each perspective" then determines how individual elements are allocated in the overall strategy map. Individual elements determine the operational focus areas and tactical plan of action.

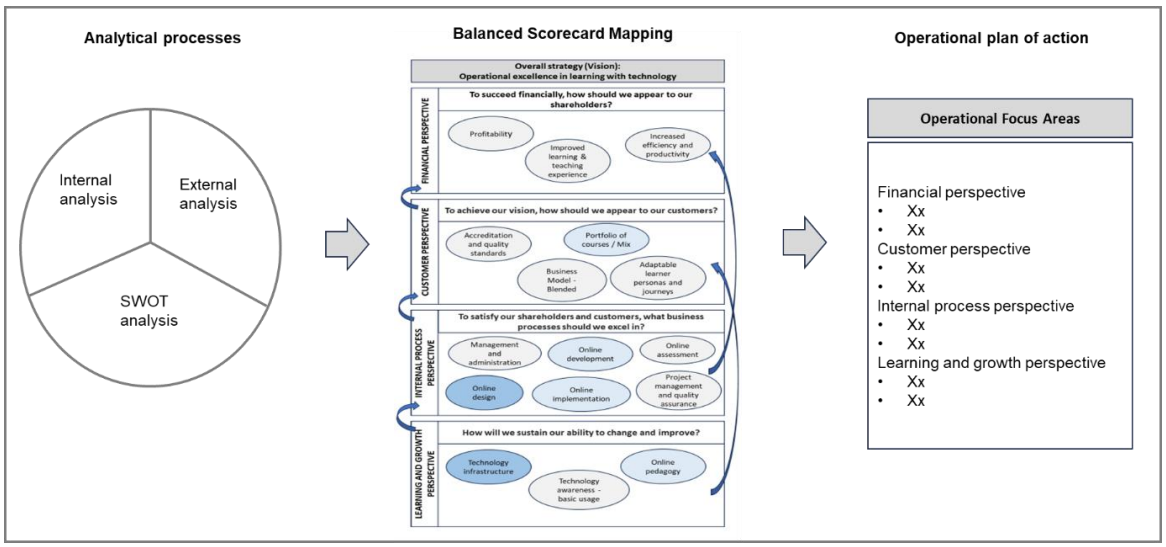


Figure 9: Strategy development framework

4.1 Strategy Development in its Situational Context

Strategy formulation and implementation develop through various stages of strategy development. The process starts with strategic analysis, continues through strategy formulation, and then drives outcomes through decision-making and implementation (Fuertes et al., 2020). It requires the interplay of variables on different levels of complexity considering the external environmental dynamics, the organisational context and ongoing strategic processes such as operational planning, resource allocation, monitoring and feedback Okumus (2001).

Although the BSC translates elements from the overall strategy into critical performance elements from different perspectives, it is not a stand-alone strategy document and often supports other strategy documents and statements (Porter, 1996; Collis and Rukstad, 2008). The BSC is effective as a strategy tool within a strategy process. It is a tool to operationalize strategic direction and drive strategy implementation (Tapinos, Dyson and Meadows, 2011).

4.2 Design Principles of the Framework

The framework development process was guided by design principles such as the objective or intent of the framework, operational applicability, concepts related to design thinking and the openness of the framework.

4.2.1 Overall intent driving the framework

The primary goal of this framework is to improve operational excellence in learning with technology. This was also the primary goal of technology according to Chief Information Officers from institutional learning organisations (Gartner Inc., 2022).

The intent is further to ensure constructive alignment between learning objectives, educational technology and its affordances, instructional strategies and learning outcomes. Investment decisions regarding new technology require an understanding of how tools can be used with effective instructional approaches and methods to maximize the productivity of learning and increase cost and time efficiency (Serdyukov, 2017).

4.2.2 Applicability in the organisational context – operational

The strategy development framework is intended to have practical value on an operational level in support of an overall strategy. The strategy map should ideally be derived from strategic objectives and themes in an organisational context. The applicability of the framework is therefore concentrated on an operational level with a specific focus on improving efficiencies.

The framework will be useful in a corporate environment or educational institution, specifically for an educational design unit or team of instructional designers who are embracing new technological advancements in their field of practice or operation. It is further suggested that it is designed as a group process with representation from different roles such as IT architecture, financial decision-makers, technical instructional designers, and educators to appreciate the potential richness of the framework in its totality.

4.2.3 Design thinking and rapid prototyping

The framework incorporates complex systemic processes and environmental dynamics in different iterative and practical innovative cycles. This allows for its adaptability and sustainability when future technological trends emerge. The principles of rapid prototyping are also integral to the model. Rapid prototyping allows for parallel cycles of research, design, development, and implementation of modular components. Modularity allows changes to a segment or unit without affecting the total unit. Plasticity refers to the time and cost efficiency of such changes. The approach is feasible and compatible with real-world design processes (Tripp and Bichelmeyer, 1990; Brown, 2008).

4.2.4 Open and adaptive to environmental context

Three different types of strategy models exist namely linear, adaptive, and interpretive and give a perspective on how strategy development occurs. The researcher resonates with the characteristics of the adaptive model as it aligns with the intent of this research.

The adaptive model is situational and can vary depending on the context. It continuously monitors the external environment and assesses internal conditions to match capabilities to opportunities and threats. It is an open and dynamic process consisting of conceptual and analytical exercises and is not only the responsibility of top management but leaders on all levels can contribute to strategy development (Chaffee, 1985).

4.3 Limitations of the Framework

Strategy development is complex and involves many role-players from various levels in an organisation. A good strategy will include a competitor analysis with a benchmarking exercise in terms of how internal capabilities compare with those of competitors. This framework does not focus on the position or capabilities of competitors but focuses specifically on improving its capabilities through internal efficiencies. The analysis of an external environment could include many determinants, but the study focussed on key trends in emerging technologies.

The balanced scorecard as a strategy implementation tool needs to be translated from an overall business strategy and its strategic themes and objectives. Since operational excellence is a key theme in learning with technology, identified through the literature review, it was chosen as the hypothetical theme and guiding principle for the strategy map.

Strategy development occurs through the collective intelligence created in group processes. In this research, the Delphi technique was used to gain insights from participants. The Delphi technique requires that the participants remain anonymous to each other, and no informal group interaction was allowed. The outcome could have been different if a team of people in the same organisation participated in the same analytical and conceptual processes through a workshop.

4.4 Recommendations for Further Research

Further research to understand the effective use of strategy development tools that can assist decision-makers in making technology investments in the face of disruptive innovation is recommended. The operational focus areas of learning with technology identified through this research indicated the needs and requirements for practice. There is an opportunity to develop some of these constructs through research. These constructs are

programmes for basic technology literacy for educators and learners; continuous professional development of an online pedagogy; development of a basic design blueprint for online learning; and guidelines for multi-media design of learning materials.

5. Conclusion

The strategy development framework suggests an approach that could be transferable to unique circumstances in a changing environment. An analysis of internal and external factors provides the context for analysing strengths and weaknesses in terms of opportunities and threats. The BSC gives a comprehensive picture of all factors to be considered strategically in terms of a company or institution's vision or objectives. The operational focus areas focus attention and future efforts to remain competitive and sustainable.

The strategy development framework defines some characteristics which guide implementation in a practical context. This study chose operational excellence as intent and strategy implementation on an operational level through a balanced scorecard map as the level of practice. Rapid prototyping provides flexibility in terms of individual components in the overall framework. Finally, the framework is open and adaptive and can be modified to fit any environment of learning with technology. It is responsive to changes in technology and other business changes. It will be ideal in a group context where the collective intelligence of group members can contribute to the richness of individual elements in the overall map and plan.

The hypothetical strategy map includes all the themes and elements for each perspective and gives a view at first glance of the total picture and how the elements fit together. These elements can function as placeholders during a strategy development process and can be adapted to an individual context. Participants agreed that the most important focus areas of the framework were the need to increase the basic technology literacy of students and educators. Other areas were continuous professional development in terms of an online pedagogy; the need for principles in terms of multimedia design; an online design blueprint and an improvement in learning and teaching experiences through efficiencies and productivity of ed-tech technologies.

Figure 10 presents the logical flow of research through different phases and the associated contribution of each activity. The research makes a methodological contribution to Design Science Research by combining the DSR process with a modified Delphi technique discussed in Section 2. The conceptual output represents the practical contribution and delivers a hypothetical strategy map for learning with technology that can be applied in a dynamic context and highlights key operational focus areas in Section 3. The research makes a theoretical contribution in presenting the strategy development framework for education technology in Section 4. The framework enhances theories around the analytical and conceptual processes when planning and implementing new emerging technologies in learning.

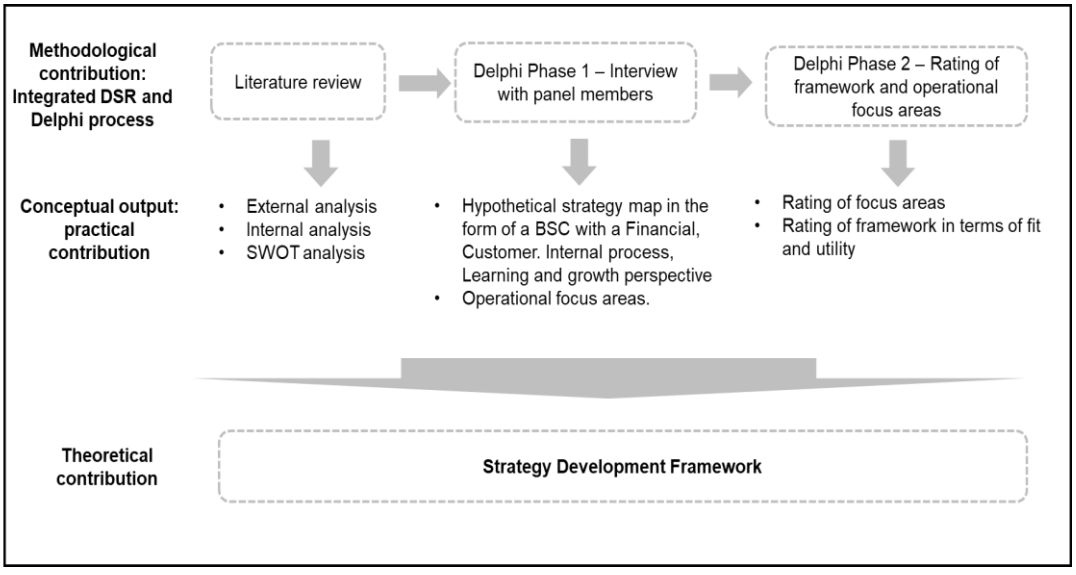


Figure 10: Research progression and contribution

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E-Learning Platform for Enhancing 21st Century Skills for Vocational School Students: A Systematic Literature Review

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Abstract: The importance of skills for vocational high school graduates in entering the workforce, facing competition, and increasing productivity, in accordance with the current industry needs, cannot be overstated. E-learning has become one of the platforms that vocational high schools can utilize to assist students in acquiring the necessary skills such as literacy, communication, collaboration and critical thinking as needed in the 21st century. However, the issue lies in determining the type of e-learning that can enhance students' learning outcomes and skills. This paper aims to present an analysis and description of the implementation of different types of e-learning in vocational high school education. The research adopts a systematic literature review approach, incorporating research questions: i) what types of e-learning are being used? ii) what are the impacts of implementing e-learning in vocational high schools? and iii) what competencies can be enhanced through the implementation of e-learning. The subject of this research is articles that have been published in Scopus and Google Scholar-indexed journals. The article selection technique employed the PRISMA method, which successfully obtained 35 articles out of the 2,093 articles. The review results indicate that there are many variations in the utilization of e-learning formats in schools. Digital learning media is one type of e-learning that is often used by teachers, although there are many other types such as e-modules, Learning Management System, multimedia, and others. In addition, the research findings showed that through e-learning, many 21st-century skills, such as literacy and critical thinking abilities can be improved. The findings further showed that e-learning contributes to the improvement of learning outcomes in psychomotor and cognitive aspects. These research findings are expected to serve as a basis for vocational school teachers to confidently utilize e-learning in their teaching activities.

Keywords: e-Learning, Vocational, 21st century skills, Smartphone, Multimedia

1. Introduction

In the 21st century, the purpose of education is to equip students with the necessary skills and knowledge to thrive in both their professional and personal lives. Numerous studies conducted in different countries have explored the implementation of e-learning as a means of facilitating learning activities (Rababa, 2021; Ahn and Edwin, 2018; Ejdys, 2021). Although e-learning's role in skill development or acquisition for vocational students has been minimally researched using systematic literature review methods, the existing literature primarily focuses on its application in public schools, universities, health fields, language learning, science learning, and the use of technological devices in education from elementary to college level. This research, which includes systematic literature review, bibliometric analysis, scooping review, and meta-analysis, has shown that e-learning is predominantly used in these areas. However, there is a need for more comprehensive research on its effectiveness for vocational students (Ramadiani *et al.*, 2020; Azmi and Widiaty, 2021; Sumarmi *et al.*, 2021).

It is important to clarify that electronic-based learning is not necessarily synonymous with online learning. Some define it as any form of learning that incorporates technology, such as computers and smartphones, and this perspective is commonly accepted as part of the broader application of electronic-based learning (Naveed and Ahmad, 2019)(Aini et al., 2020). Hence, it has been recognized that electronic learning has been adopted in nearly all nations over the recent years. However, the utilization of e-learning in developed countries cannot be equated to that in developing countries, because developed countries have indeed embraced electronic-based learning (Widyaningsih *et al.*, 2020; Alshammari, 2020; Ghosh, Muduli and Pingle, 2021).

In Indonesia, a vocational high school stands out as an educational institution that is highly committed to preparing students with the necessary 21st-century skills for the workforce (Kovalchuk *et al.*, 2022; Soenarto *et*

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al., 2020). It is widely acknowledged that graduates from Vocational High Schools are equipped with the necessary skills to seamlessly transition into the workforce. This underscores the significance of aligning learning activities with the demands of the industry (Soenarto *et al.*, 2020; Mukhadis, Ulfatin and Putra, 2019). In this context, every aspect of learning is designed to create graduates who have skills and knowledge that match the demands of the workplace (Yudiono *et al.*, 2022; Mulyadi, 2019). Educational programs deliver more than theoretical knowledge and simultaneously allocate space for practice in the applied world where relevant skills can be learned and put to use afterwards in a professional context. Including practical experience, industry-based projects and internships as the core elements of the curriculum are making these educational establishments to become the breeding grounds for the students being able to obtain technical knowledge and personal competences on which nowadays the industry has the highest demand (Yondri *et al.*, 2020; Durmus and Dağlı, 2017).

Based on various research analyses, it has been empirically demonstrated that Indonesia's open unemployment rate (TPT) in August 2022 stood at 5.86%, which translates to approximately 8.42 million individuals (Sulistiobudi and Kadiyono, 2023). Notably, graduates from Vocational High Schools (SMK) are found to be the primary contributors to this unemployment rate (Rokhim, 2023; Nazira and Kartika, 2021). However, it is crucial to understand that this situation cannot be examined in isolation, as it is intricately linked to multiple factors, one of which is the job search process. It appears that there exists a disparity between the skills acquired by students and the demands of the business and industry sectors (Wahyudi, Suharno and Pambudi, 2023; Ohara, Harto and Maruanaya, 2020). It is evident that there is a growing recognition of the significance of skill and competency development for vocational high school students in Indonesia, particularly in light of the evolving job market. Evidence showed that vocational high schools play an important role in equipping students with the practical skills required by industry, thereby preparing them to enter the professional industry (Mahmudah and Santosa, 2021). The Indonesian Ministry of Education and Culture firmly states that through the incorporating ICT into learning activities, it will significantly enhance the academic performance of vocational high school (SMK) students. Consequently, these students will have a greater chance of securing employment in diverse industrial sectors, surpassing the employment rates of high school graduates (Wagiran, Pardjono and Sofyan, 2020; Suharno, Pambudi and Harjanto, 2020). Hence, prioritizing the enhancement of skills among vocational high school students is crucial. By emphasizing electronics or ICT in the learning process, graduates will possess not only theoretical knowledge but also practical skills. This will enable students to effectively adapt to complex and dynamic work environments, thus overcoming challenges with ease.

Apart from issues related to the application of ICT to education which is currently not optimally implemented by teachers in vocational high schools, it turns out there are other problems that need attention, namely regarding the mismatch between the skills required by employers and the skills taught in educational institutions (Rosina *et al.*, 2021; Mukhadis, Ulfatin and Putra, 2019). Teachers can implement a variety of strategies to improve these skills, one of which is relatively straightforward and achievable - integrating technology into the learning process (Lim *et al.*, 2020; Montiel *et al.*, 2020). This term is commonly referred to as the utilization of E-Learning during the learning process or in the learning itself that is technology-based (Rawashdeh et al., 2021).

By incorporating technology into the learning process, specifically through electronic-based learning or e-learning, we anticipate that it will genuinely aid students in acquiring the necessary competencies. It's well-known that e-learning offers substantial benefits for Vocational High School (SMK) students, particularly in developing soft skills outside of regular class time. Moreover, the utilization of online e-learning platforms has been empirically demonstrated to provide students with interactive and captivating content, thereby stimulating their curiosity and motivating them to explore subjects beyond the prescribed curriculum (Ramadhan et al., 2022). Irrespective of their geographical locations, e-learning empowers students effectively. This facilitates the exchange of valuable insights derived from diverse experiences and perspectives, thereby fostering the development of essential communication and cooperation skills that are indispensable for their future professional pursuits (Siron, Wibowo and Narmaditya, 2020; Tawafak *et al.*, 2021). E-learning encompasses various technological devices such as computers, smartphones, tablets, and laptops, among others (Zaheer et al., 2018). By integrating e-learning into their educational journey, students in vocational high schools (SMK) can enhance their comprehension and mastery of information technology skills, which are pivotal for their future endeavors. The incorporation of E-Learning into educational endeavors presents a multitude of benefits, regardless of whether it is utilized in an online or offline setting. The main illustration of online applications showed the characteristics of e-learning which are able to improve student skills and foster critical thinking abilities which are one of the 21st-century competencies (Rawashdeh et al., 2021).

To enhance the skills of vocational high school graduates and address the challenges they currently face, it is crucial to explore various aspects that can be leveraged through e-learning. It is clear that this research will play a crucial role in advancing the field of e-learning utilization during the learning process. By examining the interaction between different e-learning activities and learning achievements, policymakers at the educational unit level will be better equipped to develop effective technology integration policies for the learning process. Consequently, this study aimed to provide a comprehensive analysis of how the implementation of e-learning can support vocational school students in improving their skills, thereby mitigating the negative perceptions and unemployment issues associated with vocational high school graduates.

The research review will focus on formulating several research questions (RQ) that require thorough investigation and answers, which were; i) what types of e-learning are utilized during learning activities; ii) how is the impact of e-learning application on improving vocational school students' skills, iii) the types of competencies that can be improved as a provision for graduates to get a job through the application of e-learning.

2. Method

In this study, researchers used a systematic literature review method (Chiu et al., 2023), This research method is used to study various articles from scientific journals and books relevant to the research topic (Snyder, 2019). Desk research is a type of research that involves gathering information and data from various accessible sources to achieve its main objective, which is to identify the implementation of E-learning and its effect on enhancing the skills of vocational school students. The scope and topics of the research articles to be included in this systematic review are determined by the main goal of the research (Patel and Patel, 2019).

The investigation commenced by identifying pertinent articles on vocational education, E-Learning, and skills in various databases, including Google Scholar and Scopus. In this article, SLR denotes the chosen reporting items for systematic review and meta-analysis techniques (PRISMA) (Santhanasamy and Yunus, 2022; Zainal and Yunus, 2022). The target time period for searching published articles is from 2018 to 2023. The search criteria for relevant published articles used several keywords, namely: "Industry", "E-Learning", "Unemployment", "Computer", "Vocational School", "21st Century Skills", and "Education and Training".

After conducting keyword searches in several scientific journal databases, the next step involves filtering the results based on the inclusion and exclusion criteria of relevant research findings. The inclusion and exclusion criteria will be explained in detail in table 1.

Table 1: Inclusion and Exclusion Criteria from scientific publications

Inclusion Criteria	**Exclusion Criteria**
Published in English	Not published in English
Paper published in a reputable journal	Duplicate publication
Publications that focus on education, learning and vocational fields	Publications that have no relationship to research keywords
Open access publications	Publications that have restricted access
Papers published from 2018 to 2023	Publications that do not focus on education

In the meantime, the research will exclude articles that do not demonstrate a connection with the research variables in terms of their titles, abstracts, and keywords (Bhangu, Provost and Caduff, 2023). To streamline the process of searching for articles, the Publish or Perish version 8 application is employed as a medium for literature search on the Scopus database. This is achieved by inputting the API Key.

The findings from several databases were then analyzed with several stages, namely the four stages carried out by researchers are identification, screening, eligibility, and inclusion as a form of the PRISMA Technique (Purnama, Wilujeng and Jabar, 2023; Saputra, Murdino and Tohani, 2023). Subsequently, an examination of numerous chosen articles was undertaken to conduct a descriptive analysis and ascertain themes pertaining to the research focus. The findings of this study will be conveyed in a manner that facilitates comprehension for readers, while still upholding the primacy of scientific principles (Khatri, 2020).

This literature review research will have several steps. The initial stage begins by searching for articles in the Publish or Perish (PoP) application, followed by inputting specific keywords related to research methodology, exclusion criteria, and published article databases. Upon completion of the article exploration, a total of 2093

selected articles from various databases were identified. These articles then undergo a screening process based on predetermined exclusion criteria to ensure relevance to the research topic and eliminate duplicates. This process aims to identify articles that align with the criteria and research topic, facilitating optimal subsequent processing and selection stages. Following the screening phase, a total of 82 articles were singled out for further assessment of eligibility. Subsequently, the full text of these articles was assessed, leading to the identification of approximately 35 relevant articles corresponding to various keywords and research topics. The findings of this literature search are conveyed through the following PRISMA flow that present in figure 1.

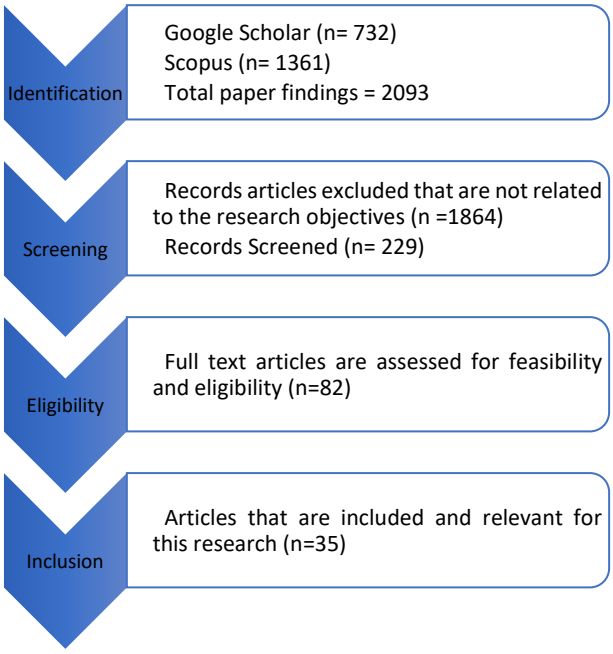

Figure 1: Analysis Using PRISMA Flow

3. Result and Discussions

Table 2 presents a summary of findings from various relevant articles obtained through the PRISMA process, serving as one of the data analysis methods for articles successfully retrieved from scientific publication databases such as Google Scholar and Scopus.

Table 2: Overview of Search Results and Article Evaluation

No.	Author	Methodology	Results	Skills Acquired
1.	Ansyari *et al.* (2021)	Research and Development	The findings from research and development show the evaluations done by experts in different areas. Material experts got a score of 87.5%, media experts got 95%, language experts got 83%, and information technology experts got a perfect score of 100%. Furthermore, small group trials with potential users resulted in a rating of 77%. The large group trial showed a percentage of 90%, indicating an improvement in assessment due to repeated explanations that helped students understand the story in online product promotion activities.	Communication & Product's Promotion Skills
2.	Dimache *et al.* (2018)	Qualitative	This study showed that IT skills of the students determine the way they perceive the system and the whole learning experience, as well as the level of knowledge acquired.	Practical Skills
3.	Aulia and Utami (2021)	Quantitative	Significant results were obtained that the use of e-learning by lecturers was able to increase student literacy as one of the skills needed in the 21st century.	Literacy Technology, Literacy Media, Critical Thinking, Creativity, and Collaboration
4.	Ebil, Salleh and Shahrill (2020)	Mixed Methods	Responses from students suggest that the practicality of implementing e-portfolios for TVET in Brunei may be influenced by teacher involvement, students' level of	Reflective thinking

No.	Author	Methodology	Results	Skills Acquired
			motivation, the specific e-portfolio software used, and the quality of existing connectivity.	
5.	Suryati, Suryana and Kusnendi (2019)	Quantitative	The findings of this study demonstrate that the schoology-based e-learning model and traditional learning models have a noteworthy impact on students' metacognitive thinking abilities. Nevertheless, several factors have been overlooked in this research as it primarily concentrates on the influence of the e-learning model on the 21st-century skills imparted to vocational school students.	Metacognitive skills
6.	Putri, Sumaryati and Jaryanto (2020)	Classroom Action Research	This research determines that the indicator of successful achievement of collaboration skills is 62.5%, which is in the good category. In pre-action, the percentage of collaboration skills indicators was 43.52% in the poor category; cycle I increased to 57.72% in the sufficient category; cycle II also increased to 72.84% in the good category. Based on this research, the SAVI learning model assisted by e-learning based Accounting Puzzles media can improve collaboration skills.	Collaborations Skills
7.	Rusnawati, Santyasa and Tegeh (2021)	Quantitative	Research findings indicate that there are disparities in both learning outcomes and critical thinking abilities when comparing students who utilize the project-based e-learning model with those who opt for the direct e-learning model. Additionally, this study reveals variations in critical thinking skills between students who engage in project-based e-learning and those who partake in direct e-learning.	Critical thinking Skills
8.	Rohendi, Wahyudin and Kusumah (2023)	Quantitative	The research results show that STEM-based media can improve vocational school students' mathematical abilities seen from students as a whole or based on student group level. Likewise, vocational school students' positive response to online learning using STEM-based media. This response means that students feel the benefits of online learning using STEM-based media.	Mathematics Abilities
9.	Darwin and Chaeruman (2022)	Quantitative	The findings indicated that the utilization of E-learning self-determination theory had a positive impact on enhancing students' listening abilities. This advantage can be attributed to its comparison with the traditional face-to-face approach. Moreover, the self-determination theory of E-learning offers greater flexibility as students can complete assignments or assessments at their convenience, regardless of location or time.	Listening Skills
10.	Yusuf and Widyaningsih (2020)	Qualitative	The research results showed that the quality of learning and students' metacognitive skills at each meeting increased. This is proven by research results which show that students fall into the good and very good categories. In conclusion, e-learning based virtual laboratory media is able to improve the quality of learning and develop the metacognitive skills of vocational school students in courses that require experimentation.	Metacognitive skills
11.	Kuatbekov *et al.* (2023)	Quantitative	Based on the findings of the self-assessment, the acquisition of digital skills has been enhanced through learning activities. The research has facilitated the identification of crucial factors that contribute to the advancement and reinforcement of contemporary media proficiencies within the realm of online education. It has been deduced that media literacy is an outcome of meticulously designed and effectively executed practical tasks undertaken by students in the digital media domain.	Media Literacy
12.	Mahmod Eyadat (2023)	Quantitative	It was found that the most serious challenges related to the use of technology were represented mainly in challenges related to technology implementation, challenges related to school capabilities, and challenges related to the curriculum. It was found that there were challenges that significantly affected student achievement.	Creative Thinking

No.	Author	Methodology	Results	Skills Acquired
			The hope is that through the use of ICT, students can achieve quite brilliant academic achievements, especially in skills that are really needed in the 21st century, such as creative thinking.	
13.	Hoerunnisa, Suryani and Efendi (2019)	Quantitative	The research results confirmed that the use of e-learning is able to increase student achievement and motivation significantly, besides that student participation in learning also tends to be active, this is due to the flexibility of e-learning which can be accessed at any time by students.	Motivation
14.	Bima, Saputro and Efendy (2021)	Research and Development	The research results show that the virtual laboratory for micro power plants has been empirically proven to be effective in supporting practical learning, especially during the Covid-19 pandemic.	Practical Skill
15.	Meidyrianto, Hamidah and Efendi (2022)	Research and Development	Through the use of PJBL animation media and portfolio assignments in class. The student competencies of SMK Negeri 7 Surakarata also showed very good results with a significance value of 0.05 from the four competencies studied, this shows the effectiveness of the PJBL model animation media and portfolio assignments when used during learning activities.	Cognitive and Practical Skill
16.	Sari, Susilawati and Anwar (2021)	Research and Development	The findings indicated that the developed e-module demonstrated high validity and feasibility for field testing, with an average material validation percentage of 91.69% and an average media validation percentage of 94.13%. Consequently, it can be concluded that the e-module for hydrocarbon compounds is exceptionally effective and captivating for implementation in a broader educational context.	Cognitive Skill
17.	Novaliendry *et al.* (2021)	Research and Development	Overall, the product from the research and development results in this research has obtained an assessment of the practicality of Android-based learning media as a learning resource of 88.46%, so the level of practicality can be interpreted as very practical to use. The assessment of the effectiveness of Android-Based Learning Media is 90.86%, so the level of significance can be interpreted as Very Good for use and is expected to be able to help students improve their understanding of the materials being studied.	Cognitive Skill
18.	Pipattanasuk and Songsriwittaya (2020)	Quantitative	The experimental group of students demonstrated significantly higher learning achievements compared to the control group, with a statistical significance level of .05. Additionally, the students expressed a high level of satisfaction with the instructional model. Consequently, it can be inferred that the utilization of augmented reality technology in the instructional model proved to be efficient and appropriate for the microcontroller foundation course designed for vocational certificate students.	Practical Skill
19.	Nugraha and Wahyono (2019)	Research and Development	The research results show that learning multimedia is suitable for use and contributes to students' psychomotor skills. The results of expert validation and product trial results were obtained with a minimum score range that had "good" criteria, so that the product being developed was said to be "viable".	Psychomotor
20.	Rachman *et al.* (2022)	Qualitative	The results of this research show that inquiry-based digital history books are needed by teachers as a means of providing critical thinking stimulus to vocational school students, as per the results of interviews conducted by social studies teachers.	Critical Thinking Skills
21.	Supianti *et al.* (2022)	Research and Development	This study showed that using Edmodo-assisted e-learning for teaching statistical materials is highly suitable for learning mathematics. Moreover, the application of these teaching materials has a positive impact on mathematical literacy skills, falling under the reasonably good category.	Mathematics Literacy

No.	Author	Methodology	Results	Skills Acquired
			Hence, it is important to enhance the teaching materials by incorporating animation, employing communicative language, and leveraging the latest technology.	
22.	Triyono, Muhtadi and Widowati (2022)	Research and Development	The results indicate that Android-based mobile media is very feasible. The empirical testing result also shows that the developed product can promote 21st century's competence such as creative thinking skills.	Creative thinking skills
23.	Sari Wahyuni and Haryani (2020)	Research and Development	The e-module was effective in improving students' critical thinking skills, with an N-gain of 0.57 in the medium category and 86.12% classical completeness. Students responded positively to the practicality of the e-module, with 77.78% rating it as very good and 22.22% as good. The student's worksheet was found to be valid, effective, practical, and capable of enhancing critical thinking skills.	Critical thinking skills
24.	Shdaifat, Shdaifat and Khateeb (2020)	Qualitative	Respondents in Jordan showed a lack of interest in using E-Learning apps for vocational education during the COVID-19 crisis. The challenges faced were found to be significant. Researchers suggest offering training courses to vocational education teachers in Jordan on how to effectively use E-Learning apps.	-
25.	Soub (2022)	Quantitative	A teacher's proficiency in online learning for vocational education falls within the medium to high range. Factors like education level and years of experience affect their skill level. The study highlights key challenges in vocational education, such as the e-learning platform and online resources constraints.	ICT Literacy
26.	Liu (2023)	Quantitative	Vocational schools have consistently prioritized the objective of securing employment as the focal point of education. Building upon this foundation, the present study aims to foster top-notch individuals by examining the English education in Higher Vocational Colleges within the cloud computing environment.	Language Literacy
27.	Pangeni and Karki (2021)	Quantitative	The study reported that e-learning was promising for the TVET sector as an innovative ICT integrated alternative pedagogy. However, teachers and schools want additional support for training and ICT infrastructures so that teachers can implement e-learning independently.	-
28.	Sirakaya and Cakmak (2018)	Quantitative	This result showed that Augmented Reality as an application can be effective in increasing learning outcomes.	self-efficacy
29.	Şeker, Bülbül and Erdinler (2022)	Quantitative	The study evaluated the demographic characteristics of the students, the opinions of Forest Industry Engineering Department students on their department, the opinions of Vocational School of Forestry students on their department, and the students' opinions about computer aided design programs. Furthermore, the study also assessed and interpreted the sectors in which the students aspire to work after graduation.	-
30.	Ma, Hwang and Shih (2020)	Quantitative	This research revealed that a machine learning-based peer tutor recommendation system (MPTRS) with automatic assessment is highly recommended for teachers to use, this is an effort by teachers to improve learning, especially on practical material for operating computer applications. This automated assessment system (AAS) utilizes computer vision technology to assess the results of student work and provide immediate suggestions or feedback.	Operating Skills
31.	He, Ratanaolarn and Sitthiworachart (2024)	Quantitative	Two experimental cases were implemented to obtain comparative data from two classes, testing the effect of gamification teaching on improving students' grades and stimulating their learning motivation.	Motivation
32.	Lee *et al.* (2022)	Quantitative	The performance of participants improved through the practice period with the experimental group showing	Motoric Skills

No.	Author	Methodology	Results	Skills Acquired
			significantly greater changes than those in the control condition. For the delayed-test, both groups declined to some extent from the post-test, but the experimental subjects did better comparatively.	
33.	Demir and Tavil (2021)	Mixed Methods	The results indicated that both technology-based materials and textbook-based materials helped listening skill development. Technology-based materials proved to be slightly more effective than textbook-based materials in quantitative results.	Listening Skills
34.	Deaconu *et al.* (2018)	Quantitative	The outcomes of our investigation have substantiated our initial suppositions, specifically the observation that employing ICT techniques in tourism courses enables students to comprehend and internalize specialized information more swiftly and effectively. Furthermore, it facilitates the cultivation and enhancement of distinct proficiencies at an elevated standard compared to conventional instructional approaches.	-
35.	Widyaningsih *et al.* (2020)	Research and Development	The findings indicated that the learning materials created were deemed valid in all areas of evaluation, including layout, navigation, functions, and pedagogy. Additionally, the students' reactions to the interactive multimedia employed were found to be both effective and practical across all aspects of assessment.	HOT Skills

3.1 Application of e-Learning Types in Different Countries and the Types of E-Learning Adopted (RQ-i)

Upon reviewing various literature, it is evident that e-learning is widely utilized across multiple countries, with diverse applications in each location. This diversity in the implementation of e-learning underscores its broad interpretation as a form of electronic-assisted learning (Garad, Al-Ansi and Qamari, 2021; Mursid, Muslim and Farihah, 2023). Therefore, the framework of thinking between researchers is certainly different and it becomes a fairness when the emphasis on the scope of e-learning is mentioned by the researchers.

Overall, e-learning is primarily utilized for vocational training, with some articles also noting its use in vocational higher education. Research conducted in various countries has revealed that the utilization of e-learning is highly diverse. In fact, it can be manifested in the form of a model or approach to learning, including the use of learning management systems, learning media, virtual laboratories, and other methods (Kuatbekov et al., 2023; Yusuf and Widyaningsih, 2020; Ma, Hwang and Shih, 2020). Several relevant studies consider the products they implement or develop to facilitate the learning process as electronic-based learning. It is interesting to note that, in general, we know that e-learning is a learning process that utilizes electronics, without specifying the type of electronics. This broad definition leaves room for interpretation by academics (Azmi and Widiaty, 2021). However, it is certain that the presence of e-learning will have a very vital role in creating a society of lifelong learners and addresses the accessibility and impact of e-learning for learners, especially in vocational high school (El-Sabagh, 2021). The analysis of research results on the implementation of different forms of e-learning across different regions has been effectively conducted and presented in table 3.

Table 3: Identify Types of e-Learning Usage in Different Countries

No.	E-Learning Types	Country	References
1.	Podcast	Indonesia	Ansyari *et al.* (2021)
2.	E-Learning (Model)	Ireland, Austria, Indonesia, Taiwan, Thailand	Dimache *et al.* (2018), Rusnawati, Santyasa and Tegeh (2021), Darwin and Chaeruman (2022), Ma, Hwang and Shih (2020), He, Ratanaolarn and Sitthiworachart (2024)
3.	Learning Management System (LMS)	Indonesia, Russia, Jordan, China, Nepal	Aulia and Utami (2021), Suryati, Suryana and Kusnendi (2019), Kuatbekov *et al.* (2023), Supianti *et al.* (2022), Shdaifat, Shdaifat and Khateeb (2020), Soub (2022), Liu (2023), Pangeni and Karki (2021)
4.	E-Portfolio	Brunei	Hj. Ebil, Salleh and Shahrill (2020)
5.	Learning Media	Indonesia, Turkey	Putri, Sumaryati and Jaryanto (2020), Rohendi, Wahyudin and Kusumah (2023), Mahmod Eyadat (2023), Meidyrianto, Hamidah and Efendi (2022), Sari, Susilawati and Anwar (2021), Novaliendry *et al.* (2021), Rachman *et al.* (2022),

No.	E-Learning Types	Country	References
			Triyono, Muhtadi and Widowati (2022), Demir and Tavil (2021), Widyaningsih *et al.* (2020)
6.	Virtual Laboratory	Indonesia	Yusuf and Widyaningsih (2020), Bima, Saputro and Efendy (2021)
7.	Multimedia	Indonesia	Hoerunnisa, Suryani and Efendi (2019), Nugraha and Wahyono (2019)
8.	Augmented Reality	Thailand, Turkey, Taiwan	Pipattanasuk and Songsriwittaya (2020), Sirakaya and Cakmak (2018), Lee *et al.* (2022)
9.	Computer Based	Turkey, Romania	Şeker, Bülbül and Erdinler (2022), Deaconu *et al.* (2018)

3.2 Impact of e-Learning Utilization on Students' Skill Improvement (RQ-ii)

E-learning, also known as electronic learning, is a method of acquiring knowledge that utilizes information and communication technology to electronically deliver learning materials. This educational approach encompasses the utilization of software, hardware, and online resources to facilitate access to learning content, regardless of whether one is connected to the internet or not (Mursid, Muslim and Farihah, 2023; Sirakaya and Cakmak, 2018).

E-learning in vocational high schools serves as a complementary tool, bridging the deficiencies in instructional resources and is recognized for its ability to enhance both theoretical and practical education (Naveed and Ahmad, 2019). Moreover, e-learning offers the opportunity to enhance the educational experience by offering additional resources, virtual assignments, and interactive simulations, all designed to strengthen the understanding of topics taught in conventional classroom settings (Ahn and Edwin, 2018).

Furthermore, electronic learning (e-learning) has the capability to act as a replacement for traditional learning activities. Through its diverse functionalities, e-learning can provide opportunities for self-directed learning, particularly beneficial for students who need alternative approaches to learning or encounter barriers to in-person instruction. As evidenced by (Cornelius and Gordon, 2022), e-learning is a flexible tool that supports educational endeavors in vocational high schools, extending beyond its classification solely as an online learning medium.

The study showed that e-learning had a favorable influence on students' academic accomplishments and abilities. Furthermore, e-learning played a significant role in enhancing 21st-century competencies, fostering learning motivation, and cultivating students' enthusiasm for education (Hoerunnisa, Suryani and Efendi, 2019). The evaluation of e-learning leads to better results than traditional learning methods, which do not fully utilize electronic technology (Pangeni and Karki, 2021).

Many studies have shown that e-learning approaches are very effective at improving the theoretical understanding of vocational school students (Yusuf and Widyaningsih, 2020; Meidyrianto, Hamidah and Efendi, 2022). Students' psychomotor and practical skills can also be improved using this method, according to several studies (Dimache *et al.*, 2018; Bima, Saputro and Efendy, 2021). Furthermore, research also conveys that e-learning plays a significant role in fostering the growth of essential skills required in the 21st century. These skills encompass creative thinking, critical thinking, digital literacy, media literacy, ICT literacy, metacognition, and listening skills within the linguistic domain (Suryati, Suryana and Kusnendi, 2019; Kuatbekov *et al.*, 2023).

Research on e-learning emphasizes the use of online features, particularly the Learning Management System (LMS). A study revealed that teachers implementing e-learning have successfully improved students' literacy skills, aligning with the requirements of 21st-century learning (Aulia and Utami, 2021). In Turkey, case studies have shown the utilization of augmented reality (AR) technology for offline e-learning purposes. It seems that the findings of this research indicate that augmented reality (AR) can be useful in raising students' cognitive achievement and enhancing their ability to assemble computers practically (Sirakaya and Cakmak, 2018).

It is evident from the numerous studies and Table 2 in the preceding subchapter that using e-learning, both online and offline, can give students access to a greater range of learning resources and make it simple for them to modify their learning process. Therefore, the school community and policy makers should always commit to enhancing the implementation of e-learning in vocational schools so that teachers can make sure that students have the comprehensive knowledge and skills necessary to tackle future difficulties.

3.3 21st-Century Competencies as Provision for Employment That can be improved Through the use of e-Learning (RQ-iii)

In several middle- or low-income nations, such as Indonesia, there is a relatively high percentage of young individuals who lead inactive lifestyles (Divayana, Suyasa and Widiartini, 2021). It is widely recognized across different nations that vocational education plays a crucial role in producing competent workers who can effectively meet the demands of the industrial sector. This holds true for Indonesia as well. Presently, the industry requires not only individuals who possess the necessary skills and competencies, but also those who can utilize their knowledge to enhance productivity in the workforce (Wagiran, Pardjono and Sofyan, 2020). Therefore, educators and policy makers must work together to support vocational high schools in their mission to guarantee that their graduates possess the skills and knowledge that employers demand.

In order to quickly land a job and launch a business, you need to be equipped with industry-specific skills and be careful when evaluating business opportunities (Mukhadis, Ulfatin and Putra, 2019; Nazira and Kartika, 2021). It is known that 21st century competencies play a central role in preparing vocational students for the changing world of work (Voogt and Roblin, 2012; Katyeudo and de Souza, 2022). Possessing essential skills like critical thinking, creativity, proficient communication, and collaboration lays a strong groundwork for students to excel and stand out in the job market (Sá *et al.*, 2021; Kwiatkowska and Wiśniewska-Nogaj, 2022). Pupils who possess early problem-solving abilities, digital literacy, and an understanding of the newest technologies will be more equipped to handle the demands of the workforce in the future. These abilities will be essential for overcoming obstacles and competing in the workplace.

Different research findings indicate that e-learning plays a significant role in enhancing the abilities and proficiencies of vocational high school students. These skills encompass the essential competencies required in the 21st-century, in addition to the academic skills acquired by students. Table 4 presents the outcomes of the analysis conducted on articles exploring the utilization of e-learning to improve the competence and skills of vocational school students.

Table 4: Summary of Contribution of E-Learning Utilization in Student Skill Improvement

No.	Skill/Competencies	References
1.	Communication & Product's Promotion Skills	Ansyari *et al.* (2021)
2.	Practical Skills	Dimache *et al.* (2018), Bima, Saputro and Efendy (2021), Pipattanasuk and Songsriwittaya (2020), Nugraha and Wahyono (2019), Ma, Hwang and Shih (2020), Lee *et al.* (2022)
3.	Literacy Technology, Literacy Media, Critical Thinking, Creativity, and Collaboration	Aulia and Utami (2021), Kuatbekov *et al.* (2023), Soub (2022)
4.	Reflective thinking	Hj. Ebil, Salleh and Shahrill (2020)
5.	Metacognitive skills	Suryati, Suryana and Kusnendi (2019), Yusuf and Widyaningsih (2020)
6.	Collaborations Skills	Putri, Sumaryati and Jaryanto (2020)
7.	Critical thinking Skills	Rusnawati, Santyasa and Tegeh (2021), Rachman *et al.* (2022), Sari Wahyuni and Haryani (2020)
8.	Mathematics Abilities	Rohendi, Wahyudin and Kusumah (2023), Supianti *et al.* (2022)
9.	Listening Skills	Darwin and Chaeruman (2022)
10.	Creative Thinking	Mahmod Eyadat (2023), Triyono, Muhtadi and Widowati (2022)
11.	Motivation	Hoerunnisa, Suryani and Efendi (2019), He, Ratanaolarn and Sitthiworachart (2024)
12.	Cognitive Skills	Meidyrianto, Hamidah and Efendi (2022), Sari, Susilawati and Anwar (2021), Novaliendry *et al.* (2021), Widyaningsih *et al.* (2020)
13.	Language Literacy	Liu (2023), Demir and Tavil (2021)
14.	self-efficacy	Sirakaya and Cakmak (2018)

Upon examining the results of numerous pertinent studies, it is evident that e-learning plays an important role that should not be undervalued. This is because e-learning has been shown to assist students in gaining a variety of competencies or skills that are essential in the 21st century, including multiple literacies, teamwork, critical thinking, creative thinking, and mathematical proficiency (Rohendi, Wahyudin and Kusumah, 2023; Mahmod Eyadat, 2023). As an example It is well known that e-learning-based learning can support a variety of competencies that are needed. Furthermore, it is indisputable that the workforce requires certain competencies, like teamwork, creativity, and individual literacy (Yondri *et al.*, 2020; Rahmadhani, Ahyanuardi and Suryati, 2022), Hence, the utilization of e-learning in vocational secondary education is anticipated to achieve greater efficiency and encompass a wider range of educational institutions.

Furthermore, another important aspect that needs attention from the research findings above is that many studies reveal that e-learning implemented in vocational education has a significantly positive impact on students' skill achievement (Pipattanasuk and Songsriwittaya, 2020). This outcome has not been widely explored in the context of vocational high schools. It is undeniable that the impact of implementing e-learning in the field of education is highly positive for enhancing skills and producing skilled graduates. Through the identification of literature, it is hoped that teachers, as well as education and vocational practitioners, can gain a more comprehensive understanding of the utilization of e-learning as a bridge to enhance both academic and non-academic skills of students.

Teachers and school-level policy makers can rest assured that they need not be concerned about funding and infrastructure of top-notch quality. The findings of this research indicate that e-learning can be defined as a form of education that makes use of digital learning tools in diverse formats, tailored to the specific attributes of the subject matter (Demir and Tavil, 2021; Widyaningsih *et al.*, 2020), to avoid simply adhering to the notion that e-learning is computer-based learning and that these devices need to be linked to the internet and paired with learning management systems.

4. Conclusion and Suggestions

According to some research findings, present-day Vocational High Schools integrate e-learning into their corresponding programs into two main types. Firstly, the web-based learning tool has Learning Management Systems (LMS) built into it and which is synthesized into the various learning processes. Another variety of online learning tools which is offline-accessible and includes various types of learning media like augmented reality, digital books, e-module, multimedia, android smartphones and computer-based applications comes within this type of e-learning technology. The application of e-learning has been tailored to the needs analysis and characteristics of the material. According to the result of this research, many studies have shown that the implementation of e-learning has a predominantly positive impact on student achievement in cognitive, psychomotor, and affective domains. In some cases, e-learning has even been found in several countries which apply it to learning activities that could enhance vocational school students' 21st-century soft skills, including technological literacy, media literacy, digital literacy, creative thinking, critical thinking, metacognitive skills, language literacy, and self-efficacy. The ultimate goal of the implementation of e-learning in any kind of form was to facilitate vocational school graduates in equipping the necessary skills that are needed in the 21st century.

The synthesis of this research review leads to several recommendations for future research, including conducting experiments to determine how applying e-learning affects students' attainment of 21st-century competencies and how easy it is for graduates to find employment. Additionally, researchers are encouraged to repeat systematic literature reviews on additional databases of indexed scientific articles both nationally and internationally using the provided keywords.

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Identifying Issues of Video Conferencing Tools for Teaching and Learning Using the PACT Framework

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Abstract: The usage of video conferencing tools in teaching and learning has become a norm in today's higher educational institutions, recognized across various academic settings. The experience gained by most educators in using video conferencing tools for teaching during the COVID-19 pandemic could be leveraged to enhance these tools. The study aims to capture the current practices and explore the issues of using video conferencing for teaching and learning in Malaysian higher educational institutions. It focuses on three target groups with hands-on experience: academicians, students, and e-learning consultants or information technology (IT) support staff. Interview and focus group protocols were developed based on the four elements of the PACT framework: People (P), Activities (A), Contexts (C), and Technologies (T). Data were gathered through focus group discussions and in-depth interviews with the target groups. There were 24 participants involved in three focus group discussions and 28 participants in individual in-depth interviews. The PACT framework was employed to analyze the data, aiding in understanding the current situation, identifying areas for improvement, and envisioning future scenarios. Qualitative data were transcribed and categorized based on the four PACT elements. The study identified differences in the People element with four scenarios/practices on physical differences, six on psychological differences, three on mental models, and five on social differences. A total of twenty differences were identified under the Activities element, with six on temporal aspects, four each on cooperation, complexity, and safety-critical aspects, and two on the nature of the content. Under the Context element, one scenario/practice was identified for organizational circumstances, five for social circumstances, and three for physical circumstances. In the Technology element, five scenarios/practices were identified: two related to the input part of technologies and one each for the output, communication, and content parts of technologies. From the scenarios/practices of the responses, a total of fifty-two issues related to using video conferencing for teaching and learning were identified. These findings will serve as the basis for ideation in developing innovative video conferencing toolkits for teaching and learning.

Keywords: Video conferencing tools, Teaching and learning, PACT framework, Higher educational institutions

1. Introduction

Video conferencing has opened a new dimension for 21st-century education, enabling teaching and learning to be conducted anywhere in the world, including collaborative activities with other institutions. Video conferencing has become widely used in both business and education, with its usage accelerated during the COVID-19 pandemic (Adipat, 2021; Rio-Chillcce, Jara-Monge and Andrade-Arenas, 2021). The high daily usage of these tools for interactions has now become the new normal, extending participants' locations from local to global compared to physical interactions (Adipat, 2021). Popular video conferencing tools include Skype, Webex Meetings, Zoom Meetings, BlueJeans Meetings, Google Meet, Intermedia AnyMeeting, RingCentral Video, GoTo Meeting, ClickMeeting, Microsoft Teams, Zoho Meeting, Slack, MyOwnConference, and Loom. The advancement of video conferencing has flourished alongside the progress of the Internet and technology.

In Malaysia, the most widely used video conferencing tools among educators are Google Meet and Microsoft Teams. Other tools such as Zoom Meetings, Webex Meetings, and Skype are also utilized for teaching and learning. These tools can be accessed via any communication device without time and venue constraints, saving

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both students' and educators travel time for face-to-face meetings (Adipat, 2021). Common features of video conferencing tools include instant group video calls, video recording, screen and file sharing, access to the desktop, and editing during virtual meetings. These features bring teaching and learning closer to a face-to-face environment, enabling both students and educators to achieve their teaching and learning goals.

Research on video conferencing is still limited, and ongoing improvements are needed for video conferencing platforms. The goals of this study are to capture current practices and explore issues related to video conferencing for teaching and learning using the PACT framework (P-People, A-Activities, C-Contexts, and T-Technologies. The findings will serve as the basis for developing innovative video conferencing toolkits for teaching and learning.

2. Video Conferencing Tools for Teaching and Learning

Literature defines video conferencing as real-time interaction using digital tools at any location with an internet connection (Camilleri and Camilleri, 2022; Purnell, 2019; Rop and Bett, 2012). Video conferencing tools are widely used for teaching and learning after the Covid-19 pandemic, as educators can conduct real-time virtual lectures to a broader range of borderless students, facilitate student engagement, monitor their progress, and provide immediate feedback (Camilleri and Camilleri, 2022). Additionally, virtual classes can be recorded or archived, allowing students to catch up with lectures and use them as revision material. Students can access their learning materials uploaded to the video conferencing platform at their convenience time (Camilleri and Camilleri, 2022).

The basic tools used in video conferencing include cameras, microphones, monitors, and mobile devices. Gladović, Deretić and Draskovic (2020) shared some important points about the basic equipment of video conferencing. They emphasized the importance of camera position, quality, and functionality during video conferencing. Additionally, they highlighted the significance of audio quality, noting that a slight delay of 0.5 seconds can cause misalignment between sound and images. Another disclosed point is the importance of lighting and the background of the participants involved in video conferencing.

Video conferencing tools used for teaching and learning have been accepted by students (Bandung, Tanjung, and Subekti, 2017; Sutterlin, 2018) and teachers (Gladović, Deretić and Draskovic, 2020). The tools are also perceived as very helpful for virtual classes by Rio-Chillcce, Jara-Monge, and Andrade-Arenas (2021). There are many reasons for using video conferencing tools as a teaching and learning modality. Literature reveals that video conferencing improves students' academic performance (García and Vidal, 2019; Sufyan, et al., 2020) and is an effective tool for learning (Maher, Moussa and Khalifa, 2020). Students also reported being comfortable with video conferencing tools, and they were motivated in their virtual classes (Rio-Chillcce, Jara-Monge and Andrade-Arenas, 2021). Dynamic interaction occurs in the application of video conferencing tools with suitable methodologies and teaching strategies (César et al., 2020). Other advantages of video conferencing tools include overcoming shyness of speech, thus encouraging more opinion contribution (Sufyan, et al., 2020). Gladović, Deretić and Draskovic (2020) highlighted the use of video conferencing in education, which extends teaching beyond textbooks and creates a new way of materials presentation, enabling connections between students and teachers from every part of the world. At the same time, teachers are accelerating the development of strategies that align with the advancement of technology in education.

Besides the unforeseen factor of the COVID-19 pandemic that has accelerated and expanded the usage of these tools, the teaching and learning environment recognizes immense benefits. These include catering to large groups of students (Nainggolan, et al., 2016), extending activities from local to global reach (Rio-Chillcce, Jara-Monge and Andrade-Arenas, 2021), addressing the shortage of educators (Marconi, et al., 2018), improving the quality of teaching and learning, solving transportation and distance issues (Wang, Minku and Yao, 2015), and eliminating travel costs (Adipat, 2021; Rio-Chillcce, Jara-Monge and Andrade-Arenas, 2021). Additionally, such technology enables synchronous and asynchronous teacher-student and student-student interaction (Ip, 2012), effective communication between educators and students (Al-Samarraie, 2019), and distance collaboration in learning between institutions (Hurst, 2020).

However, issues have been identified in using video conferencing platforms, such as subjects requiring laboratory work (Rahim, et al., 2020), network connection and speed, and self-conscious behavior (Maher, Moussa and Khalifa, 2020). Some educators still face psychological challenges due to the new teaching modality (Rio-Chillcce, Jara-Monge and Andrade-Arenas, 2021) and have to attend training on using these new digital tools to overcome psychological issues. Earlier studies also identified background noises and technical issues

that may influence interaction (Gillies, 2008), difficulties in maintaining concentration due to distractions, especially if speakers are not visible to students (Lee, 2007).

Challenges of using video-conferencing tools were reported by a few researchers. According to Ip (2012), the teaching methodology and pedagogy for video conferencing need to be developed, and the syllabi also need to be adjusted to fit the approach. It was also pointed out in the same study that the promotion of intercultural communication competence has its specific teaching methods and tools. Adipat (2021) emphasized that teachers must carefully plan learning sessions, set goals and expectations, as well as examine all conferencing tools that will be used to ensure the effective use of video conferencing as an educational tool.

Al-Samarraie (2019) summarized the use of video conferencing systems based on the learning paradigms: constructivism and cognitivism (p.130), as shown in Table 1.

Table 1: Features supported by video conferencing learning paradigms

Learning paradigms	Features supported by video conferencing
Constructivist	Collaborative learning Problem-solving Interaction and reflection
Cognitivist	Dialogue Competence

The features supported by video conferencing within the constructivist paradigm include collaborative learning, problem-solving, interaction, and reflection. In collaborative learning, students construct knowledge, while lecturers can engage them in various activities to support interpretation in learning problem-solving. The teamwork process is accurately reflected in video conferencing systems, providing information to assist students in reflecting on their responses to learning tasks and the learning environment. According to Al-Samarraie (2019), supportive communication such as sharing, presentation, and file transfers holds pedagogical value, creating external representations of theoretical concepts, evidence, and personal elaborations (p.130).

In the cognitive paradigm, video conferencing contributes by recording additional dialogue activities that facilitate the personal acquisition of information and knowledge. Feedback from the dialogues eases ambiguities, and opportunities to communicate after classes connect students with instructors, promoting knowledge acquisition. Learning materials available on the video conferencing platform give students the opportunity to recall prerequisite knowledge and connect with previously learned materials.

Al-Samarraie (2019) summarized that video conferencing issues from the literature are no longer relevant due to technological advancements, such as the lack of built-in microphones and the restriction of allowing only one person to speak. However, attention is still needed for inconveniences in learning complete knowledge when instructors constantly modify their teaching techniques, background noises, technical issues, and students' difficulties in maintaining concentration (p.132).

Rio-Chillcce, Jara-Monge and Andrade-Arenas (2021) shared their survey results on using video conferencing in the learning process during the pandemic. They reported that most teachers are psychologically and physically ready to use video conferencing tools. Additionally, teachers acknowledged medium stress levels and extended working hours for more than three hours per day. They admitted to fluid and constant communication with students in breakout rooms and felt comfortable with the new delivery method. Similarly, students revealed that video conferencing tools helped them in learning. They agreed that they have medium-high knowledge of video conferencing platforms but believed they needed to continually strengthen their digital knowledge.

3. The PACT Framework

PACT is the acronym for People, Activities, Contexts, and Technologies. This framework employs a human-centered approach, wherein people utilize technologies to engage in activities within specific contexts. The effectiveness, acceptance, productivity, safety, ethics, and sustainability of interactive systems depend on the interplay of these elements in PACT (Benyon, 2014, p.21). Benyon (2014) outlined four advantages of adopting a human-centered approach. The first advantage is the return on investment, emphasizing that considering people's needs and product usability leads to widespread acceptance, making the system more effective and users more productive. The second advantage is product safety. The third is ethics, ensuring truthful and open

design practices in a human-centered environment. The final advantage is sustainability, achieved through enhanced human values and acknowledging human diversity in design.

Moreover, the PACT framework is valuable for both analysis and design activities, aiding in understanding the current situation, identifying areas for improvement, and envisioning future scenarios (Benyon, 2014, p.43).

During PACT analysis, researchers need to explore the potential variations within each element of PACT. This can be accomplished through brainstorming, envisioning techniques, or data collection methods such as observations, interviews, and workshops (Benyon, 2014, p.43). Carroll (2002) emphasized that activities in context require technological support, and changes in technology can alter the nature of activities, as illustrated in Figure 1.

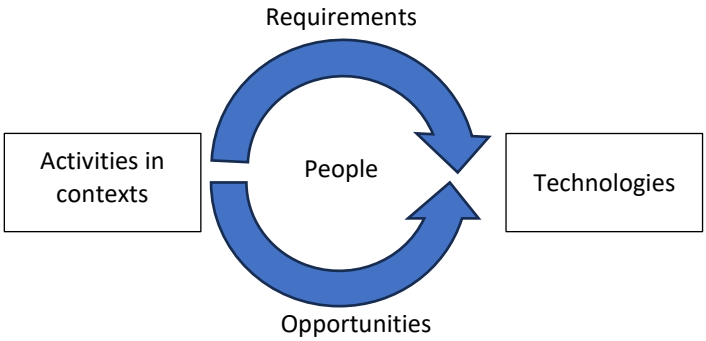

Figure 1: Activities and technologies (Source: Carroll, 2002, Figure 3.1, p.68)

3.1 People

People is the initial element in PACT, and due to the inherent diversity among individuals, Benyon (2005) categorizes People into three main types: Physical differences, Psychological differences, and Usage differences. In an earlier report by Benyon (2014, p.27-33), four types of differences were identified, as outlined in Table 2.

Table 2: Categories of People element

Types	Explanations
Physical differences	Physical characteristics such as height, weight, personalities, cognitive skills, and preferences. This encompasses all variations in the five senses – sight, hearing, touch, smell, and taste.
Psychological differences	Differences in people's physiology, including logical thinking, spatial ability, language, and memory.
Mental models	Mental models denote the understanding and knowledge individuals possess. Those with a robust mental model can perform actions adeptly, while those with a poor mental model may rely on rote actions.
Social differences	Individuals have varying reasons, goals, motivations, and interests in using products. Novices and experts often have distinct requirements, and the requirements for technology differ between homogeneous and heterogeneous groups.

3.2 Activities

Benyon (2014) outlined the primary features of the Activities element, encompassing temporal aspects, cooperation, complexity, safety-critical attributes, and the nature of the content, as summarized in Table 3 (p.33-34). In an earlier case study, Reinius (2011) regarded 'safety-critical' as a subset of safety features.

Table 3: The main features of Activities element

Features	Explanations
Temporal aspects	Temporal aspects cover features of activities such as usage, time pressures, peaks and troughs of working, and response times of the system.
Cooperation	This feature addresses the capacity of activity - whether it involve solitary or group participation. In group activities, considerations include awareness of others, communication, and coordination.

Features	Explanations
Complexity	Complexity involves the level of task definition, categorized as well-defined or vague. Well-defined tasks are more manageable for users, while vague tasks require additional time for exploration due to the need for extra information search before progressing to the next step.
Safety-critical	Certain activities are deemed 'safety-critical,' where any mistake could lead to injury or a serious accident. Hence, planning for potential risks is crucial.
The nature of the content	The nature of the content pertains to considerations of data requirements for activities. For instance, displaying color video necessitates a screen that supports color.

3.3 Contexts

Activities always occur within a specific context. Benyon (2014) categorized the Contexts element into three types: organizational context, social context, and physical circumstances. He defined context as either surrounding an activity or as the features connecting activities into a coherent whole. The three types of contexts are summarized in Table 4 (Benyon, 2014, p.34-35; Benyon, 2005 as cited in Reinius, 2011, p.19).

Table 4: The main features of Contexts element

Types	Explanations
Organizational	Organizational context pertains to the work environment, encompassing different locations, timings, and the impact of technology on communication and work practices within an organization (Benyon, 2005 as cited in Reinius, 2021, p.19).
Social	Social context involves the surroundings of the activity. A supportive environment aids individuals in the activity and addresses privacy concerns. Assistance may include training manuals, tutorials, or access to experts when individuals encounter problems.
Physical circumstances	The physical environment refers to the actual location where the activity occurs, including natural aspects such as weather and ambient sounds.

3.4 Technologies

Technologies represent the final element of the PACT framework, serving as the medium for interactive systems where various tasks can be executed with data or information. The Technologies element is categorized into four parts: input, output, communication, and content, as summarized in Table 5 (Benyon, 2014, p.36-43; Benyon 2005 as cited in Reinius, 2011, p.19).

Table 5: The main features of Technologies element

Parts	Explanations
Input	Input devices determine how people securely and safely input data and instructions into a system. Examples of data input include text, barcodes, voice, QR codes, touchscreens, and augmented-reality fiducial markers. Input devices include switches, buttons, trackballs, joysticks, data gloves, fingers, stylus pens, mice, speech, and various sensors (air pressure sensor, acoustic sensor, vibration detector, infrared motion, and accelerometer).
Output	Display technologies consider human perceptual abilities such as vision, hearing, and touch. Common visual output devices include screens or monitors driven by graphics cards. Speech output, as seen in satellite navigation systems, is also prevalent. Printers produce text or illustrations on paper, and haptics provide a sense of touch, allowing direct and immediate interaction with devices and media.
Communication	Communication in technologies refers to how people interact with devices, encompassing aspects like bandwidth, speed, and how the system communicates back to users. Communication can occur through wired or wireless means.
Content	Content relates to the form of data within the system, emphasizing the need for it to be up-to-date, accurate, and presented effectively.

4. Methodology

The study employed an exploratory method to delve into the current practices of utilizing video conferencing (VC) tools in teaching and learning, along with the didactics involving other tools for educational purposes. Three distinct target groups (TG) from Malaysian Higher Learning Institutions were involved in the research: TG 1 comprised academicians or researchers, TG 2 consisted of e-learning consultants and IT support staff, and TG 3 included students from higher learning institutions. All target groups possessed hands-on experience in video conferencing for teaching and learning.

Data were collected through focus group discussions and in-depth interviews with the specified target groups from higher learning institutions in Malaysia. There were 24 participants involved in the three focus group discussions and another 28 in individual in-depth interviews. Among them, 5 were e-learning consultants or IT support staff, 21 were university students, and 26 were academicians or researchers. The interview protocol was developed based on the four elements of the PACT framework: People, Activities, Contexts, and Technologies (Benyon, 2019). An investigative and explorative approach using the PACT framework was employed to comprehend the PACT dimensions within the three target groups.

The PACT framework served as a guide for data analysis. Transcribed data were categorized into four major elements: People, Activity, Context, and Technology. The presentation of the data was organized according to the three target groups of the study. The PACT analysis was employed as the framework to discern the existing scenarios and practices of video conferencing systems in teaching and learning. It aimed to identify current issues with the system and gather suggestions for enhancing video conferencing tools in future teaching and learning. The framework structured the analysis to understand the interactions between People, Activities, Contexts, and Technologies within the user interface. The study explored the potential variations in people, activities, contexts, and technologies in the current scenarios and practices of video conferencing systems in teaching and learning, including didactics involving other tools, through brainstorming and envisioning techniques.

5. Findings and Discussions

The study's findings were analyzed based on the PACT elements, segmented into three target groups.

5.1 People

The findings concerning People are categorized into four types, as outlined in Table 6. In terms of physical differences, the study identified variations in speaking and hearing abilities. Participants exhibited differences in voice characteristics, speech volume, and accents, prompting adjustments to device speaker volumes to ensure clear communication during video conferencing. Sensitivities to surrounding noise also differed among participants, with some students facing challenges in prolonged engagement due to noise disruptions in their environments. This aligns with Al-Samarraie's (2019) summary, where background noise was identified as an issue in video conferencing.

Diverse psychological aspects among individuals were observed, reflecting differences in intelligence and language abilities. Language barriers were evident among some participants, while others displayed a mix of active and passive involvement during video conferencing. Technical skills emerged as a primary factor influencing video conferencing tool usage, ranging from novice to tech-savvy. Varied levels of technical skills impacted technology control and usage, limiting lecturers in conducting constructivist instruction. Consequently, many lecturers preferred direct instruction over constructivist approaches due to these technological skill limitations. Some students highlighted challenges in maintaining self-discipline for self-learning.

The study identified diverse mental models among participants. While most could perform actions by rote, a smaller percentage demonstrated the ability to simplify complex solutions and apply them to relevant fields, indicating a strong mental model.

The social differences among the participants are evident in the motivation to use video conferencing tools for teaching and learning. Not all educators are motivated to shift their delivery platform from face-to-face to video conferencing. For those motivated educators, their enthusiasm and commitment to teaching vary compared to those who had no choice but to transition to video conferencing platforms, especially during the COVID-19 pandemic. This highlights the heterogeneous nature of educators in using video conferencing platforms. Conversely, students form a more homogenous group, sharing similar age ranges, backgrounds, and belonging to the same faculty.

Table 6: Summary of People differences

Category	Respondent's category	Scenarios / Practices of the response	Issues of using video conferencing tool
Physical differences	Educators	• Difficulty in capturing students' soft-spoken responses and different accents. • Duration of concentration varies among students.	• Variations in speech volume and ascent due to individual traits and cultural background. • Lack of pedagogical skills to engage students in online learning.
	Students	• Disturbance in concentration from surrounding.	

Category	Respondent's category	Scenarios / Practices of the response	Issues of using video conferencing tool
		• Individual sensitivity towards educators' voice pitch.	• Lack of conducive learning environment at home. • Lack manpower to support concurrent lectures.
	Technician	• Difficulty in assisting technical adjustment of the volume and pitch.	
Psychological differences	Educators	• Language barrier, and shyness of students to speak. • Difficulty in handling mixed active and passive learners • Resistant to change from lecture centred to students centred. • Difficulty in adopting constructivist instructions.	• Language barrier due to the mode of language practice. • Heterogenous type of learners. • Shyness due to a lack of confidence. • Educators lack pedagogical skills for video conferencing classes. • No streaming of students based on their individual learning ability. • Students lack self-discipline in online classes.
	Students	• Different levels of ability to pick up points of discussion. • Difficulty in establishing self-learning discipline environment.	
	Technician	-	
Mental models	Educators	• Inability of students to simplify complex solutions and apply them in the relevant field. • Difficulty in handling multilevel intelligences of students.	• Lack of higher-order thinking skills. • Lack of online pedagogical knowledge. • Lack of clear instructions for online learning.
	Students	• Different levels of understanding in following instructions.	
	Technician	-	
Social differences (Rio-Chillcce, Jara-Monge and Andrade-Arenas, 2021)	Educators	• Resistant to change the delivery method from face-to-face to online. • Novice in using online platforms to teach. • Different levels of technological skills to operate video conferencing tools. • Different levels of students' motivation to learn via the video conferencing platform.	• Lack of technical skills in online teaching and learning. • Preference of educators in mode of delivery. • Insufficient technical training for educators. • Lack of students' motivation to learn via online platform. • Lack of manpower and facilities to support the technical needs of the educators.
	Students	• Different levels of technological skills affect their usage of video conferencing tools. • Different motivation levels to learn via the video conferencing platform. • Different technological levels skills of lecturers.	
	Technician	• Insufficient manpower and facilities to support the technical needs of the educators.	

5.2 Activities

The findings of the Activities element are presented based on the five main features (Table 7): temporal aspects, cooperation, complexity, safety-critical, and the nature of the content (Benyon, 2014).

In the temporal aspects, the most common activities in video conferencing, as shared by respondents, include live lessons, discussions, sharing of resources (notes, tutorials), and teaching videos. One common problem was Internet speed, leading to interruptions in live classes and difficulties uploading long recorded videos. Some respondents lived in areas with poor Internet access, causing issues with activities requiring downloading, uploading, and online video watching. Assessment activities, such as quizzes and tests, were also conducted via video conferencing platforms. Lecturers noted the difficulty of invigilating students' tests and monitoring attendance in online classes through video conferencing platforms.

Individual and group tasks were conducted, but due to the limitations of skills on video conferencing tools, some respondents from TG1 mentioned not engaging in the cooperation feature as they lacked the necessary skills. In cases of group tasks, the issue was how to keep all students active all the time in group activities.

There were implications that students attending video conferencing classes preferred well-defined tasks compared to vague tasks, as stated in the Complexity feature. Educators assigned more well-defined individual tasks, while group tasks were considered vague.

Regarding the Safety-critical feature, lecturers raised concerns about assessment procedures and the confidentiality of questions. Due to limited Internet access, many students could not turn on their cameras during online assessments. Students admitted that they could easily copy from each other during online assessments. Technical staff shared that limited use of breakout rooms and frequent interruptions in uploading long videos hindered the proper supervision of assessments. They also pointed out that students' limited data subscriptions hindered the proper supervision of assessments.

Nature of content features for video conferencing classes included text, slides, and videos with colours supported by the video conferencing platform. There was congruence between TG1 and TG2 that natural content features were provided. Respondents from TG3 revealed that most tools, such as smartphones, tablets, and laptops, could support the content. The issues raised were the high cost of purchasing multiple applications to support the teaching and learning process, and the technical skills to handle multiple types of files.

Table 7: Summary of Activities differences

Features	Respondent's category	Scenarios / Practices of the response	Issues of using video conferencing tool
Temporal aspects	Educators	• Time pressure to upload all teaching materials, tutorials, and quizzes on a weekly basis. • Difficulty uploading big data files such as pre-recorded video lessons. • Students' login and leave the online class physically but maintain the login in the platform.	• Longer time taken in preparing and uploading teaching materials. • Limited space and period to store recorded video in the platform. • Difficulty in tracing students' presence and engagement. • Longer hours for learning. • Unstable Internet connectivity and accessibility. • Lack of financial support in data subscription.
	Students	• Use daytime to attend online classes and night-time for revision, discussion, and tutorial. • Time taken to download recorded lessons. • Problem in downloading study materials.	
	Technician	• Frequent interruptions in uploading long video of more than 20 minutes.	
Cooperation	Educators	• Difficulty in keeping students active for individual and group tasks. • Difficulty in conducting segregated group activities.	• Lack of skills to use online engaging tools. • Lack of adoption of online engaging tools. • Limited knowledge of using breakout rooms. • Lack of demand for technical support.
	Students	• No motivation and interest in participating group activities. • Most of the tasks are individual tasks. Live group task difficult to carry out as many lecturers not using the breakout room feature for group discussion.	
	Technician	• Underutilization of breakout room feature.	
Complexity	Educators	• Instruction of tasks assigned not clear. • Preferred individual tasks as not familiar to the features of conducting group activities.	• Lack of well-defined individual or group tasks to ease students' self-learning. • Lack of technical skills in conducting group activities. • Lack of commitment in group activities. • Lack of skills to engage students in group activities.
	Students	• Not all members actively participate in group assignments. • Prefer to discuss physically in group assignment so that all members can concentrate in the work. Online group discussion has too many distractors.	
	Technician	-	
Safety-critical	Educators	• Difficulty in invigilating assessment online. • Possible assessment paper leak.	• Lack of standard procedures in conducting assessment. • Confidentiality of assessment questions.
	Students	• Avoid turning on the camera due to limited data subscriptions.	

Features	Respondent's category	Scenarios / Practices of the response	Issues of using video conferencing tool
		• Copying from one to another always happen during assessments. • Access to Internet source during assessment.	• Limited data subscription hindered the proper supervision of assessments. • Risk of plagiarism.
	Technician	• Unable to turn on video camera through the assessment duration.	
The nature of the content	Educators	• Needs of preparing various types of files (Example: doc. Pdf, AVI, MP4) for teaching and learning (Note, tutorial, assignment and assessment).	• Lack of skills to use different types of files. • Limited budget to subscribe multiple applications for teaching and learning.
	Students	• Needs of installing and purchasing applications to read or run various type of files.	
	Technician	• Not all applications proposed subscribe by the university.	

5.3 Contexts

The third element of PACT is Contexts. The findings of Contexts are presented based on the types of contexts: organizational context, social context, and physical circumstances (Table 8).

The organizational context is defined by the features of video conferencing tools, allowing participants to attend or conduct classes without location limitations. Recorded online classes and videos enable students to learn at their own pace and time. While TG1 appeared unaware of guidelines, TG3 revealed a university policy allowing flexibility in venue and learning time.

Findings related to the social context can be identified in two aspects: instruction on technical and privacy issues. Most technical issues for learning were addressed by uploading pre-recorded videos explaining procedures. Despite encouraging students to share on video conferencing platforms, there is a need for heightened awareness of privacy issues, as suggested by TG3.

In the third context, which is related to physical circumstances, video conferencing classes could be conducted by TG1, and TG2 would attend from any convenient location with internet access. Respondents expressed concern about noisy environments disrupting classes and causing distractions. TG3 suggested that this issue could be resolved if the platform could use Artificial Intelligence (AI) technology to reduce surrounding noises and only pick up related voices.

Table 8: Summary of types of Contexts

Types	Respondent's category	Scenarios / Practices of the response	Issues of using video conferencing tool
Organizational	Educators	• University do not have guideline for conducting video conferencing classes adherence to course structure/ subject syllabus.	• No standard guidelines and policies for video conferencing classes at university level.
	Students	• No consistent guideline for video conferencing classes.	
	Technician	-	
Social	Educators	• Prepare instruction as note or short demonstration video prior to conduct activities. • Not active in knowledge-sharing.	• Lack of well-defined instructions for activities. • Lack of knowledge-sharing culture. • Lack of knowledge and awareness on digital and web security. • Lack of 24/7 help desk. • Lack of content monitoring team.
	Students	• Time taken to understand activity's instruction in digital form prior to start activity. • Share any think they like. • Live question not available all time.	
	Technician	• No monitoring team on the content shared.	
Physical circumstances	Educators	• Conduct class at different locations such as at home, office, lecture room. • Attending classes in a noisy environment of some students	• No guideline on venue environment. • Disturbance of noises from various environments of attendees.

Types	Respondent's category	Scenarios / Practices of the response	Issues of using video conferencing tool
		and the unwanted voices disturbs the class.	• Lack of artificial intelligent equipment.
	Students	• Attend online classes anywhere with internet access.	
	Technician	• Encourage to use artificial intelligent microphone to conduct or attend classes at a noisy environment.	

5.4 Technologies

The findings of Technologies element are presented in four parts: input, output, communication, and content (Table 9). Respondents only used simple devices for input, such as a stylus pen, smartphone, computer/laptop/tablet, headset (speaker and microphone), webcam, selfie ring light, touchpad, writing pad, and Wi-Fi booster. Not all devices could be used, as revealed by TG3. On the other hand, output devices used by the respondents could support the uploading of materials, and the haptic feature in most devices eased the output process. The output devices used by the respondents included computer/laptop/tablet, speakers and an additional monitor, and a printer. TG3 revealed that vision and hearing human perceptual devices were mostly used, as lecturers had no ability to use touch perceptual.

For communication in technologies, limited bandwidth hindered video conferencing classes in interior areas. While urban and suburban areas could communicate with access to 3G or 4G, they always encountered interruptions due to the service provider. Rural areas have better communication technologies; hence, they could communicate well in video conferencing classes. In terms of the content parts of technologies, participants from all target groups consensually agreed that video conferencing effectively presented the content in a good manner.

Table 9: Summary of parts of Technologies

Parts	Respondent's category	Scenarios / Practices of the response	Issues of using video conferencing tool
Input	Educators	• Only a few devices use for input such as writing pad and stylus pen, laptop or tablet, headset.	• Lack of multiple devices for input. • Stability of input devices.
	Students	• Commonly use input devices such as Smart phone, computer /laptop/tablet, headset.	
	Technician	• Provision of unavailable input devices.	
Output	Educators	• Use of conventional visual output devices. • All devices support the files and videos uploaded, and the haptic technology used in the devices makes the output more convenient.	• Lack of video conferencing toolkit with haptic technology.
	Students	• No advanced technological devices such as artificial intelligences devices but conventional visual output devices used by lecturers.	
	Technician	• Provision of unavailable output devices.	
Communication	Educators	• Frequent disconnected from live communication.	• Unstable Wi-Fi access and connectivity.
	Students	• Frequent disconnected from internet especially in rural areas and during rainy days.	
	Technician	• Upgraded internet connectivity system and speed. • More frequent check on modem and router.	
Content	Educators	• Difficulty in keeping up to date video conferencing system and the supported application.	• Extra budget to keep all application and system up to date.
	Students	• Affordability to update all applications use for video conferencing classes.	
	Technician	-	

6. Conclusion

The virtualization of education in the new normal is in a transition stage to meet the primary goals of both educators (TG1) and students (TG2), with support from IT experts (TG3). Assessing video conferencing tools for teaching and learning using the PACT framework has captured the issues of using video conferencing tools and the shortfalls of the ability of both educators and students to capitalize on the availability of video conferencing tools in education. In general, concentration is the distraction caused by unconducive environments and lack of engagement of TG1, and TG2. Currently, video conferencing tools are limited to individual tasks, as most educators have not embraced group tasks with widely dispersed groups in breakout rooms.

It has been recognized that the adoption of video conferencing tools has been associated with immense benefits for both educators and students in terms of flexibility of time and venue. The engagement of video conferencing tools by TG1, identified as being very personalized, facilitative, and responsive to available technology in institutions is limited by technological skills. TG2 is very adaptive but constrained by internet accessibility and available devices. Additional limitations experienced by TG2 were attributed to video conferencing tools' communication skills and low auditory recognition memory performance. TG3 highlighted that the competencies of TG1 need to be upskilled, particularly in group tasks, in their ability to operate video conferencing tools as an educational tool. They added that more advanced technological devices need to be acquired for incorporation into teaching and learning processes. These findings can serve as the basis for ideation in developing innovative video conferencing toolkits for teaching and learning. The findings can also serve as innovative ideas for video conferencing platforms developers to improve the functionality of the platforms.

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Learning Analytics Intervention Using Prompts and Feedback for Measurement of e-Learners' Socially-Shared Regulated Learning

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Abstract: The future of university learning in Sub-Saharan Africa has become increasingly digitally transformed by both e-Learning, and learning analytics, post-COVID-19 pandemic. Learning analytics intervention is critical for effective support of socially-shared regulated learning skills, which are crucial for twenty-first-century e-Learners. Socially-shared regulation is the major determinant of successful collaborative e-learning. However, most e-learners lack such skills thereby facing socio-cognitive challenges, due to the unavailability of intelligent support during learning. This research aims to investigate and understand the effect of Learning Analytics instructional support using feedback and prompts, on e-learners' SSRL indicators. A theoretical model was derived from these factors and built from selected features. Both survey data and behavioral trace data were employed in the Learning analytics-based intervention. In this paper, only a segment of the data is discussed. The e-learners' perceptions and feedback confirmed that Learning Analytics-based interventions using prompts and feedback are effective in promoting SSRL in collaborative e-learning contexts. The findings indicated that the success of SSRLA-based intervention be tied to support from instructors and academic counselors, particularly feedback on previous problems and quizzes. This will improve e-learners' SSRL skills for quality educational experience, hence motivate e-learners, and help lecturers to identify at-risk learners in web programming problem-based courses. In conclusion, without adequate utilization of the Learning Analytics interventional trace data, critical information about learners' behavior patterns in terms of their online interactivity with the course activities and their SSRL profiles and strategies cannot be disclosed leading to little improvement of e-Learning interventions.

Keywords*:* Socially-shared regulated learning, Learning analytics intervention, Feedback and prompts, Collaborative e-Learning, Quality educational experience

1. Introduction

The future of university learning in Sub-Saharan Africa, post COVID-19 pandemic, has become increasingly digitally transformed through e-Learning and learning analytics (LA). The global expansion of e-Learning adoption has been successful due to the affordability and flexibility of Learning Management Systems (LMS), such as Moodle which is commonly used for teaching in universities. In Kenya, the adoption of e-learning in most universities' teaching, learning, was driven by government policies on social distancing to suppress the spread of the COVID-19 (en.unesco.org/covid19/educationresponse, 2020; Kibuku, Ochieng' & Wausi, 2020; Akinyi & Oboko, 2020). The term "e-learning" refers to web-based systems such as LMS which enable learners to easily collaborate, and access educational content, and activities, while obtaining support during the process of learning, with instructors delivering the curriculum and learning materials (Araka, et al, 2020; Delen & Liew, 2016).

Despite the benefits of e-learning adoption, this growth has led to an increase in e-learners' socio-cognitive challenges, especially lack of intelligent support on their Socially-Shared Regulated Learning (SSRL) skills as seen through the low interaction with e-learning activities, and collaborative platforms. SSRL skills are essential for successful quality educational experience (QEE) for the 21st century e-learning (Viberg, Khalil, & Baars, 2020). There is lack of a Learning Analytics intervention that uses prompts and feedback approaches, and maps Moodle LMS features to SSRL strategies for QEE. To provide effective instructional support to e-learners, there is need for an intelligent intervention of the learners' SSRL strategies (Akinyi & Oboko, 2020). Learning Analytics involves integrating and analyzing educational data which is collected for insights and patterns on how learners interact, and collaborate in learning activities while studying online, with a goal of supporting students by providing interventions to reinforce positive learning and improve poor learning skills (Lodge, et al., 2019).

This research aimed at investigating the effect of Learning Analytics intervention using prompts and feedback on e-learners' SSRL strategies in an e-learning context. The use of Learning analytics (LA) in education brings the

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promise of essential benefits (Akçapinar et al. 2019; Chatti, et al., 2012), such as personalized learning to each e-learner's preferences, helping learners adapt the pace and control iterations to improve the mastery of the topic and promote equity in overall learner performance. Learning Analytics-based scaffolding reduces cognitive load and increase socially-shared regulation which improves quality educational experience. Measurement of SRL using LA scaffolding techniques is categorized under the "current wave", as it serves as a tool for promoting SSRL skills in e-learners (Araka et al., 2020).

1.1 Problem Statement

There is lack of a Learning Analytics intervention that uses prompts and feedback approaches, and maps Moodle Learning Management Systems features to SSRL strategies for QEE.

1.2 Research Question

RQ1: Which instruments and approaches can be used to measure and promote SSRL in collaborative e-learning contexts?

RQ2: Which features can be mapped to LMS factors to develop a SSRLA instructional support model to best predict the performance of e-learning students based on their SSRL skills?

2. Socially-Shared Regulated Learning Model

This study was underpinned by Hadwin, Järvelä, and Miller's: Socially-shared regulated learning (SSRL) model, Figure 1. SSRL model explains self-regulation in the social and interactive learning contexts using ICT in collaborative e-Learning environments (Panadero, 2017), and focuses on the situational, contextual and motivational SRL aspects (Hadwin, et. al., 2011) to improve QEE. The operational definition of SSRL in this study, builds on Winne and Hadwin's (1998) model of SRL, which outlines four phases of self-regulation, such as task perception, goal setting/ planning, applying strategies, and evaluating/adapting (Järvelä et al. 2013).

The SSRL model indicates the existence of three modes of regulation in collaborative settings: self-regulation (SRL), co-regulation (CoRL), and shared regulation (SSRL). First, SRL in collaboration refers to the individual learner's regulatory actions that involve adapting to the interaction with the other group members. Secondly, CoRL in collaboration "refers broadly to affordances and constraints stimulating the e-learner's appropriation of strategic planning, enactment, reflection, and adaptation that occurs when interacting with other learners or group members" (Hadwin et al., 2011). Lastly, SSRL, the third category in collaboration, occurs when "deliberate, strategic and transactive planning, task enactment, reflection and adaptation" are taken within a group (Hadwin et al., 2011).

In SSRL model, SRL deploys five different facets of tasks which are identified using the COPES acronym which stands for Conditions Operations Products Evaluations Standards (Winne and Hadwin, 1998; Greene and Azevedo, 2007). The SSRL model unfolds in four linked feedback loops (Hadwin & Oshige, 2011). In the first loop, using internal and external representations of the current task, groups "negotiate and construct shared task perceptions (Winne & Hadwin, 1998). On the second loop, groups decide how they will tackle the task as a group and establish agreed goals for it. On the third loop, teams carefully plan their collaboration and strategically keep track of their advancement. In the fourth loop, groups evaluate and regulate for future performance. The groups might alter their task perceptions, goals, plans, or methods based on this monitoring activity to increase their collective activity toward the learning goal (Nguyen, et al., 2022).

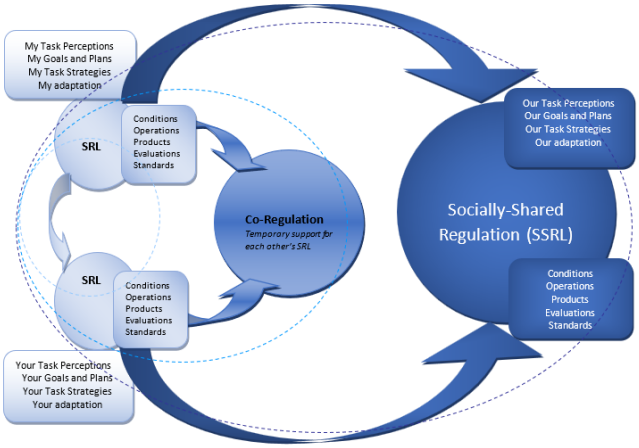

Figure 1: Socially-Shared Regulated Learning model-1 (Adapted from Hadwin et al. 2011)

2.1 SSRL Strategies used in e-Learning

SSRL strategies refer to research-based instructional techniques targeted at assisting e-learners with monitoring and management of their own learning skills and habits (Zimmerman, 2008) for ease in acquiring and retaining knowledge in a manner that is methodological and structured. They enable a learner to actively engage self-regulated processes, as different self- regulated learners utilize different strategies during learning process (Wandler & Imbriale, 2017; Alvi et al., 2016). When learners apply SRL strategies in their e-learning environments, their QEE and academic achievement projections can easily be predicted (Wang et al., 2013). For this study, the adopted SRL strategies included metacognitive, cognitive, motivational and resource management.

Cognitive strategies are used by students to optimize personal regulation, as they help students to acquire knowledge through retaining information (Akinyi & Oboko, 2020). They include: Critical thinking, Elaboration, and Organization describes a learner's capability to underscore major concepts covered during learning (Effeney et al., 2013).

Metacognitive define a learner's awareness to monitor, plan and regulate learning" (Akinyi & Oboko, 2020; Alvi et al., 2016) and are used to enhance behavioral functioning. Examples include, Time-management, the capability of applying a learner's study-time constructively while undertaking an online course (Effeney et al., 2013).

Resource Management Strategies mandate that students make the most of their surrounding learning settings, including their peers and teachers (Akinyi & Oboko, 2020). E-learners often consult a variety of sources, including books, periodicals, libraries, and the internet, ask for help and occasionally work in groups to ensure QEE. Examples include: Peer-learning, which entails teaming up with other students to help one learn (Akinyi & Oboko, 2020; Effeney et al., 2013). Help-Seeking, encourages a learner to seek assistance from lecturers or better placed peers, to overcome challenges while learning (Effeney et al., 2013). Effort-regulation refers to the students' persistence in performing their task when they encounter a difficult task (Cho & Shen 2013).

Motivational Strategies affect learners' participation in SRL and influences the behavior, motivation, and feelings by self-efficacy, a crucial motivating factor in SRL (Bandura, 2012). Efficacy is a trait shared by highly successful students who are intrinsically motivated to learn. Extrinsically driven students are more likely to be less self-motivated, which means that they will utilize less SRL methods than intrinsically motivated students (Makokha & Mutisya, 2016).

2.2 Learning Analytics Technology

Learning analytics (LA) technology is the process of measuring, collecting, analyzing and reporting learners' data in their context, so as to understand, measure, optimize student learning process, experience, and the e-learning environment, with an objective of improving QEE on the overall performance outcomes (Baars, & Viberg, 2022; Long & Siemens, 2011). With the application of LA during e-Learning, there is a possibility of measuring key indicators of learner performance, supporting development of SRL skills, improving decision-making, improving learning outcomes, motivation and informing institutional strategy (Verstege et al., 2019; Azevedo et al., 2010).

Visualizing LA data and understanding student behavior with the support of Social-cognitive LA intervention can enhance online student interactions leading to better engagements among e-learners (Kaban, 2023). With the intervention of prompts and feedback during e-Learning, the possibility of measuring key indicators of learner QEE on academic performance, encourages the development of students SSRL skills, improve decision making, learning outcomes, motivation and inform institutional strategy (Verstege et al., 2019; Azevedo et al., 2010).

3. Methodology

Our current work was carried out in the context of a SSRLA-based socially-shared regulated learning instructional support extended from a Moodle LMS. A deductive research approach was employed, whereby SSRL, an SRL theory, was developed based on literature review. The research design provided a way to analyze literature, identify SRL strategies, and measurement instruments used on LA-based interventions, and for feature selection so as to build a SSRLA instructional support. A descriptive survey was used to investigate the SSRL level of learners. The descriptive survey was adopted given its possibility to examine a situation the way it is and provide quantitative information, summarized through statistical analyses (Akinyi & Oboko, 2020; Engelhart, 1972). LA-based prompts and feedback interventions were developed and integrated within Moodle LMS, for the SSRL strategies applied by learners. The Model validation was done through experimental analyses and experimental evaluations respectively, as will be shared in the next phase of this research.

For the systematic literature review and a survey, the results obtained were SRL strategies, LA indicators as well as the established socially-shared learning factors. This study reviewed literature about LA support on SRL strategies in socially-shared e-Learning, based on clearly formulated research questions. Before conducting the systematic review, the research problem was specified in a clear and structured manner by framing it using specific keywords. Some of the keywords used included Learning Analytics instructional support for SRL, e-Learning SRL strategies and approaches, Machine Learning techniques on SRL, and e-Learning QEE on performance. Literature Analysis was based on literature, where the researcher identified various SSRL strategies and a SSRL model best suited for an e-Learning environment for improving QEE on performance.

From the SRL Models Analysis, the SSRL model (Hadwin, et. al., 2013) was analyzed together with the SRL theories selected during the systematic literature review, then the factors for the conceptual assessment framework were analyzed.

A three-months qualitative survey was conducted, on 21 Universities in Kenya, with an aim of informing more on the problem and giving more clarity on the research problem. It investigated the e-learner awareness and use of SRL strategies, LA experience, motivation, perceptions and challenges faced by e-Learners in Universities in Kenya.

In light of the e-learning challenges identified, a need for the ongoing methodological development is obvious, which entails having a real-time measurement strategy that takes place as e-learners engage in the learning process (Azevedo et al. 2017).

In order to see the extent to which the expected contribution was achieved, two research questions were addressed:

RQ1: Which instruments and approaches can be used to measure and promote SSRL in collaborative e-learning contexts?

RQ2: Which features can be mapped to LMS factors to develop a SSRLA instructional support model to best predict the performance of e-learning students based on their SSRL skills?

3.1 Participants and Sample Size

This research adopted Purposive sampling on 21 Universities in Kenya. University lecturers, through their departmental Program coordinators, were requested to provide contacts of their class representatives, for ease of facilitation. The researchers then made a formal invitation e-poster through their e-mails and via a WhatsApp invitation link, for the students to fill in a google form as a formal registration into the course. The sampled participants were informed of the purpose of the study by the researcher, and their consent was sought before responding to the survey. Such an assurance was required so as to eliminate any form of ethical issues that might come up while using university curriculum material to conduct experiments therefore intentionally disadvantaging some learners. Participation was on a voluntary basis.

The research targeted students pursuing Computer Science degree course, and were in their second, third or fourth years of study, due to the complexity of the experimental course, Laravel Frameworks for web

development. Laravel was chosen due to its practical nature, hence more learning activities to measure, and also based on the challenges usually experienced by final-year students during projects development as confirmed from the pre-study findings. The experiment was facilitated by an experienced instructor, a lecturer from Technical University of Mombasa, and an academic counselor from Technical University of Kenya.

In the survey, research participants completed a mandatory course survey when enrolling into the Laravel Frameworks course for the first time. The survey included a measure of SSRL using questions adapted and customized from the MSLQ questionnaire by Duncan and McKeachie (2005). The questionnaire was distributed through e-mail invitations to the participants. The invitation e-mail contained the purpose of the Research study, a link to the URL and WhatsApp forum where the questionnaire was located. Learners were required to enter their demographics (course level, gender, education, university), time commitment (hours per week), course intentions (intend to watch all lectures; intend to complete all assessments), prior experience with the course topic, the number of prior e-Learning courses started, the number of completed courses, their SSRL strategies, and motivations. The descriptive survey was adopted as it examined the situation the way it was and provided quantitative information that would be analyzed through statistical analysis, hence providing a basis to answer our research questions (Engelhart, 1972). The researcher customized a MLSQ questionnaires using a web-based tool, Google forms. This approach was preferred because it enabled a faster collection of responses and the ease of exporting data for qualitative analysis. The Course Survey link: https://forms.gle/yUNMvDUjiimsPnb49.

4. Results

This research sought to investigate the most suitable interventional instruments, and factors that can enable LA to effectively support SSRL, based on the survey responses from MSLQ questionnaire, so as to clearly understand e-learners preferred SRL strategies. These findings would enable lecturers, LMS designers, LA researchers be more engaging in offering scaffolds to their at-risk learners. The research thus, encourages collaborative and autonomous socially-shared regulated learning for QEE.

4.1 Research Question1 Results

Research Question 1:

RQ1: Which instruments and approaches can be used to measure and promote SSRL in collaborative e-learning contexts?

The following instruments and approaches were used in this study:

4.1.1 Evidence-Centered Design (ECD) framework

Mislevy, Steinberg, and Almond developed the Evidence-centered design (ECD) framework in 2003 for designing, constructing, or implementation of educational assessments based on evidentiary arguments (Lee & Recker, 2017; Mislevy et al., 2012). This study used ECD to help draw valid inferences between the constructs of SSRL and learner trace logs that were captured in Moodle LMS, ie psychological constructs (students' cognitive processes) and individual traces (Lee & Recker, 2017). Through EDM, valid inferences were formed between the variables (e.g., detailed logs of student activities in Moodle online learning system) and the psychological constructs of interest (latent variables), based on a construct-centered approach.

The ECD framework provided explicit evidentiary linkages between the targeted assessment constructs (student model), evidential components (evidence model), and assessment tasks (task model). It measures student SRL by using trace logs captured by a learning management system. According to Lee & Recker, 2017, the ECD framework consists of five layers (domain analysis, domain modeling, conceptual assessment framework, assessment implementation, assessment delivery), in this study we focus on the core layer that is closely related to assessment implementation, the conceptual assessment framework (CAF) (Lee & Recker, 2017; Riconscente, Mislevy, & Hamel, 2005). The CAF consists of several models, and each model asks critical questions such as What are we measuring? How do we measure it? Where do we measure it? (Lee & Recker, 2017; Mislevy, Almond, & Lukas, 2003).

- Student Model: What are we measuring?

A learner or student model contains variables that are related to e-learners' knowledge, skills, or abilities that the researcher wishes to measure, (Lee, & Recker, 2017; Mislevy et al., 2012). In this study, the focus was to measure 3 types of SRL strategies: cognitive, resource management, and metacognitive. To measure student use of SRL strategies, we use the theoretical constructs from the MSLQ (Lee, & Recker, 2017; Pintrich et al.,

1993). MSLQ is one of the most widely used instruments and the subconstructs of SRL are clearly defined. According to the MSLQ, students' SRL consists of four components: motivation (value, expectancy, affect), cognitive strategies (rehearsal, elaboration, organization, critical thinking), metacognitive strategies (planning, monitoring, regulating strategies), and resource management strategies (or behavior) (Lee, & Recker, 2017).

- Evidence Model: How do we measure it?

The evidence model is associated with how we measure e-learners' knowledge, skills, or abilities (Lee, & Recker, 2017). It refers to e-learners' behaviors that reveal the constructs described in the student model and also links the student model with the task model (Lee, & Recker, 2017). From Cognitive construct, the first subconstruct, Elaboration (EL) used the frequency of course viewed (COV), files downloaded (FID), e-notes read (ENR) and videos viewed (VIV). The second subconstruct used user logins (ULI). The third subconstruct, critical thinking (CT) used posts created (POC) and workshop updated (WOU).

From Resource management construct, the fourth subconstruct, Peer learning involves engaging others during learning whenever needed. Students' use of peer learning strategies was measured using the number of discussions viewed (DIV), Wikis viewed (WIV), Workshop Viewed (WOV), WhatsApp posts (WHP) and Webinar attended (WEA). The fifth subconstruct, Effort regulation refers to e-learners' regulation of their own effort, including persistence during difficult or boring activities and tasks (Lee, & Recker, 2017; Pintrich et al., 1993). Learners' use of the effort regulation strategy was measured using the number of Quiz attempt viewed (QAV), Assignment Attempt viewed (AAV) and Project submitted (PRS). The sixth subconstruct, help-seeking is about the usage of other stakeholders whenever needed during the learning process, and was measured using the number of Discussions created (DIC), Wikis updated (WIU) and Q and A Posted (QAP).

From Metacognitive construct, the seventh subconstruct, Planning and goal setting used Dashboard viewed (DAV), Most preferred day (MPD) and, Most preferred time (MPT). The eighth subconstruct, monitoring used Quiz attempt reviewed (QAR). The ninth subconstruct, Self-assessment used Quiz attempt viewed (QAV). The tenth subconstruct, time-management, refers to students' efficient use of time (Lee, & Recker, 2017; Pintrich et al. 1993), and used the regularity of log-in intervals (intervals between login points) to measure time management strategy using Quiz attempt submitted (QAS), Assignment attempt submitted (AAS), Total time spent (TTS).

- Task Model: Where do we measure it?

The task model focuses on where we measure learner abilities, knowledge, or skill. It describes the tasks, situations, or environments that elicit the behaviors described in the evidence model. This research measured students' SRL in Moodle LMS. E-learners' activities related to SRL strategies (e.g., viewing learning materials, participating in online discussions) were used to elicit the variables described in the evidence model (Lee, & Recker, 2017).

Figure 2 gives a summary of the CAF to measure students' use of Resource Management SRL strategies using Moodle LMS trace logs and how the student, evidence, and task models are related to each other.

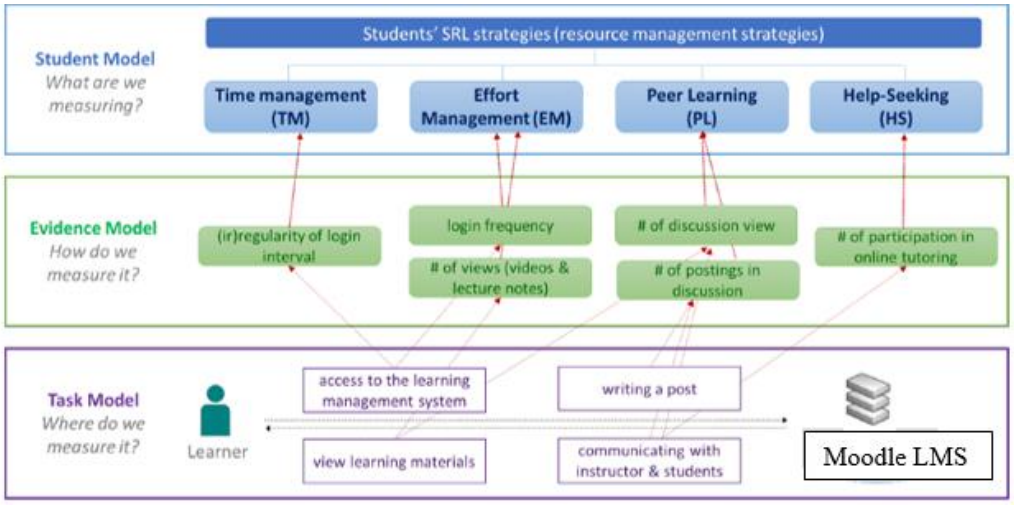

Figure 2: Conceptual assessment framework (CAF) to measure students' use of Resource Management SRL strategies (Adapted from Lee & Recker, 2017)

4.1.2 Motivated Strategies for Learning Questionnaire (MSLQ)

For this study, the Motivated Strategies for Learning Questionnaire (MSLQ) was also used to measure SRL as a self-report instrument (Pintrich et al., 1993). This instrument is considered an aptitude measure of SSRL, as it regards self-regulation as a student's typical attribute and over time, it aggregates students' responses (Zimmerman, 2008). Throughout the learning process, the ability of learners to use self-regulated strategies keeps changing and is not static (Dignath et al., 2008).

Socially-shared and self-regulated learning strategies were measured using the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich, et al., 1993). It is a self-report instrument designed to assess college students' motivational orientations and their use of different learning strategies for a college course (Pintrich et al., 1993). It was used in data collection, as it has made a major contribution to the SRL field (Pintrich et al., 1993b). Researchers have indicated that MSLQ has a strong reliability and sound validity (Pintrich, Smith, Garcia & McKeachie, 1991; Pintrich, Smith, Garcia & McKeachie, 1993) within traditional higher educational settings hence can fit well in online contexts. The MSLQ is a self-reporting tool with 81 items, divided into a Motivation section with 31 items, and a Learning strategies section with 50 items which are subdivided into three general types of scales: cognitive, metacognitive and resource management (Duncan and McKeachie, 2005). The resulting questionnaire used a seven-point Likert scale ranging from 1 ("not at all true of me") to 7 ("very true of me") with no specific labels for the other response categories, as shown in Table 1 below.

Self-reported data from learners via instruments like surveys, SSRL quizzes, questionnaires, interviews, MSLQ and its subsets (Araka, et al., 2020). Some studies have found MSLQ as being the most used instrument in investigating students' motivation and SRL strategies (Honicke and Broadbent, 2016; Duncan and McKeachie (2005); Moos and Ringdal, 2012). This emphasizes the highly significant impact of Pintrich's MSLQ in SRL (Broadbent, J., & Poon, W. L., 2015). This research adopted the MSLQ questionnaire and customized it to suit the research objectives within a SRL e- Learning environment.

Table 1: Summary of the MSLQ Research Questionnaire Items Used in the Study

Item No.	Type	Information Gathered
Items 1-9	Multiple choice	Demographic information
Items 10-15	Checkboxes	Commitment And Experience With E-Learning:
Items 16-22 (1-7)	Likert Scale	Experience with Self-Regulated Learning (SRL) Strategies: Metacognitive Activities BEFORE Learning
Items 23-29 (8-14)	Likert Scale	Experience with Self-Regulated Learning (SRL) Strategies: Metacognitive Activities DURING Learning
Items 30-35 (15-20)	Likert Scale	Experience with Self-Regulated Learning (SRL) Strategies: Metacognitive Activities AFTER Learning
Items 36-40 (21-25)	Likert Scale	Time Management
Items 41-44 (26-29)	Likert Scale	Environmental structuring
Items 45-51 (30-36)	Likert Scale	Persistence
Items 52-57 (37-42)	Likert Scale	Help seeking

4.1.3 Learning Analytics dashboard using personalized feedback and prompts

Today, Learner analytics (LA) is seen as a fast-growing field that focuses on utilization of educational data which is generated from LMSs. Upon collection of learners' log data, analysis is done so as to make inferences which can generate patterns, inform and understand e-learners' interactive behavior while learning. Learning analytics (LA) technology is the process of measuring, collecting, analyzing and reporting learners' data in their context, so as to understand, measure, optimize student learning process, experience, and the e-learning environment, with an objective of improving QEE on the overall performance outcomes (Baars, & Viberg, 2022; Long & Siemens, 2011). With the application of LA during e-Learning, there is a possibility of measuring key indicators of learner performance, supporting development of students SRL skills, improving decision-making, improving learning outcomes, motivation and informing institutional strategy (Verstege et al., 2019; Azevedo et al., 2010; Davis et al., 2016).

Visualizing LA data and understanding student behavior with the support of SSRL factors on LA intervention can enhance online student interactions leading to better engagements among e-learners (Kaban, 2023). LA-based approaches could be applicable in measuring and supporting e-learners SRL (Pardo et al., 2019) with little support being offered to adopt SSRL through LA (Viberg, Khalil, & Baars, 2020). LA would be very important in supporting e-Learners in developing their ability for regulation of their own learning across collaborative e-Learning environments (Viberg, Khalil, & Baars, 2020).

Web-enabled feedback and Prompts were employed in this study to provide personalized feedback to e-learners. Such feedback was facilitated through the use of LA reports submitted to the course administrator and instructor who then used the feedback to assess e-learners' application of SSRL strategies (Cho & Shen, 2013; Winne & Hadwin, 2013).

In this study, LMS log data was collected, recorded, and carefully integrated into LA-based personalized dashboard for participants in the experiment group. The flow chart in Figure 3 illustrates how LA-based personalized interventions were generated. In this study, learning analytics included a range of log data, such as students' login records to the LMS (e.g., the days and numbers of the students' logging in and off the LMS), numbers of views of the video recording of lectures, frequencies of reading the e-book, the number of messages posted on the discussion forum, the number of weekly tests they took, and their test scores as well (Ustun, et al.,2022).

LA-based personalized dashboard interventions were provided to each student in the experimental group once a week for 10 consecutive weeks. These personalized interventions were pushed to each student via the messaging feature on the LMS (Ustun, et al.,2022). LA-based interventions were provided as individual, customized feedback and prompts to each student in the experiment group. The content of such messages was based on students online learning behaviors as reflected in the LMS log data and the records of their testing attempts and results (Ustun, et al.,2022).

The graphics in the LA dashboard was interpreted with concise explanations, and LA-based personalized messages included specific recommendations for actions (Ustun, et al.,2022). For example, the LA-based feedback and prompts read like,

> *"You have never viewed this week's Session 1 video and e-Notes.*
>
> *You need to work on the videos to be able to do Assignment 1 successfully."*

Or,

> *"You participated in the Wikis collaboration forum only once in week 4. Increased participations in discussions will be beneficial for your Quality Educational Experience."*

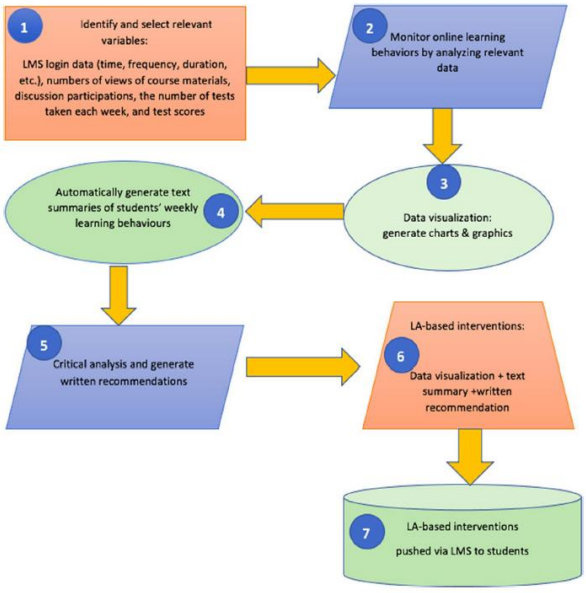

Figure 3: Creation process of LA-based personalized interventions on SSRL (Adapted from Ustun, et. Al., 2022)

4.2 Research Question2 Results

RQ2: Which features can be mapped to LMS factors to develop a SSRLA instructional support model to best predict the performance of e-learning students based on their SSRL skills?

4.2.1 Feature mapping of SRL strategies to LMS factors

Traditionally, the self-regulatory aspects of students' metacognition have been measured using questionnaires. However, research on SSRL measures has shown that learners can be inaccurate in calibrating their learning behaviors (Sanne et al 2019; Zhou & Winne. 2012). There is contention among some researchers (Greene and Azevedo, 2010) that students are not accurate reporters of their behaviors and therefore we should question the validity of self-reported measures. On the other hand, other researchers e.g. (Karabenick and Zusho, 2015) emphasize the importance of understanding students' conception of themselves.

Since disagreements exist regarding SSRL measurements, particularly whether self-reports represent a valid and reliable approach to measuring these processes, researchers have advocated the use of behavioral data (Zhou & Winne. 2012). Learning analytics techniques were used via Moodle LMS logs to generate simple metrics in order to assess learner's proficiency in self-regulation. This approach provided promising insight into learning processes as an alternative to traditional approaches for measuring self-regulated learning. From Table 2, this was done by examining the frequencies of students' SSRL behaviors as revealed from the system logs and the relations between SSRL behaviors and student learning performance (Zheng, Xing, & Zhu, 2019). Additionally, questionnaires were used in order to assess whether students were aware or not of the strategies they used, by comparing their answers with the observed learning sequences.

In this study, we have defined a simple, reduced set of SSRL categories so that the reported data is presented in such a way that is easy to understand and interpret (Figure 4). As for which categories to choose, we considered the ones that have been observed to be most correlated with academic performance, according to studies such as the ones just cited. Furthermore, we made sure that our available data could be directly associated to these categories. In the end, we have settled with the following five categories: cognitive strategies, resource management strategies, metacognitive strategies, learner characteristics, and QEE on performance.

Table 2: Summary of SRL Features, Strategies, Variables and Measures for LMS Log metrics (Source: Authors)

Student Model **(What are we measuring?)**				**Evidence Model** **(How do we measure it?)**
SSRL Strategy	**Description**	**Variables**	**Operational definition**	**Measures and Indicators** **(Moodle LMS sub-variables)**
Cognitive	Learner integrates new information with prior knowledge.	Elaboration	• The ability to link new and existing information with a goal of recalling new contents	• Course viewed (COV) • Files downloaded (FID) • E-Notes read (ENR)
	Learner selects appropriate information	Organization	• A learner's capability to underscore major concepts covered during learning	• User-logged in (ULI)
	Learners apply previous knowledge to solve problems	Critical Thinking	• Learner's ability to scrutinize online learning content carefully	• Post created (POC) • Workshop Updated (WOU)
Resource Management	Manipulating available resources and maximize	Peer Learning	• Using a study group or friends to help learn	• Discussion viewed (DIV) • WhatsApp Posts (WHP) • Webinar Attended (WEA)

Student Model **(What are we measuring?)**				**Evidence Model** **(How do we measure it?)**
	learning environments			• Wikis Viewed (WIV) • Workshop Viewed (WOV)
		Effort Regulation	• Persisting in tasks • Active participation	• Quiz attempt reviewed (QAR) • Assignment Attempt Viewed (AAV) • Project Submitted (PRS)
		Seeking Help	• Seeking help from peers or instructors when needed	• Wikis Updated (WIU) • Q & A Posted (QAP) • Discussion created (DIC)
Metacognitive	Improve performance by assisting learners in checking and correcting their behavior as they proceed on a task	Planning and Goal setting		• Dashboard viewed (DAV) • Most Preferred Day (MPD) • Most Preferred Time (MPT)
		Monitoring		• Quiz summary viewed (QSV)
		Self-assessment		• Quiz attempt viewed (QAV)
		Time management	• Using their time well • Regularity of log-in interval	• Quiz attempt submitted (QAS) • Assignment attempt submitted (AAS) • Total Time Spent (TTS)
Learner Characteristics	Showing prior-experience	Extrinsic motivation	• Average score in Motivation & experience	• Prior Experience (PRE) • Learner Motivation (LEM)
QEE on Performance	Showing improvement on activity engagements.	Scoring a grade on quiz or projects	• Setting and pursuing learning goals	• Average Quiz Grade (AQG) • Total Activity Engagements (TAE)

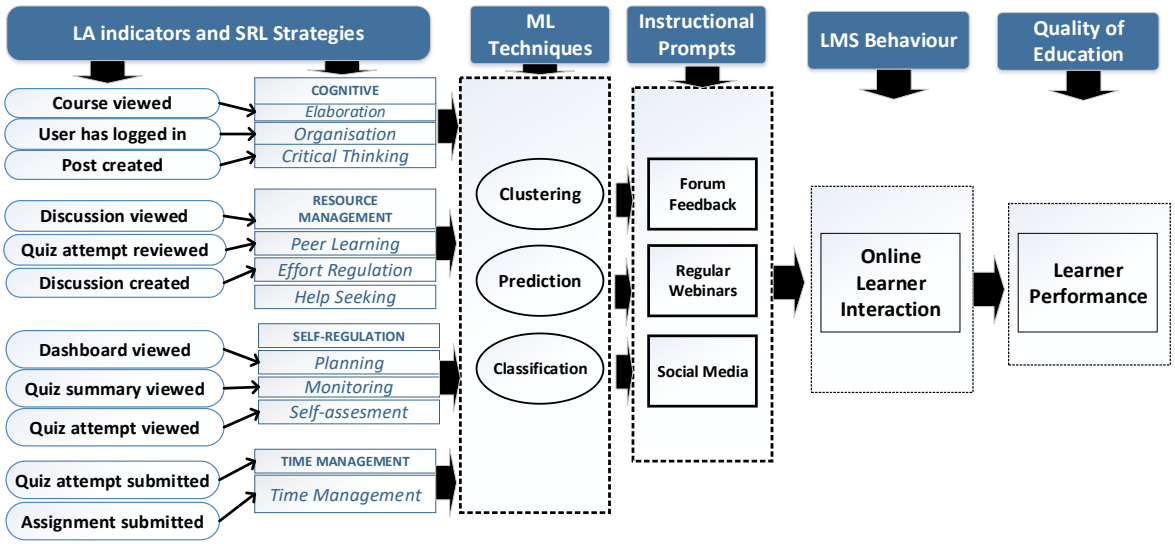

Figure 4: The SSRLA instructional support model with features mapped to LMS factors (Source: Authors)

5. Discussions and Findings

The purpose of this study was to investigate the effect of Learning Analytics intervention using prompts and feedback on e-learners' SSRL strategies in an e-learning context. The findings indicate that LA-based support has the ability for measurement and provision of intervention which would stimulate e-learners SSRL skills while learning online. Through this, the researchers were able to provide SSRL factors and strategies that could be adopted as interventions to student SRL and its implications for advanced LA-based research, concurrent with studies by Nguyen, et al., 2022, and Kim et al., 2018.

The findings confirm that LA scaffold using Prompts and Feedback can support e-Learners in developing their ability for regulation of their own learning across SSRL Moodle e-Learning environment, and this concurs with findings from Viberg, Khalil, & Baars, 2020. This can be categorized into three Strategies. First, Cognitive strategies, which describes how the e-Learner integrates new information with prior knowledge, selects appropriate information and applies previous knowledge to solve problems. Secondly, Resource management strategies, which entail manipulating available resources and maximize learning environments. The provision of consistent information on learners' use of cognitive tools during the learning process was made possible by log files traces (Malmberg et al., 2014). Third, Metacognitive strategies which improve performance by assisting learners in checking and correcting their behavior as they proceed on a task

Based on e-learners' log data from the Moodle LMS, SSRLA-based intervention can offer visual feedback that are simple to perceive and understand. As frequently advised by researchers (Ustun et al., 2022; Viberg, Khalil, & Baars, 2020; Schumacher & Ifenthaler, 2018; Yilmaz & Yilmaz, 2020; Uzir et al., 2020), they also include tailored prompts and feedback recommendations.

The study looked at how university students' QEE based on their SSRL skills was affected by LA-based interventions. In order to encourage and remind e-learners to plan, monitor, and manage their own learning progress during e-learning sessions, LA-based feedback and prompts were used consistent with Yilmaz & Yilmaz, 2020. This research confirms that LA-based feedback and prompts, along with highly individualized, informative recommendations, are necessary to maintain e-learners' engagement and motivation (Ustun et al., 2022).

It is notable that self-reported-instruments like the MSLQ are still being used to measure SSRL, so as to give a clear analysis and report on the preference and behaviour of e-learners. The feedback generated by the LA instrument will enable instructors and course administrators to provide better scaffolding to the e-learners for a more engaging and motivated learner experience. LA scaffolds will also be able to give early warnings especially to at-risk learners so as to lower the attrition rates. This proposed SSRLA model can be used in the implementation of the current "third wave" of SSRL measurement in e-learning contexts. So as to curb the challenges encountered when using self-reported instruments like MSLQ, the researchers propose the use of LA techniques to measure SSRL in collaborative e-learning environments.

6. Conclusion and Recommendation

This study was set to establish the effect of LA intervention on SSRL strategies intervention using prompts and feedback on e-learners' SSRL strategies in a socio-cognitive e-learning environment and to develop an LASSRL model based on these factors. The potential of LA techniques in measuring task-specific SSRL process on a collaborative e-learning context over time has been established in this study. The study is based on the social cognitive theory, with the most modelled SRL strategies being cognitive, resource management and metacognitive.

This research focused on Learning Analytics instructional support on learners in an e-learning context and it matters because the proposed intervention, has indicated improvement to Quality Educational Experience (QEE), performance and motivation measurement through the SSRL behavioral patterns of learners.

The success of SSRL is tied to the support from instructors and academic counselors, particularly feedback on previous problems and quizzes, which are regarded as environmental conditions (Hadwin & Oshige 2011), as well as their personal perceptions and efficacy. This study derives its motivation on the fact that without adequate utilization of the trace data, critical information about learners' behavior patterns in terms of their online interactivity with the course activities and their SSRL profiles and strategies cannot be disclosed leading to little improvement of e-Learning interventions (Lodge et al., 2019). Recent studies confirm that more experienced e-learners who make use of appropriate SSRL strategies in constructing and selecting courses of actions to improve their QEE, are believed to be better able to self-regulate during learning than inexperienced ones.

The empirical literature reviewed explicitly discussed the relevant potential of LA to measure and support SRL, but was limited to providing more options for improving learning support on SSRL. This suggested that Learning Analytics support needed to be critically examined further to understand how it could be effectively transformed into teaching to improve students' conditions for SSRL in collaborative e-Learning contexts. The potential of improving students' QEE and learning outcomes were also explicitly underlined. The proposed SSRL model will be useful in blended e-learning environments for Universities from Sub-Saharan region and beyond.

Authors' Contributions

All the authors, GLA, RO, and LM, approved and equally contributed to the final manuscript for submission. They all made substantial conceptual contributions, gathered and analyzed the data. They also drafted and critically revised the manuscript in keeping with scholarly guideline, and have provided final approval before publishing. They have agreed to be accountable for the accuracy of this publication work.

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Availability of Data and materials

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The authors declare that they have no competing interests.

Ethics

This article is original and contains unpublished material. Both the corresponding author and the co-authors confirm that they have read and approved the manuscript and that no ethical issues are involved. The authors declare that they have no competing interests. The researchers sought ethical approval from Kenyatta University Ethics Research Centre and NACOSTI. Student's participation was on a voluntary basis during the survey and experiment processes. This assurance was necessary to eliminate any ethical issues that could be raised from experimenting with curriculum material and knowingly disadvantaging some students. Before the experiment was undertaken, the study anonymized datasets and information collected, by replacing them with anonymous IDs.

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EJEL Editorial 2024: The Allure of AI in Education

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Abstract: The objectives of this editorial are to provide a brief overview of the themes of EJEL papers published in 2023, compare these themes with the areas of work suggested in the previous Editorial (Charbonneau-Gowdy, et al., 2023), and propose new areas of focus for future research. The present Editorial will primarily concentrate on the main challenges arising from the release and use of GPT-3 and GPT-4 in 2023.

Keywords: e-Learning, AI, AT chatbot

1. Introduction

We start this year's Editorial by sharing some key figures from the previous year of publications in EJEL.

The number of submitted and accepted papers in 2023 increased by 2% and 16% respectively compared to the previous year (2022:282 /32, 2023: 287/37).

To address some of the gaps in EJEL publications identified in our previous editorial (2023), we launched three special issue (SI) calls in 2023: i) Educational Escape Rooms (SI EER), ii) Artificial Intelligence in education (SI AI) and iii) Extended Realities for Learning (SI XR). Currently, there are 17 published papers from these SIs (2 EER, 7 AI and 8 XR), however, they are not included in the sample of papers discussed in this editorial, as their date of publication is in 2024.

There were 33 papers published in 2023 (including the editorial and one experience report) spread across 5 issues in Volume 21 and with authors from 20 different countries. These papers reflect various methodologies including quantitative (N=21, 64%), qualitative (N=16, 48%), systematic literature review (N=7, 21%) and design science research (N=3, 9%), focusing mainly on tertiary education (N=24, 73%), and learners' perspectives (N=19, 58%). The research themes include general areas such as benefits and challenges of e-learning, students' performance, satisfaction, and engagement, but additionally more speci107-fic topics particularly around e-learning approaches (e.g., mobile learning, game-based learning, seamless learning, computer-supported collaborative learning, i.e. CSCL, flipped classroom), e-learning tools (e.g., MS Teams), and new e-learning issues such as technostress.

While the journal continues to pride itself on inclusivity and diversity of perspectives, the editorial team would like to encourage more submissions related to novel learning methods, technologies and emerging issues, including teachers' perspectives and at different educational levels.

In the previous editorial (2023), we reported some discrepancies between the subjects of the most popular EJEL publications and the areas of interest suggested by the EDUCAUSE Horizon report (Pelletier et al., 2022), the European Framework (Redecker, 2017) and recent e-learning reviews from major journals (Lara, Aljawarneh,

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and Pamplona, 2020; Zhang, et al., 2022; Martin, Dennen, and Bonk, 2023). While we recognise that it is still early for these findings to have an impact on the submissions this year, it is worth noting that the gaps identified in the previous editorial still are evident in the volume of papers published in 2023. For this reason, we repeat our call for more publications on the issues related to the economic, political, and environmental areas of e-Learning and challenges in the areas of assessment, AI, and hybrid learning spaces.

2. Literature Review

With the call for publications on these issues in mind, the focus of this section of the editorial is on artificial intelligence (AI). In it we provide a critical summary of the existing literature chosen by our editorial team as representative on this topic from the broad educational scholarship. Gaining an overview of the various topics related to AI that are being discussed in the e-learning scholarship hopefully can not only provide insight into AI in terms of what is expected to be its deep influence on education, but also an impetus for further research.

Generative Artificial Intelligence, or GenAI, is described as a technology that accesses deep learning models, i.e. patterns and structures that have been "taught" to it through input training, to generate text, images, videos, or other data in response to prompts. ChatGPT, DALL-E and Bard are some now well recognized examples of GenAI. How these tools will affect both learning and learners, indeed education as we know it, is a matter of increasing concern and discussion in scholarship. We have chosen four articles to provide an overview of this discourse.

A recent study by Chan and Hu (2023) offers new insights into generative AI (GenAI) in higher education (HE), with a focus on student voices. The authors argue that although students, like faculty, are often most affected by the decision to use new technologies in learning contexts, they are rarely involved in discussion. The aim of their research is to understand students' familiarity with and their attitudes towards AI and thus to inform universities about adopting GenAI in teaching and learning across the disciplines. Drawing on the results of a survey (*n=399*) with undergraduate and postgraduate Hong Kong students, the authors report on generally positive attitudes towards GenAI citing such features as its personalised learning support and its brainstorming and analysis capabilities. Students were also aware of various issues and challenges surrounding GenAI – especially those related to academic integrity, ethics, and privacy. Concerns around accuracy were expressed as well. Theoretically, the study is grounded in Davis' (1989) user acceptance theory and the writings of Biggs' (1999, 2011) both of which are tied to the importance of student perception and its impact on their learning and its outcomes. In other words, students who perceive their learning environment positively are more likely to succeed in it. The findings demonstrate that while students are knowledgeable of GenAI, they are also careful and cautious about its use. Their positive perception is important for educators and HE institutions to build on as they consider whether and how to integrate GenAI (and other technologies) into teaching and learning in a mindful and ethical way that capitalises on students' existing knowledge without compromising academic integrity and sacrificing privacy.

The second article we reviewed was conducted by Chiu (2023) and addresses the increasingly pivotal role that GenAI tools such as ChatGPT and Midjourney are playing in transforming educational practices, policies, and research directions. The author highlights the lack of extensive discussion on GenAI's impact, particularly in school settings, despite its growing integration into higher education. The study focusses on the perspectives of teachers and leaders and is framed around a systematic review of the literature into the role of AI in four key educational domains: learning, teaching, assessment, and administration. The aim was to uncover how GenAI is reshaping school education in these four areas and influencing student and teacher outcomes from participants' perspectives. The qualitative study involved 88 schoolteachers and leaders from various backgrounds who participated in surveys and focus groups after attending GenAI technology workshops. A hybrid thematic analysis was employed to generate themes and subthemes reflective of GenAI's impact on educational practices and policies. Findings suggest that GenAI promotes a re-evaluation of educational goals, highlighting the importance of AI literacy, critical reasoning, digital media, information literacy, and generic skills development. The insights and implications of the study both for teaching and policy indicate the need for: i) teacher professional development that focuses on curriculum leadership, AI literacy, facilitating skills, and interdisciplinary teaching approaches; ii) a shift in assessment practices toward more formative approaches and those that assess generic skills and AI literacy; iii) training of administrative staff to leverage these technologies to improve efficiency in their tasks; iv) incorporating AI more broadly across the institution and v) rewriting educational standards to include AI literacy.

In a third study, Urban, et al. (2024) experimentally compared two groups of university students who were asked to fulfill a written task on improving product sales of a company. Drawing on hybrid human-AI regulation theory

(Molenaar, 2022a; 2022b), the aim of the study was to examine the impact of ChatGPT on problem solving performance, i.e. the quality, elaboration, and the originality of the solution. Participants were divided into 2 groups. The experimental group (*n=77*) used ChatGPT for solving the problem within the assigned task, while the control group (*n=68*) solved the task without ChatGPT. ChatGPT was used by the experimental group as a support in finding at least three solutions for an appointed problem in the task. The dependent variables investigated were originality, creative problem-solving, on-task self-efficacy, self-evaluation, perceived task interest, perceived task difficulty, and perceived mental effort. While the ChatGPT group reported more on-task self-efficacy, less mental effort, and achieved higher performance compared to the control group, ChatGPT did not make the task more interesting. The authors argue that GenAI tools such as ChatGPT can help learners develop or enhance their own ideas, instead of replacing them and likewise improve on the quality of their solutions. Yet, results on participants' self-evaluation of performance showed that perceived usefulness and ease of task resolution by using ChatGPT did not automatically lead to more useful and original solutions. Further, prior experiences with GenAI tools were found to influence the quality, self-elaboration, and originality of the ideas.

The fourth paper we reviewed by Klyshbekova and Abbott (2023) examines the capabilities/limitations of ChatGPT-3 in terms of assessment and its disruptive innovation capabilities. The authors created a fictional essay topic and rubric and then evaluated the output of ChatGPT. ChatGPT was assigned to write an essay on a given topic, to follow a specific reference style and to assess its own work based on Paul's (2005) Intellectual standards rubric for quality control. The 6-week experiment involved a 5-step iterative query process prompting ChatGPT: 1) to write an introduction to the topic on Technology in Education inclusive of context and the aims of the article; 2) to develop an argument supported with a rationale based on its pre-mentioned introductory arguments and including five appropriate references; 3) to author a conclusion supported by the pre-mentioned arguments without the addition of new information; 4) to design a rubric and 5) to rate its own essay using the rubric produced. The authors evaluated the output first using Paul's (2005) rubric criteria - clarity, accuracy/precision, relevance, depth of logic and fairness. They then further applied a disruptive innovation lens asking GPT to reassess its output with an author-designed rubric. Generally, the results demonstrated ChatGPT-3's capabilities to produce an essay on a specific topic but with disappointing results – the essay being deemed generally descriptive and repetitive in nature with limited perspective in terms of referencing key scholars and lacking creativity and proficiency nor managing to keep within the required word count. Findings also revealed issues with ChatGPT's generated rubric in terms of design, marking scheme and grading. While ChatGPT evaluated its output at 91/100, the authors assessed it at 41/100 due to its generic nature and lack of depth of analysis. The authors concluded that ChatGPT is not yet at the disruptive innovation stage, but only completing the "illusion of complete assessment capabilities."

Each of the four articles summarized above offers a window into recent research into GenAI and its emerging capabilities and limitations in a variety of educational settings and for diverse uses. They also open a dialogue for further inquiry. Despite the different methodological approaches adopted in each of these studies, it is worth noting that the authors reach an important consensus regarding the emergent use of AI. The authors concur that regardless of i) the level of education, ii) whether AI be employed for teaching, learning and/or assessment, iii) in administration areas or for other institutional functions, access and experience with AI must be assured for all and be used to promote privacy and ethical behaviours. While their findings shed light on both the capabilities and limitations of GenAI, they open the door to myriad questions and invite further empirical analysis.

Just as a growing number of other researchers, members of our editorial team are also adding to this discourse by responding to the increasing AI questions that are being raised. Their scholarship reports on such topics as:

- Understanding the paradoxes of GenAI (friend/foe, capable/dependent, accessible/restrictive, popular/banned) with a view to exploiting it as a potential impetus in transforming education (Lim, et al., 2023)
- Data justice and fairness in AI usage for the good of learning and learners. (Pechenkina, 2023)
- Providing a synthesized view of the empirical research conducted in the last decade on AI and what it can tell us about where and what research in AI is being carried out. (Marengo, et al., 2023)
- The capabilities of AI in writing a conclusive bachelor's thesis. (Schwenke, Söbke and Kraft, 2023)

It is important to note that the authors of each of the papers in this literature review take a positive stance regarding the use of AI and its possibilities for improving learning. Yet, at the same time they recommend caution about the "how" it is used and its limitations. It is evident from the variety of topics covered in the combined

literature in this review that there is much left to be explored about GenAI and its present and potential impact on education.

3. Discussion

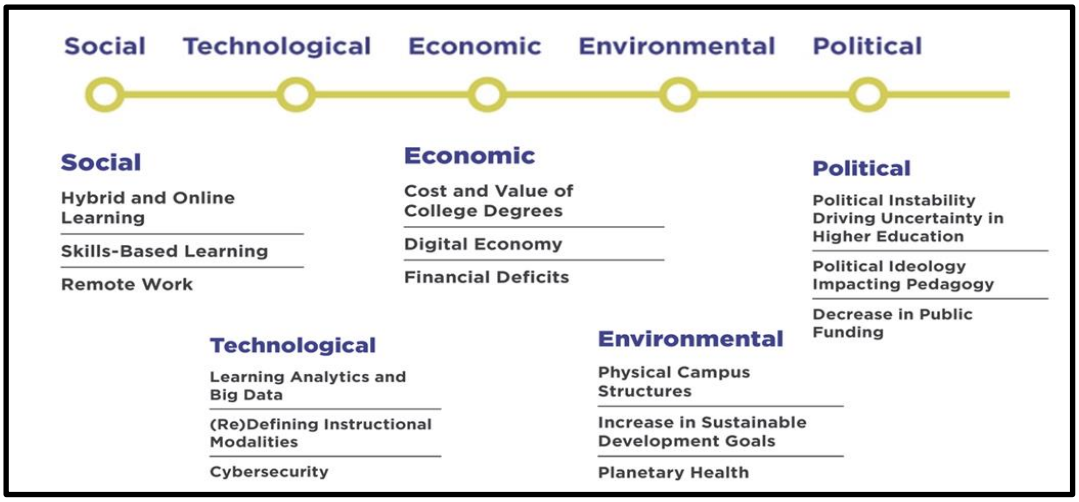
While acknowledging that our sample is not comprehensive, a deeper analysis of the representative literature in this brief overview mapped against the gaps in research that were highlighted in our previous EJEL Editorial offer some interesting insights. Most notably is the fact that these papers suggest a growing interest on the part of researchers to target AI as a topic of critical interest to explore. Also, evident in this particular sample of the AI literature are the following observations:

- an emphasis on a human rather than a system perspective, for example on giving voice to teachers and on the personalization potential of GenAI.
- a general expression of cautiousness on the part of educators, students, institutions, and researchers about the use of GenAI and its current capabilities.
- a preference for evidence-based research as opposed to technical, theoretical and conceptually based reports that are primarily quantitative.
- a focus on the tertiary level rather than the broader context of education.
- attention being given to the topic of assessment.

In the kinds of studies called for in our earlier Editorial, categorized under the headings *pedagogy, people* and *systems* focussed, we can see that researchers in this sample of AI reports are responding both in terms of assessment (*pedagogy*), in terms of teachers' and learners' perspectives and the personalization of learning (*people*) as well as security and privacy concerns (*systems*). Collectively, these AI studies also reflect a response to the gaps cited by the American-based Educause under their *Social* and *Technological Practices* categories and repeated by the European Framework for Digital Competences of Educators (EFDCE) for attention given to the area of *Assessment.*

Most noticeable in this literature is the glaring lack of empirical evidence for professional development and instructor training. While much of this scholarship underscores the critical need for action and research in training educators in the use of AI and indeed add important knowledge on this topic, none offer clear grounded evidence of this training being carried out *in practice*. We reiterate the urgent need for this empirical evidence.

In terms of the classifications cited in our earlier Editorial for more research related to the digital formation of educators, which is an area underlying both the European Framework for Digital Competences of Educators (2017) and the EDUCAUSE macro trends (Figure 1), of particular interest as we cited above are those related to the *environmental*, *political* and *economic* tensions around professional development in e-learning generally, but in AI specifically.



Source: First published, in 2022, in EDUCAUSE Horizon Report Teaching and Learning by Pelletier et al. (2022) under the Creative Commons licence CC BY-NC-ND 4.0 .

Figure 1: EDUCAUSE Horizon Report: Macro Trends in Postsecondary Teaching and Learning (Pelletier et al., 2022)

These areas are closely tied to concerns for education in the 21st century and the potential for the deep impact that AI will have on this and all areas of our lives. We see it as our combined responsibility as a journal and as researchers to respond and promote empirical research in teacher formation in AI with these perspectives in mind.

4. Conclusions

The enthusiasm that is evident in researchers' responses to the calls for scholarship for EJEL's special issues over this last year, is indeed encouraging. It is obvious judging by the level of this response that scholars are concerned about the emergent power of technology and about ensuring that stakeholders in education are well informed of its use in learning contexts and in ways that matter. Yet despite this enthusiasm and the new knowledge that this scholarship represents, most of us can admit that we have still much to learn ourselves about ways to harness this power for the good of education for all.

Encouraging as well are the findings from the individual papers that are summarized in our review of the literature on the latest GenAI technology. The review indicates that some of the gaps cited in our previous Editorial are being targeted in these studies such as those pertaining to *assessment* (pedagogy), *teachers' perspectives* (people) and *ethical/security issues* (systems). Of course, adding further to this discourse and to the need for empirical research that connects theory to practice on these topics in e-learning, remains essential. Whether it be on e-learning topics more generally or GenAI specifically, empirical studies related to *teachers' perspectives* and the *political*, *economic,* and *environmental* aspects of their *digital competency development* remain high on the list of areas needing to be addressed. Recognizing that when it comes to e-learning, indeed all institutional learning, educators and their practices are the closest link we know of to quality learning results, it lies within our key mandate as a journal and research community to contribute and promote further dialogue in this vital area of research.

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