iafor

journal of education technology in education

Volume 10 – Issue 2 – 2022

Editor: Michael P. Menchaca

Editor-in-Chief: Joseph Haldane

ISSN: 2187-0594

iafor

IAFOR Journal of Education: Technology in Education
Volume 10 – Issue 2 – 2022

IAFOR Publications

The International Academic Forum

IAFOR Journal of Education: Technology in Education

Published by The International Academic Forum (IAFOR), Japan
IAFOR Publications, Sakae 1-16-26-201, Naka-ward, Aichi, Japan 460-0008

Executive Editor: Yvonne Masters

IAFOR Journals Administrator: Ruth Mund
Publications Manager: Nick Potts

IAFOR Journal of Education: Technology in Education
Volume 10 – Issue 2 – 2022

Published August, 2022

ISSN: 2187-0594

ije.iafor.org

IAFOR Journal of Education: Technology in Education

Volume 10 – Issue 2 – 2022

Edited by Michael P. Menchaca

Associate Editor: Daniel Hoffman

Associate Editor: Devayani Tirthali

Foreword

There can be little doubt that the technology that we have come to rely on today makes and shapes our modern lives. Technology's role within education over the past few years during the global pandemic has highlighted its importance and centrality. IAFOR would not be able to operate and facilitate its global platform without ever-better and more refined tools, and the example of this finished journal is testament to this.

This Technology in Education issue of the *IAFOR Journal of Education* is the result of collaborative human endeavour and technology, as indeed its scope centres on that very intersection. I would like to thank everyone involved in making this issue possible. The finished product is a truly international effort, involving many different scholars, as authors, as reviewers, as editors, as senior administrators; and not to forget the dedicated publishing team.

In keeping with the international, intercultural and interdisciplinary mission and spirit of IAFOR, the articles in this journal are from authors around the world and reference many different fields. Within these pages are examples, findings and results from studies across the world which readers, drawing on their own contexts, will find of comparative and contrastive interest.

These articles should be seen as a window to the world, from wherever you happen to be in the world.

Happy Reading,

Joseph Haldane
Editor-in-Chief
IAFOR Journal of Education

Editorial Advice

Preparing a submission to the *IAFOR Journal of Education* is more than writing about your research study: it involves paying careful attention to our submission requirements. Different journals have different requirements in terms of format, structure and referencing style, among other things. There are also some common expectations between all journals such as the use of good academic language and lack of plagiarism. To assist you in reaching the review stage for this or any other peer-reviewed journal, we provide the following advice which you should check carefully and ensure that you adhere to.

1. Avoiding Plagiarism

Plagiarism is a practice that is not acceptable in any journal. Avoiding plagiarism is the cardinal rule of academic integrity because plagiarism, whether intentional or unintentional, is presenting someone else's work as your own. The *IAFOR Journal of Education* immediately rejects any submission with evidence of plagiarism.

There are three common forms of plagiarism, none of which are acceptable:

1. ***Plagiarism with no referencing***. This is copying the words from another source (article, book, website, etc.) without any form of referencing.
2. ***Plagiarism with incorrect referencing***. This involves using the words from another source and only putting the name of the author and/or date as a reference. Whilst not as grave as the plagiarism just mentioned, it is still not acceptable academic practice. Direct quoting requires quotation marks and a page number in the reference. This is best avoided by paraphrasing rather than copying.
3. ***Self-plagiarism***. It is not acceptable academic practice to use material that you have already had published (which includes in conference proceedings) in a new submission. You should not use your previously published words and you should not submit about the same data unless it is used in a completely new way.

2. Meeting the Journal Aims and Scope

Different journals have different aims and scope, and papers submitted should fit the specific journal. A "scattergun" approach (where you submit anywhere in the hope of being published) is not sound practice. Like in darts, your article needs to hit the journal's "bullseye", it needs to fit within the journal's interest area. For example, a submission that is about building bridges, will not be acceptable in a journal dedicated to education. Ensure that your paper is clearly about education.

3. Follow the Author Guidelines

Most journals will supply a template to be followed for formatting your paper. Often, there will also be a list of style requirements on the website (font, word length, title length, page layout, and referencing style, among other things). There may also be suggestions about the preferred structure of the paper. For the *IAFOR Journal of Education* these can all be found here: https://iafor.org/journal/iafor-journal-of-education/author-guidelines/

4. Use Academic Language

The *IAFOR Journal of Education* only accepts papers written in correct and fluent English at a high academic standard. Any use of another language (whether in the paper or the reference list) requires the inclusion of an English translation.

The style of expression must serve to articulate the complex ideas and concepts being presented, conveying explicit, coherent, unambiguous meaning to scholarly readers. Moreover, manuscripts must have a formal tone and quality, employing third-person rather than first-person standpoint (when feasible), placing emphasis on the research and not on unsubstantiated subjective impressions.

Contributors whose command of English is not at the level outlined above are responsible for having their manuscript corrected by a native-level, English-speaking academic prior to submitting their paper for publication.

5. Literature Reviews

Any paper should have reference to the corpus of **scholarly** literature on the topic. A review of the literature should:

- Predominantly be about contemporary literature (the last 5 years) unless you are discussing a seminal piece of work.
- Make explicit international connections for relevant ideas.
- Analyse published papers in the related field rather than describe them.
- Outline the gaps in the literature.
- Highlight your contribution to the field.

Referencing

Referencing is the main way to avoid allegations of plagiarism. The *IAFOR Journal of Education* uses the APA referencing style for both in-text citations and the reference list. If you are unsure of the correct use of APA please use the Purdue Online Writing Lab (Purdue OWL), – https://owl.english.purdue.edu/owl/resource/560/01/ – which has excellent examples of all forms of APA referencing. Please note APA is used for referencing not for the general format of the paper. Your reference list should be alphabetical by author surname and include DOIs whenever possible.

This short guide to getting published should assist you to move beyond the first editorial review. Failure to follow the guidelines will result in your paper being immediately rejected.

Good luck in your publishing endeavours,

Dr Yvonne Masters
Executive Editor, *IAFOR Journal of Education*

Table of Contents

From the Editors

The current issue comes to press amongst a sense of reflection and renewal within education. Prompted by the challenges of a global pandemic, many of us are contemplating how to make the field – and all that it encompasses – more nimble and flexible. The goal, of course, is to improve teaching and learning for everyone, everywhere. And, for readers of the Journal, it should come as no surprise that technology, in all its shapes and sizes, figures prominently in our collective search to improve what we do and how we do it.

It is within this broader context that the current issue's six articles are presented. Two of the articles focus on issues of education policy and technology. They ask key questions about the readiness of our educational systems and our ability to enact policies that align with the needs of modern learners. Another set of articles concentrates on the role technology is playing in the process of language learning – an ever-present need for life in our interconnected, multicultural society. The final two articles examine specific technology-enabled innovations. These works describe efforts to test the possibilities of digital tools designed to support diverse learners in different content areas. Taken together, these manuscripts continue the Journal's ongoing commitment to high-quality, interdisciplinary scholarship.

To help you get oriented, here is a brief summary of each article in the issue.

In the first article, Onuh and colleagues consider how internet connectivity affects students' capacity to meet assessment and learning expectations. Using a count data model, they provide evidence that students with poor internet connectivity tend to have higher rates of missed assessments. Conclusions advanced by the study encourage educational institutions to create online learning policies that align with the technical realities of the digital age.

Miço and Cungu, in their article titled, "The Need for Digital Education in the Teaching Profession," analyze the state of digital education in Albania. Employing a survey based on the European Digital Competence Framework, the authors pinpoint a number of specific areas of education in need of improvement such as teacher training and physical infrastructure. The article concludes by encouraging policy makers to consider ways to support regional and national efforts to enhance the system's digital development.

In the third article, Rottenhofer and colleagues share an interdisciplinary study exploring the use of computational thinking skills to support language learning. Using a multiple-case study approach, the work presents evidence that secondary language learners were medium to low users of learning strategies related to computational thinking. In the authors' view, strengthening these strategies is an avenue for enhancing language learning skills and preparing them their future professional lives.

In another manuscript focused on technology and language learning, Alvi shares an investigation of the influence of presence on the second language learning experience. Situated in India, this study extends the Community of Inquiry framework, by proposing a more comprehensive model that incorporates different forms of presence (e.g., emotional, technological). Conclusions shared in the paper indicate that accounting for different forms of presence should be considered when designing and implementing second language learning experiences.

In the fifth article, Mokmin and Ridzuan explore how to leverage immersive technologies to help students with learning disabilities benefit from physical education. Drawing on theories of motor and multimedia learning, the authors describe an application designed to make physical education more accessible for secondary students with disabilities. In the conclusion, the authors suggest that carefully designed immersive technologies coupled with appropriate learning material may extend physical education opportunities to a more diverse group of learners.

For the final article of the issue, Meletiadou presents a case study exploring educational digital storytelling as a mechanism for developing 21st century skills. Detailing findings based on quantitative and qualitative data, this mixed-methods study provides evidence that digital storytelling can help learners improve on a variety of cognitive, affective and interpersonal outcomes including writing performance, critical thinking skills, self-confidence, and intercultural awareness. The article concludes by discussing the implications of digital storytelling and suggesting some implementation strategies for higher education.

Overall, these articles illustrate the quality and variety of education-related scholarship happening around the world from Austria to the Philippines. Together they represent our collective effort (a) to understand how technology is influencing – directly and indirectly – the field, and (b) to position education to face the known and unknown challenges of the future.

Daniel L. Hoffman and **Devayani Tirthali**, Associate Editors
Michael P. Menchaca, Editor
IAFOR Journal of Education: Technology in Education
tech.editor.joe@iafor.org

Notes on Contributors

Article 1:
The Link between Internet Connectivity and Missed Assessments in the Online Class Modality

Willington Onuh is a Professor of Economics at De La Salle University Dasmarinas-Cavite Philippines. He earned PhD in Development Studies (major in Economics) from De La Salle University Manila Philippines in 2004. He was a Visiting Research Fellow at the Institute of Developing Economies (IDE) Chiba, Japan in 2005 and Visiting Professor at the School of Economics and Business Administration, Moraga California in 2009. He has written and published on issues related to health, poverty, education, development and business economics.
Email: willingtonoonuh@dlsud.edu.ph

Dr Olivia M. Legaspi is a full-time professor at the College of Education of De La Salle University- Dasmariñas (DLSU-D) in Cavite, Philippines, teaching undergraduate and graduate courses in curriculum and instruction, educational technology, and educational management, which also serve as her research interests. She obtained her EdD major in Educational Management degree in DLSU-D. She is an assessor of the Lasallian Schools Supervision Office (LASSO) and of the Commission on Higher Education (CHED) Institutional Sustainability Assessment (ISA), a member of the CHED Region IV-A Regional Quality Assessment Team (RQAT), and an accreditor of the Philippine Accrediting Association of Schools, Colleges and Universities (PAASCU).
Email: omlegaspi@dlsud.edu.ph

Dr Susan T. Mostajo is a professor and the Senior Director of Human Resource Management Office of De La Salle University – Dasmariñas (DLSU-D), Cavite, Philippines. She is registered both as Psychologist and as Guidance Counselor. She obtained her doctorate degree in Counseling Psychology at DLSU-D. She is affiliated with local and international professional organizations in her field of expertise. Currently, she is serving her third term as President of the Asian Association of School HRMD Practitioners, Inc. (AASHPI). As a research advocate, she has presented and published articles in various areas like human resource management, psychology, education, service science, and experience design.
E-mail: stmostajo@dlsud.edu.ph

Don S. Malabanan taught undergraduate and graduate level finance and economics courses at the De La Salle University-Dasmariñas in Cavite, Philippines from 2002 to 2022. He holds a Masters of Science in Computational Finance degree from De La Salle University, Manila, Philippines. He was the first CITI-FINEX Rafael B. Buenaventura Jr. Outstanding Finance Educator Awardee for Luzon (excluding NCR). His research and consultancy work focused on corporate finance, valuation, financial markets, and industry analysis. He has, likewise, been actively involved in institutional research at the tertiary level.

Rosario T. Reyes is a faculty member of De La Salle University-Dasmariñas, Cavite, Philippines and teaches Entrepreneurship and Finance. She earned her Master in Business Administration degree from the same university and is finishing a dissertation paper for Doctorate in Business Administration at the De La Salle University Manila, Philippines.

Article 2:
The Need for Digital Education in the Teaching Profession: A Path Toward Using the European Digital Competence Framework in Albania

Dr Heliona Miço is a lecturer of Public Law, in the Law department at "Epoka University" and researcher of human rights and the right to education, accreditation, child's rights and social justice. Dr. Miço was educated at Faculty of Law in University of Tirana, Albania and graduated with bachelor degree. She has defended her PhD at the Institute of European Studies, in University of Tirana with the theses "A general overview of the right to education in Albania. Development of this right in accordance with international standard and European legislation." She is involved as a researcher in "Introducing modules on law and rights in programmes of teacher training and educational sciences: A contribution to building rights-based education systems in countries in transition" (EduLAW) Erasmus+ Mundus Curriculum Development project and as a lecturer at the University of Salerno (UNISA), Italy for Teaching Mobility in the framework of the Erasmus+ Program.

Dr Jonida Cungu is a researcher in the field of lexicology and semantics, and lecturer at the department of linguistics at the Faculty of Humanities, University of Elbasan "Aleksandër Xhuvani". She finished her studies at the University of Elbasan "Aleksander Xhuvani", in the Faculty of Humanities, branch of language and literature. She has worked in pre-university education and higher education. She has completed in-depth university studies ("master" level) in the language department at the Faculty of History and Philology of the University of Tirana, and further doctoral studies in the field of lexicology and semantics. She finished her doctorate in 2016 and received the scientific degree "Doctor of Science". She is engaged in academic teaching activities in courses such as: introduction to linguistics, language training, general linguistics, semiotics. Her academic and scientific activity includes research in the field of lexicology and semantics, language culture and education.

Article 3:
Using Computational Thinking to Facilitate Language Learning: A Survey of Students' Strategy Use in Austrian Secondary Schools

Marina Rottenhofer is a university assistant in the department of STEM education at the Johannes Kepler University Linz, Austria. She is deputy head of the JKU COOL Lab, a teaching and learning lab for everyone focusing on computer science and digital education. In addition, she has been involved in various national and international projects on the topics of computational thinking, STEM didactics, talent promotion and brain-friendly learning. As part of her doctoral studies, she is investigating the use of computer science models as a teaching and learning strategy to promote computational thinking skills. Due to her teaching qualification in the subjects English and Italian, her dissertation focuses particularly on language teaching and learning.
Email: marina.rottenhofer@jku.at

Lisa Kuka started her academic education at the University of Applied Sciences St. Pölten, Austria with a specialization in Digital Media Technology and later on moved to the Johannes Kepler University, as well as the University of Art and Design in Linz, Austria for the Teacher Training Programme specialized in English, computer science and media design education. Next to teaching media design and applied computer science courses at a College for Higher Vocational Education, she works as a research and teaching assistant aspiring to gain her PhD

at the Department of STEM Education at the Johannes Kepler University Linz, Austria. Her research interests include AI in Education, computational thinking, and digital literacy.

Sandra Leitner is a research associate in the Department of STEM Education at the Johannes Kepler University in Linz, Austria. In addition, she is a teacher for Spanish, Psychology and Philosophy and teaches at a secondary school. Furthermore, she is active in the promotion of gifted students with her training as a European Consul of High Ability (ECHA). Since 2021, she has been working on her dissertation in the field of STEM education for girls, in which she investigates how girls become enthusiastic about STEM in creative learning environments and how to keep them enthusiastic from kindergarten to the workplace.

Dr Barbara Sabitzer has been a professor of instructional technology at the Johannes Kepler University in Linz, Austria, since 2017. There she is responsible for the training and further education of computer science teachers as well as for teaching computer science basics for other subjects. In addition, Barbara Sabitzer founded and leads the JKU COOL Lab, which offers workshops, clubs, advanced training and much more for children, young people and adults on the topics of computer science and digital education. As part of her habilitation, she worked on effective, brain-friendly teaching and learning methods and developed a flexible teaching concept (COOL Informatics), which forms the basis of the JKU COOL Lab and her teaching.

Article 4:
A Comprehensive Community of Inquiry Framework for Exploring Technology Enhanced Language Learning

Dr Irum Alvi is an Assistant Professor at the Department of Humanities, English & Applied Sciences University Departments, Rajasthan Technical University, Kota, India.
Email: irumalvi@gmail.com

Article 5:
Immersive Technologies in Physical Education in Malaysia for Students with Learning Disabilities

Dr Nur Azlina Mohamed Mokmin holds a Doctorate Degree (PhD) in Instructional System Development. Her work focuses specifically on the application of Artificial Intelligent, Virtual Reality, and Augmented Reality in education. Her current research is on the application of immersive technologies for medical and health studies. She is currently teaching in the Centre of Instructional Technology and Multimedia, Universiti Sains Malaysia (USM). Previously she worked at Malaysian Polytechnics before continuing her service with the government in USM. As the head of innovation for the center, she has done a lot of teaching, training, and developing various software projects. She also has won awards for innovation and her university services.

Nurul Nabilah Izzati Binti Ridzuan holds a Master of Instructional Multimedia and Bachelor of Computer Science (Hons.) Multimedia Computing from Universiti Sains Malaysia and Universiti Teknologi MARA (UiTM), respectively. Her related coursework are Multimedia Authoring, Virtual Reality and Computer Graphics (2D and 3D). She is experienced in using Adobe After Effects and 3ds Max.
Email: nabilahizzatiridzuan@gmail.com

Article 6:

Using Educational Digital Storytelling to Enhance Multilingual Students' Writing Skills in Higher Education

Dr Eleni Meletiadou is a Senior Lecturer (Associate Professor) in Equality, Diversity, and Inclusion in Higher Education at London Metropolitan University Guildhall School of Business and Law. She is an enthusiastic peer learning, writing, and assessment scholar and an award-winning researcher and adviser with over 20 years of international experience. She is the Chair of the European Association for Educational Assessment (AEA-Europe) Inclusive Assessment SIG and an Expert Member of the European Association for Language Testing and Assessment (EALTA). She is the Conference Track Chair of the British Academy of Management Knowledge & Learning SIG and the European Academy of Management (EURAM) Doctoral Accelerator Mentor.
E-Mail: elenim@outlook.com

The Link between Internet Connectivity and Missed Assessments in the Online Class Modality

Willington Onuh
De La Salle University-Dasmariñas, Dasmariñas City, Cavite, Philippines

Olivia M. Legaspi
De La Salle University-Dasmariñas, Dasmariñas City, Cavite, Philippines

Susan T. Mostajo
De La Salle University-Dasmariñas, Dasmariñas City, Cavite, Philippines

Don S. Malabanan
De La Salle University-Dasmariñas, Dasmariñas City, Cavite, Philippines

Rosario T. Reyes
De La Salle University-Dasmariñas, Dasmariñas City, Cavite, Philippines

Abstract

Many published papers provide insights on factors affecting learning performance; however, they do not address how internet connectivity affects students' capacity to meet assessment and learning expectations. To address this gap in the literature, we draw from a survey of 257 students at the undergraduate level to investigate two questions: (a) To what extent does internet connectivity affect missed assessments? and (b) How do students vary through the distribution of missed assessments? We used a count data model, specifically, negative binomial (NB) regression, to determine incidence rate ratios and odds of missed assessments. The NB results showed that students who indicated poor internet connectivity during the semester had about a five times higher incidence rate of missed assessments than students who did not indicate poor internet connectivity. Surprisingly, despite two-thirds of students reporting poor internet connectivity, the chance of accumulating seven missed assessments during the semester was very minimal. The results may provide insights to faculty and education policymakers at the institutional level on ways to design online learning to meet learning expectations.

Keywords: internet connectivity, learning performance, missed assessments, online modality

Since COVID-19 was declared a pandemic by the World Health Organization (WHO) in the first quarter of 2020, there has been no shortage of research papers on how it has transformed learning in higher educational institutions around the world. Online learning in many parts of the world, especially in developing countries, faced a number of constraints, such as access to internet connectivity, financial resources to procure technological devices and physical environment conducive for effective learning (Fishbane & Tomer, 2020; UNESCO, 2020; Affouneh et al., 2020; Crawford et al., 2020; Limniou et al., 2021). Furthermore, because online learning is dependent on digital tools, many schools implemented varying digital learning activities based on resource capacity and platform limitations (Joshi et al., 2020). While there are a number of new online learning technologies available in the market today to boost both learning and delivery capacity by faculty (Goh & Sigala, 2020), many schools lack the capacity to procure these new technologies. Even when schools can afford such platforms, students may not have adequate digital devices or a conducive environment to engage faculty (Arora & Srinivasan, 2020, Agarwal & Kaushik, 2020; Chick et al., 2020).

Experiences in online modalities are not entirely negative. An expansive body of research shows positive effects of online transition on students (Babbar & Gupta, 2021; Muthuprasad et al., 2021; Chisadza et al., 2021). Chisadza et al. (2021) identified clear opportunities with respect to the shift to online learning. Babbar & Gupta (2021) measured benefits of online learning in terms of innovations in the types of assessments used in higher education. Muthuprasad et al. (2021) explored students' preferences for various attributes of online classes including online learning environment. They found that the main attraction to online classes are flexibility and convenience brought by online learning. For the most part, it has become increasingly possible for students to get into classes from the comfort of personalized spaces.

From all indications, digital inequality, described by Beaunoyer et al (2020) as "… access to networks or connected devices, or when it comes to the skills required to navigate computerized spaces optimally" (p. 1), remains a problem for online education in developed and developing countries. Prior studies have shed light on various aspects of the problem of digital inequality: sustainability or environmental conditions in Mexico (Vargas et al., 2020); internet connectivity and socio-economic class in Ireland (Cullinan et al., 2021); internet usage and academic achievement in Indonesia (Soegoto & Tjokroadiponto, 2018); internet access and power outage in Nigeria (Ivwighreghweta & Igere, 2014); low income students and online education in India (Jain et al. (2021); limited laboratory-related courses and internet connectivity in the Philippines (Rotas & Cahapay, 2020; Cahapay, 2020); academic performance and access to WiFi in South Africa (Chisadza et al., 2021); and internet connectivity and lower remote learning proficiency in the USA (Katz et al., 2021).

There has been almost no empirical work on the relationship between internet connectivity and missed assessments except for Katz et al. (2021) which focused on the association between internet connectivity and lower learning proficiency in an online modality. Given how the education sector around the world was forced to go online and the inherent problem of balancing quality and expectations of students' compliance with online assessments, there is an important gap to fill in understanding the full range of what might be necessary in designing online learning. When many schools transitioned to an online modality, the traditional institutional guidelines governing the conduct of class were formulated for face-to-face context. Applying these guidelines without clear understanding of underlying factors driving student responses to assessments became a problem. Granting extensions to assessments submitted after a deadline in face-to-face classes is a common issue faculty deal with all the time. In online settings, missed assessments assume a different dimension because not only are

digital devices needed, but also internet connectivity is required to drive the virtual meeting and facilitate timely submission of assessments. Understanding how internet connectivity is related to the number of missed assessments can serve as a reference for setting guidelines that govern expectations in online learning and outcomes as well as the administration of these assessments.

To contribute to literature, the study investigated two questions: (a) To what extent does internet connectivity increase or decrease missed assessments? and (b) How do students vary in the distribution of missed assessments? We use a count data model which allows for discrete values in regression estimation to examine the relationship between internet connectivity and number of missed assessments and analyzed odds of missing assessments. The goal is to understand a possible potential allowable number of missed assessments that students may incur in an online modality without penalty. Overall, our focus on the relationship between internet connectivity and missed assessments distinguishes our paper from the only similar work done in the US using a unique data set from 30 universities from 19 states and the District of Colombia on internet connectivity and lower Remote Learning Proficiency (Katz et al., 2021).

Prior studies have made enormous contributions to online learning in the literature especially in the area of learning outcomes; however, this study may be the first to model missed assessments of students in an online modality in higher education using a count data model. We believe that the findings appeal to a broad spectrum of online advocates, readers and educators including education policymakers.

The rest of the paper is organized as follows: Section 2 describes the data sources and summary statistics including institutional context of missed assessments, Section 3 gives the empirical strategy including detailed theoretical and empirical formulation of the estimation process, Section 4 discusses the main results, and Section 5 offers concluding remarks and draws policy implications.

Educational Setting and Data

Institutional Context of Assessments and System's Theory in Education

Assessment is a key process of learning in higher education. In fact, assessment has been described by Hodges et al. (2014) as "intrinsically linked to student learning and performance" (p. 189). Assessment as an integral part of higher education has been exhaustively studied and theorized (Hodges et al., 2014) and its role in feedback mechanisms facilitating learning has been well-documented (Graham et al., 2021). But as educational institutions transitioned from the traditional face-to-face to online classes, many schools were faced with two problems occurring simultaneously: relevant data for suitable guidelines for online classes and adequate digital infrastructure including stable internet connectivity (Chisadza et al., 2021; El Said, 2020).

There are three types of assessments that are commonly used in varying forms in online modalities: formative, enabling, and summative. Formative assessment, as the name implies, involves more frequent informal activities used in between teaching to gauge students' understanding of lectures and does not count toward grades directly. It is used to prepare students for either enabling or summative assessments (Burkhardt & Schoenfeld, 2018). Enabling assessment is periodic and more frequent compared with summative assessment.

Enabling assessment may be described as mini-summative in the sense that it gauges progress of learning on a much smaller scale at different points within the same module (e.g., consisting of few chapters). It is not uncommon to have two or three in one module depending on the subject. Examples include multiple choice questions, short essays, debate exercises, etc. On the other hand, summative assessment is usually designed to gauge overall grasp of the entire module or multiple modules and may involve written examinations, written research papers or well-designed projects (Guangul et al., 2020).

Overall, assessment has been described as a good measure of both quality and progress in online learning (Babbar & Gupta, 2021). However, even when assessments have been developed by experts to elicit a given performance, its usefulness will ultimately depend on digital infrastructure and home conditions driving communications and feedback in both directions (students and faculty) for smooth and unrestricted learning to take place (Yan & Carless, 2021). Yet not enough attention has been given to the effect of internet connectivity on students' ability to meet online assessment expectations. Assessments help faculty make better decisions on students' progress (Carless & Winstone, 2020); however, when students are unable to submit assessments in a timely manner due to poor WiFi reception or internet connectivity, faculty may apply penalties indiscriminately which is contrary to how the feedback mechanism should work. Kintu et al. (2017) notes that, "efficient use of a learning management system and its tools improves learning outcomes in e-learning and blended learning environments" (p. 5). Evidence of the challenges faced in an online modality due to lack of clear cut guidelines governing conduct has been documented (Guangul et al., 2020).

Our goal in this section is to situate online assessment within the literature of learning outcomes using general systems theory applied to education to inform our empirical strategy in Section 3. In the conceptual framework (Figure 1), we propose that well-thought out institutional guidelines for the online modality should be informed by inputs from missed assessments in a feedback mechanism. System's Theory in Education is anchored on General System Theory (GST) founded by Von Bertalanffy in the 1930s (Drac, 2015), which has been used extensively in educational research to analyze educational output as a function of inputs at different levels (John, 2010; Garira, 2020). Systems theory acknowledges the universality of the feedback mechanism as a necessary component to achieve desired learning outcomes. Viewed through this lens, institutional guidelines become part of a school's inputs in an educational production function in which minimizing the number of missed assessments is an objective function to be achieved for desired learning outcomes to occur (John, 2010).

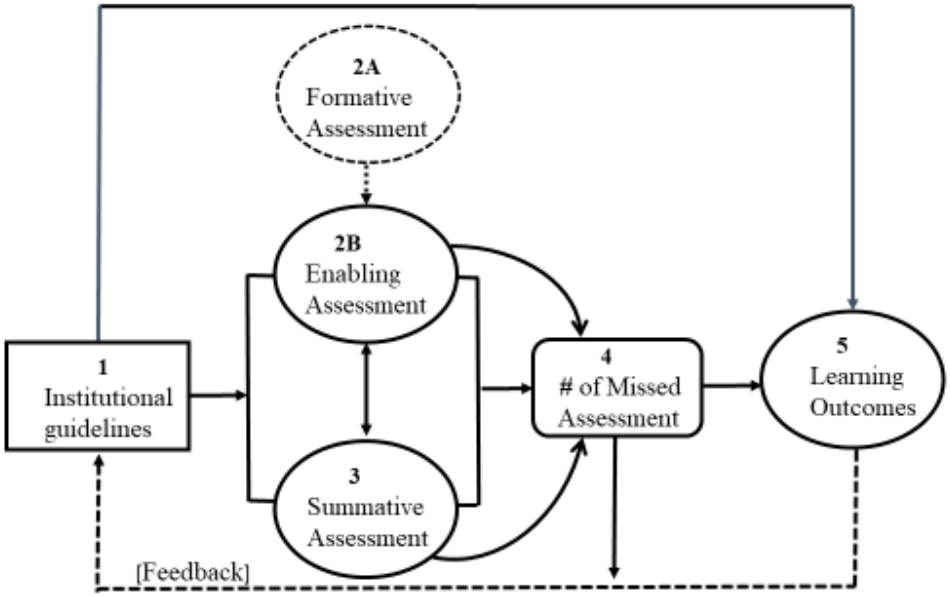
We denote missed assessments as the sum of enabling and summative assessments students' failed to submit on deadline during a given semester. In reality, some students may miss only one type of assessment, enabling or summative, and not necessarily both. Institutional guidelines should be formulated with a clear understanding of what these rules are supposed to address. For example, how many missed assessments can be tolerated in online modality in a given subject per semester? When and how should faculty intervene if there is a clear indication that the reason for missed assessment is not valid? These questions relate broadly to the spectrum of issues associated with formulating guidelines for effective learning outcomes.

Exhaustive discussion of factors affecting learning outcomes are diverse and complex (Malecka et al., 2020), and beyond the scope of this paper. The study's goal is to highlight that feedback mechanisms could be used to improve learning outcomes through integrating relevant institutional guidelines. Figure 1 illustrates the relationships between institutional guidelines, missed assessments and learning outcomes. When institutional guidelines are set arbitrarily,

there is a possibility that they may create a ripple effect influencing enabling and summative assessments, total number of missed assessments and learning outcomes

Figure 1

Proposed Relationship between Institutional Guidelines and Missed Assessments with Feedback Mechanism



As shown in Figure 1, formative assessment does not count toward grade and is assumed to influence enabling assessment indirectly because many faculty members do not incentivize its completion. It is used to prepare students for graded assessments such as enabling or summative. Guangul et al (2020) noted that, "formative and summative assessments in conjunction with appropriate feedback systems are used to support learning in higher education" (p. 521). Our framework (Figure 1) depicts the possible interplay between enabling and summative assessments. The double-headed arrow indicates that enabling assessment may influence summative assessment, and can itself be influenced by summative assessment. This is primarily because a missed assessment is assumed to be cumulative, that is, inability to submit an enabling assessment may influence submission of a summative assessment and vice versa. As shown in Figure 1, the feed forward from [1] through [4] to [5] may occur in an environment where institutional guidelines are set arbitrarily. The dashed line depicts a system which provides for a number of missed assessments to be used as input for policy changes at the institutional level through a feedback mechanism. In case of well-thought out guidelines, the possibility of [1] to [5] upper loop may be realized on efficiency grounds due to the absence of impeding factors. Additionally, the feed forward from [1] through [4] to [5] may be improved as well using a feedback mechanism. The proposed conceptual framework can be used to understand a system in which minimizing the number of missed assessments and improved learning outcomes are objective functions. An empirical link between missed assessments and internet connectivity may provide the starting point in addressing policy changes at the institutional level. We describe our data set and present summary statistics below.

Data Source and Summary Statistics

This study was based on the data collected from 257 undergraduate students enrolled in online classes at a private university in the Philippines during the second semester of school year 2020-2021. The student participants were from two colleges (Education, CE and Business Administration, CB) covering 4 programs (Education, Economics, Finance and Entrepreneurship). The two colleges were selected based on the professors' willingness to join the study and ability to handle the challenging data collection process. Participating faculty teach courses with term papers (with well-defined rubrics for evaluation) as part of the final requirement. The rubrics used to evaluate the final requirement were comparable across programs to reduce instructional heterogeneity.

Internet connectivity was measured through student binary answers [yes or no] to the question: Have you missed an assessment deadline or online class due to poor internet connection? The number of missed assessments was measured through the question: How many times in the last semester? The actual number of missed assessments and performance scores on the final class requirement were generated from class records downloaded from the online platform**.** Students were given at least one week to submit assessments. The online platform prevented submission after the deadline**.** Other characteristics, such as personal and family background were collected from students using survey questionnaire forms. Data collection was approved by the University's Ethics Review Committee. As expressed in the informed consent document, participation in the survey was voluntary and included a statement regarding the right of students to withdraw at any point during the data generation process without consequences. There were no incentives given to any student for answering the questionnaire to avoid undue influences and to minimize errors. Table 1 reports the definitions of socio-economic and demographic characteristics of student participants.

Table 1
Definition of Variables used in the Analysis

Variable name	Definition
Dependent variable	
Missed Assessment*	Number of missed assessments
Explanatory variables	Students who reported to have missed assessments due to poor internet
Internet connectivity	connection, value=1 if yes,0 otherwise
Team participation	value =1 if the output is solo, 0 otherwise
Performance	Final score on paper
Age	Age of respondent
Household size	Number of people in the household
Gender	value =1 if respondent is male, 0 otherwise
Study hour	Number of hours per week in studying
Father's Employed	value =1 if employed, 0 otherwise
Mother's Employed	value =1 if employed, 0 otherwise
Father's Education	value =1 if college graduate, 0 otherwise
Mother's Education	value =1 if college graduate, 0 otherwise
College of Business (CB)	value =1 if home college is Business, 0 otherwise
College of Education (CE)	value =1 if home college is Education, 0 otherwise
Job	value =1 if student has a part-time job, 0 otherwise
GPA	Current Grade Point Average (as of last semester)
Team preference	value =1 if student always prefer individual work not group, 0 otherwise
Electricity bill	Estimated cost of family electricity bill per month

Note. *Summative and enabling assessments submitted after deadline

Table 2 reports descriptive statistics of students who participated in the study. The average number of missed assessments was 2.6 (SD = 3.04), but ranged from 0 to 15. The minimum number of graded assessments in a given semester was 12 (4 summative and 8 enabling). Assessments were structured to ensure that one assessment did not carry too much weight in the final grade. Formative assessments were not graded, but were commonly used by faculty to provide students with an opportunity to practice skills as a lead-in to both enabling and summative assessments. About 66% of students reported having poor internet connectivity, while 34% did not report experiencing poor internet connectivity.

Table 2

Descriptive Statistics

Variable	Mean	Std. Dev	Min	Max
Poor internet connection (yes)	0.66	0.47	0	1
Number of missed assessments	2.60	3.04	0	15
Gender (male)	0.31	0.46	0	1
College of Business (yes)	0.79	0.41	0	1
GPA	3.35	0.64	1	4
Working student (yes)	0.19	0.67	0	8
Preference for group output (yes)	0.67	0.46	0	1
Father is college graduate	0.63	0.48	0	1
Father has a job (yes)	0.79	0.40	0	1
Mother is college graduate	0.68	0.46	0	1
Mother has a job (yes)	0.59	0.49	0	1
Study hours/week	23.88	20.52	1	120
Household size	5.21	2.53	0	26
Electricity bill (monthly)	4375.48	2982.83	600	18000
Age	19.65	1.77	15	35
Performance (Avg.score final paper)	88.76	7.37	70	97
Solo (individual output = yes)	0.52	0.50	0	1

Note. Monthly bill expressed in Philippine pesos (US$1=Php50).

Theoretical and Empirical Strategy

Formulation of Missed Assessments

Examining the link between internet connectivity and missed assessments presents special econometric challenges. First, the number of missed assessments by students is a count variable, therefore, treating it simply as continuous variable and applying linear regression will result in biased estimates and may be improved using a count model such as Poisson (Greene, 2003). Second, using the Poisson model does not guarantee unbiased estimates. This is because missed assessments may not conform to the restrictive nature of the Poisson model. Greene (2003) points out, “Poisson has been criticized because of its implicit assumption that the variance equals its mean” (p. 743). Assessments are typically cumulative, missing one assessment increases the chance of missing another assessment as course requirements progress over the duration of the semester. This may explain why the independence assumption of the Poisson model is often violated (Sturman, 1999; Wooldridge, 2002).

To address this challenge, we first modeled missed assessments using the restrictive Poisson model to assess whether missed assessments conform to the standard Poisson’s assumption which states that the of mean of missed assessments must equal its variance. Preliminary analysis of the data indicated that the Poisson model did not apply. If the Poisson model was applicable, it would imply that missing one assessment does not necessarily increase the chances of missing another assessment. In reality, our data analysis implied that it does, meaning that a less restrictive model like negative binomial is more appropriate for analyzing missed assessments.

Negative binomial is less restrictive and allows for the possibility that variance of missed assessments can exceed the mean (Yirga et al., 2020). We modeled the number of missed assessments of each student (y_i) in the four programs during the semester using a negative binomial model, which is assumed to take nonnegative integer values (i.e., 0 or greater than zero). We assumed that y is a random variable which shows the number of times students have missed assessments during the second semester, school year 2020-2021. The maximum likelihood estimator using the Poisson distribution is used to estimate the mean. Essentially, we are looking for the mean (lamda, λ) of missed assessments given the number of assessments (y_i) missed by each student during the second semester. This problem can be said to follow the Poisson distribution and each missed assessment has a Poisson distribution expressed as $y_i \sim$ Pois (λ). The probability density function (PDF) of each missed assessment given the mean parameter (λ) can be formally expressed in equation 1 including all relevant equations used in the estimation process (Appendix 1). Our primary specification related the number of missed assessments (y) to other explanatory variables (x's) in which the key variable is internet connectivity shown in equation 12 (Appendix 1).

Results and Discussion

We examined the link between internet connectivity and missed assessments in two ways: differences between students reporting poor internet connectivity and those who did not report poor connectivity in our sample (Table 3) and incidence ratio (Table 4). Table 3 shows that the mean number of missed assessments among students who reported poor internet connectivity was 3.62 (SD = 3.12; higher than sample mean in Table 2), while among students who did not report experiencing poor internet connectivity, which was about 0.80 (SD = 1.81) missed assessment. The p-value is highly significant, which implies that between the two groups, the number of missed assessments was on average different. This first evidence provides the need for further analysis using negative binomial in Table 4.

Table 3

Comparison of students' characteristics using two sample t test

Variable	Poor Internet Connectivity				*t*	
	Yes		No			
	Mean	Std.D	Mean	Std.D		
Missed Assessment	3.62	3.12	0.80	1.81	-7.24	***
GPA	3.27	0.66	3.54	0.51	3.35	***
Study hours	22.53	18.84	26.60	23.40	1.50	
Household size	5.18	2.22	5.27	3.07	0.27	
Electricity bill	4435.6	2951.62	4290.57	3059.73	-0.36	
Age	19.79	1.88	19.37	1.51	-1.77	*
Performance	88.36	8.60	89.64	3.95	1.31	

Note. ***1% ; *10%

Table 4

Generalized binomial regression for missed assessments

Variable Missed Assessment (Count = dependent)	IRR		Std. Error	Conf. Interval (95%)	
Internet connection(poor=yes)	4.936	***	0.927	3.415	7.133
Age	1.146	***	0.064	1.027	1.281
Home College (CBAA=yes)	2.137	**	0.695	1.129	4.045
Household size	1.052	*	0.032	0.991	1.117
Study hours	0.996		0.004	0.988	1.004
Group preference (Individual = yes)	0.871		0.139	0.635	1.192
Education of father (college=yes)	1.056		0.197	0.733	1.523
Education of mother (college=yes)	1.258		0.251	0.851	1.861
Job of mother (employed=yes)	1.135		0.187	0.821	1.569
Job of father (employed=yes)	0.794		0.159	0.536	1.176
Student (parttime job =yes)	1.181		0.124	0.962	1.449
Gender (male)	1.033		0.174	0.742	1.438
Electricity bill	0.999		0.001	0.999	1.000
Constant	0.209	***	0.027	0.001	0.267
Lnalpha	-0.404		0.192	-0.779	0.084
Alpha	0.667		0.127	0.458	0.972
LR test of alpha=0: chibar2 (01);	111.49				
Prob >= chibar2	0.000				
Log likelihood	-415.952				
Number of observation	214				
LR chi2 (12)	77.87				
Prob > chi2	0.000				
Pseudo R2	0.086				

Note. ***1%, **5% and *10%

The results of our empirical link between missed assessment and internet connectivity based on equation 12 (Appendix 1) are presented in Table 4. But before evaluating the coefficients, we tested the appropriateness of the negative binomial model. As discussed in the model formulation (Appendix 1), negative binomial models assume that the conditional means are not equal to the conditional variances. To test this assumption, we used a likelihood ratio test that alpha equals zero. This test compares this model to a Poisson model. The lower left section of Table 4 shows the associated chi-squared value of 111.49 with one degree of freedom. The probability value is highly significant, which suggests that alpha is non-zero and implies that negative binomial model is more appropriate than the Poisson model.

The coefficients in Table 4 are expressed as incidence rate ratios (IRR). Results indicated a positive and significant link between poor internet connectivity and missed assessments. Students who reported to have poor internet connectivity had a 4.93 times higher incidence rate of missed assessments than students who did not report to have poor internet connectivity holding other variables constant. On average, older students tended to have higher incidence of missed assessments. To put it differently, a one-year increase in age tended to increase

missed assessments by 1.15 times (or about 15%). The incidence rate of missed assessments for students from CB was 2.13 times higher than the incidence rate of students from CE. Additionally, household size tended to increase the incidence rate of missed assessments. Increase in household size by one increased the incidence of missed assessments by 1.05 times (or about 5%).

Perhaps relationships between internet connectivity and missed assessments is not surprising, given that results from previous studies in online learning have alluded to it indirectly. In particular, Joshi et al. (2020) showed that educational technologies are correlated with the level of learning outcomes. Babbar and Gupta (2021) and Allen (2015) described assessments as the key driver of quality in any educational system, and recommended requiring academic institutions to focus on the integrity of assessments. Our results not only point attention to internet connectivity as a barrier to online learning, but also highlight issues regarding expectations and compliance by students with respect to online requirements. In Figure 2 and Table 5, we revisit the problem of missed assessments through visual illustration of predicted odds given the sample of students in this study.

The findings on age indicate that missed assessments may increase with age. We found this counterintuitive since older students tend to be more mature and responsible. But, literature has also shown that students of different age categories may be interested in different sets of assessments (Aldrich et al., 2018), which may explain the differences in missed assessments. Older students may also have additional non-school responsibilities related to work and/or family. However, the link between age and missed assessments has not been explicitly examined by previous studies and may require more research to understand the mechanisms through which age affects missed assessments.

Less surprising is the incidence rate of household size and missed assessments. Though previous studies may have linked household size to an array of factors including educational goals, our interest lies on how size of household may impact the home environment setting in online modalities, which in turn may influence students' missed assessments. Household size may be associated with home factors producing concurrent mechanisms with countervailing effects. For example, an increase in household size may increase the number of people using the internet at a given time which in turn may affect internet stability especially when bandwidth is low.

To examine the probability and odds of missed assessments, we used information on mean values of missed assessments from Table 2 and a special command from *Stata* software to probe further on the number of missed assessments by students. We calculated the odds of missed assessments by students, and used the calculated probabilities to generate Figure 2, which visually illustrates the relationship between mean probability and number of missed assessments in the sample. The computation of probability and odds of missed assessments in Table 5 provides useful quantitative information. For example, there is a 7% chance of not missing assessments across all four programs in the sample, which tells us that it is possible to have zero missed assessments in a given semester. While the zero missed assessment is not impossible, it is not a realistic expectation for all students given what we know from Table 4. However, looking at the other extreme, there is only about a 1% chance of missing seven assessments in a semester. We can also examine Table 5 through cumulative probability (pcum), that is, the odds of a specific number of missed assessment. For example, the odds are about 75% that students miss at least two but no more than four assessments, with the peak at two (25% odds). We transformed Table 5 into a visual representation in Figure 2. In this

representation, the vertical axis records probability ranging from 0 to a little over 25% and the horizontal axis records the number of missed assessments. As can be gleaned from Figure 2, missed assessments peaked at number two. Notice how the number of missed assessments decreases after number six missed assessments and progressively approaches zero. Figure 2 provides interesting insights regarding missed assessments and can help inform policy makers regarding the number of missed assessments that may be deemed reasonable in any given semester considering all possible scenarios including poor internet connectivity and other home factors. As Figure 2 illustrates, the 7th missed assessment lies to the right and far away from the mean of the entire sample suggesting that the probability of accumulating the 7th missed assessment is very low.

Table 5

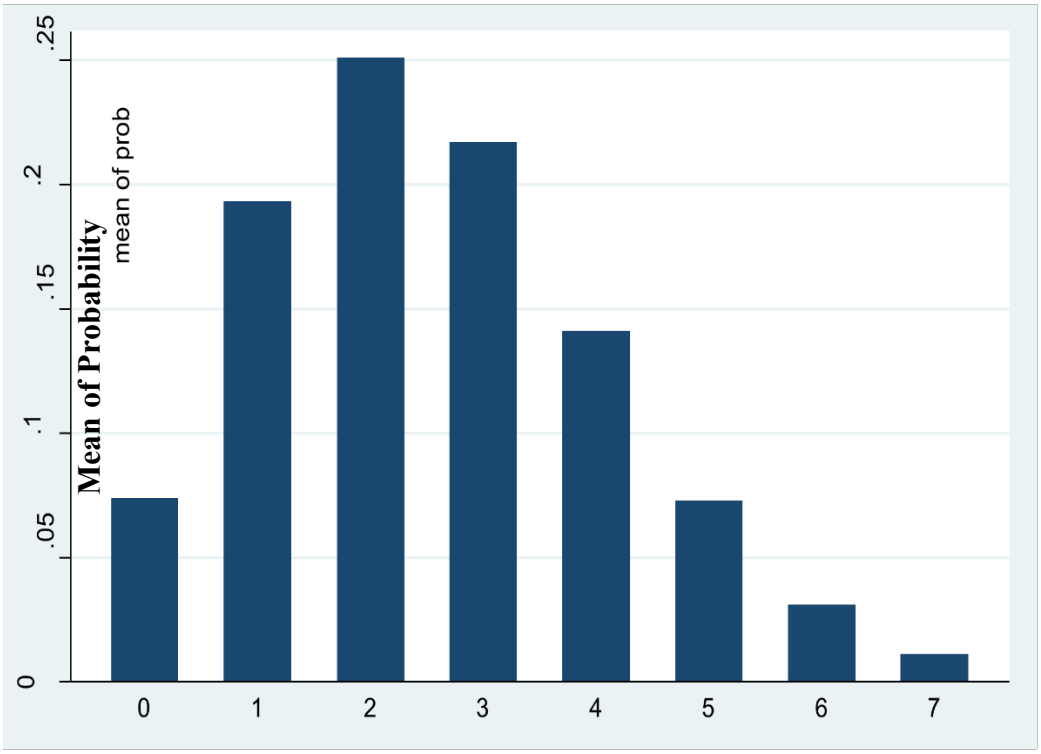
Probability or Odds of Missed Assessments (2.6)*

** Number	Probability	Cumulative probability (pcum)
0	0.074	0.074
1	0.193	0.267
2	0.251	0.518
3	0.217	0.736
4	0.141	0.877
5	0.073	0.951
6	0.031	0.983
7	0.011	0.994

Note. *Mean of missed assessments; **number of missed assessments

Figure 2

Number of Missed Assessments with Mean of Probabilities



Suppose that an institutional policy mandates the number of allowable missed assessments during each semester to be arbitrarily set at one? This will be impractical given the underlying forces which may increase missed assessments in a given semester. However, in order to compel students to maintain a sense of responsibility and adhere to expectations regardless of home conditions, it may be reasonable to keep the number of allowable missed assessments to between six and seven beyond which some level of penalty may be assessed in the form of decreased score. Without clear-cut institutional guidelines, faculty are left with the burden of having to figure out what may constitute valid reasons for missed assignments. As shown in Figure 2, mean probabilities can help to inform institutional rules governing expectations of students in online modalities.

Conclusion, Implications, and Recommendations

The unprecedented occurrence of COVID-19 pandemic compelled educational institutions to carry out online learning modality which created challenges to school administrators, teachers, and students particularly on the effective facilitation of the teaching-learning process. As this method relies heavily on internet connectivity, the current study delved into finding the link between internet connectivity and students' missed assessments. Results revealed that there is a positive and significant link between poor internet connectivity and missed assessments. The findings also showed that other factors, such as age and household size are related to missed assessments.

Our results have broader implications for the ongoing debate about how to design effective online classes and the challenges of incorporating timely submission of assessments to aid feedback between faculty and students, and most importantly to promote quality learning.

While online class can never be a perfect substitute for face-to-face, institutional guidelines must be forward looking to allow feedback and the possibility that online classes will persist way into the future, even after the COVID-19 pandemic has ended (El Said, 2020). The analysis we have presented here suggests that a key impediment to online learning may well be institutional guidelines that fail to take into account the larger picture of underlying factors affecting students. The biggest takeaway from this research is that home environment, which includes internet connectivity, greatly influences online learning. Finding an innovative way to improve unstable internet connectivity is a key driver to promote both the quality and expectations of learning. These may appear to be overstated since quality and expectations were not directly measured in this study. In a more practical sense, the inability to summit assessments in a timely manner, hampers the feedback mechanism that reinforces learning, which in turn may affect quality of learning.

The results offer other insights. For example, the probabilities of missed assessments calculated in this study raises important questions regarding multiple claims of missed assessments given that the chances of the 7th missed assessment in a semester based on our sample is extremely small. Our results present an opportunity for school administrators and advocates of online learning to revisit rules governing the conduct and expectations in online modalities. In the second (2) section of this paper, we presented the educational context of assessments, we asked two specific questions that faculty in any online modality may confront: how many missed assessments can be tolerated in a given subject per semester or term?; and when and how should faculty intervene if there is a clear indication that the reason for missed assessment is not valid? These questions relate broadly to the spectrum of issues associated with formulating guidelines for effective learning outcomes and deserve answers. One possible approach to answering these questions might involve implementing the type of framework proposed in Figure 1. Our results provide a guide to institutional policymakers. Clearly, addressing issues regarding internet connectivity is critical to any strategy aimed at improving learning outcomes.

Nevertheless, it is important to take note of the limitations of this study. Sample size is small, therefore both robustness and generalizability of the findings may benefit from expanding the sample size of this study. Although additional information such as dates present in online classes, actual number of missed assessments, late submission of assessments and types of assessments were generated from the online platform, other diverse and complex factors such as study habits, learning attitude, digital skills, personality among others were not measured in the survey instrument. Internet connectivity responses were based on students reported experiences which we have no way of verifying in real time or during the period when assessments were given. However, the methodology and model used in this study has provided interesting insights and direction for future research. Future studies may utilize longitudinal or bigger and more representative datasets to extend and test the robustness of findings. Quasi-experimental design may help to probe further on the relationship between internet connectivity and missed assessments for different categories of students across schools.

Acknowledgements
We have benefitted immensely from the feedback and insightful comments of two anonymous professors.

References

Affouneh, S., Salha, S., & Khlaif, Z. N. (2020). Designing quality e-learning environments for emergency remote teaching in coronavirus crisis. *Interdisciplinary Journal of Virtual Learning in Medical Sciences*, *11*(2): 135–137. https://10.30476/IJVLMS.2020.86120. 1033

Agarwal, S., & Kaushik, J. S. (2020). Student's Perception of Online Learning during COVID Pandemic. *The Indian Journal of Pediatrics, 87***,** 554 . https://doi.org/10.1007/s12098-020-03327-7

Aldrich, R. S., Trammell, B. A., Poli, S., Potter, S., & Garringer, K. (2018). How Age, Gender, and Class Format Relate to Undergraduate Students' Perceptions of Effective Course Assessments, InSight: A Journal of Scholarly Teaching, *13*, 118–129. Retrieved on September 10, 2021 from https://files.eric.ed.gov/fulltext/EJ1184937.pdf

Allen, J. (2015). A Bayesian hierarchical selection model for academic growth with missing data. ACT. Retrieved on September 14, 2021 from https://forms.act.org/research/ papers/pdf/WP-2014-04.pdf

Arora, A. K., & Srinivasan, R. (2020). Impact of pandemic covid-19 on the teaching – learning process: A study of higher education teachers. *Prabandhan: Indian Journal of Management*, *13*(4), 43-–56. https://doi.org/10.17010/pijom/2020/v13i4/151825

Babbar, M., & Gupta, T. (2021). Response of educational institutions to COVID-19 pandemic: An inter-country comparison. *Policy Futures in Education*, *0*(0), 1–23. https://doi.org/10.1177/14782103211021937

Beaunoyer, E, Dupéré, S., & Guitton M. J. (2020). COVID-19 and digital inequalities: Reciprocal impacts and mitigation strategies. *Computers in Human Behavior,*111*,*1–9. https://doi.org/10.1016/j.chb.2020.106424.

Burkhardt, H., & Schoenfeld, A. (2018). Assessment in the service of learning: challenges and opportunities or Plus ça Change, Plus c'est la même Chose. *ZDM Mathematics Education*, 50, 571–585. https://doi.org/10.1007/s11858-018-0937-1

Cahapay, M. B. (2020). Reshaping assessment practices in a Philippine teacher education institution during the coronavirus disease 2019 crisis. *Pedagogical Research*, 5(4), em0079. https://doi.org/10.29333/pr/8535.

Cameron, A. C., & Trivedi, P. K. (1999). Essentials of Count Data Regression. Retrieved from https://www.researchgate.net/publication/210052843.

Carless, D., & Winstone, N. (2020). Teacher feedback literacy and its interplay with student feedback literacy. *Teaching in Higher Education*. https://doi.org/10.1080/13562517.2020.1782372.

Chick, R. C., Clifton, G. T., Peace K. M., Propper, B. W., Hale, D. F., Alseidi, A. A., & Vreeland, T. J. (2020). Using technology to maintain the education of residents during the COVID-19 pandemic. *Journal of Surgical Education, 77*(4), 729–732. https://doi.org/10.1016/j.jsurg.2020.03.018.

Chisadza, C., Clance, M., Mthembu, T., Nicholls, N., & Yitbarek, E. (2021). Online and face-to-face learning: Evidence from students' performance during the Covid19 pandemic. *African Development Review*, *33(S1)*, S114–S125. https://doi.org/10.1111/1467-8268.12520

Crawford, J., Butler-Henderson, K , Rudolph, J, Malkawi, B, Glowatz, M, Burton, R, Magni, P., & Lam, S. (2020). 'COVID-19: 20 countries' higher education intra-period digital pedagogy responses'. *Journal of Applied Learning & Teaching*, *3*(1), 1–20. https://doi.org/10.37074/jalt.2020.3.1.7

Cullinan, J., Flannery, D., Harold, J., Lyons, S., & Palcic, D. (2021). The disconnected: COVID-19 and disparities in access to quality broadband for higher education students. *International Journal of Educational Technology in Higher Education, 18*(26). https://doi.org/10.1186/s41239-021-00262-1

Drac, M. (2015). Ludwig von Bertalanffy's organismic view on the theory of evolution. J. Exp. Zool. B Mol. Dev. Evol. 324 (2), 77–90. https://doi.org/10.1002/jez.b.22611

El Said, G. R. (2020). How Did the COVID-19 Pandemic Affect Higher Education Learning Experience? An Empirical Investigation of Learners' Academic Performance at a University in a Developing Country. *Advances in Human-Computer Interaction*. Retrieved from https://www.hindawi.com/journals/ahci/2021/6649524/

Fishbane, L., & Tomer, A. (2020, March 20). As classes move online during COVID-19, what are disconnected students to do? Retrieved on September 6, 2021 from https://www.brookings.edu/blog/the-avenue/2020/03/20/as-classes-move-online-during-covid-19-whatare-disconnected-stude nts-to-do/

Garira, E. A. (2020). A Proposed Unified Conceptual Framework for Quality of Education in Schools. SAGE Open. Retrieved from https://doi.org/10.1177/2158244019899445

Goh, E., & Sigala, M. (2020). Integrating Information & Communication Technologies (ICT) into classroom instruction: teaching tips for hospitality educators from a diffusion of innovation approach. *Journal of Teaching in Travel & Tourism*, *20*(2),156–165. https://doi.org/10.1080/15313220.2020.1740636

Graham, A. I., Harner, C., & Marsham, S. (2021). Can assessment-specific marking criteria and electronic comment libraries increase student engagement with assessment and feedback?. *Assessment & Evaluation in Higher Education.* https://doi.org/10.1080/02602938.2021.1986468

Guangul, F. M., Suhail, A. H., Khalit, M. I., & Khidhir, B.A. (2020). Challenges of remote assessment in higher education in the context of COVID-19: a case study of Middle East College. *Educational Assessment, Evaluation and Accountability*, *32*, 519–535. https://doi.org/10.1007/s11092-020-09340-w

Greene, W. H. (2003). Econometric Analysis (5th ed). N.Y, USA: Prentice Hall.

Hilbe, J. M., & Greene, W. H. (2007). Count response regression model. In C.R. Rao, J.P. Miller & D.C. Rao (Eds), *Epidemiology and Medical Statistics, Elsevier Handbook of Statistics Series*, London: Elsevier.

Hodges, D., Eames, C., & Coll, R. K. (2014). Theoretical perspectives on assessment in cooperative education placements. *Asia-Pacific Journal of Cooperative Education,* Special Issue*, 15*(3), 189–207.

Ivwighreghweta, O., & Igere, M.A. (2014). Impact of the internet on academic performance of students in tertiary institutions in Nigeria. *Journal of Information and Knowledge Management, 5*(2), 47–56.

Jain, S., Lall, M., & Singh, A. (2021). Teachers' Voices on the Impact of COVID-19 on School Education: Are EdTech Companies Really the Panacea? *Contemporary Education Dialogue, 18*(1) 58–89. https://doi.org/10.1177/0973184920976433

John, R. (2010). The economy and the function of production in education. Retrieved from http://www.scielo.org.ar/pdf/vf/v13n1/v13n1a06.pdf

Joshi, A., Vinay, M., & Bhaskar, P. (2020). Impact of coronavirus pandemic on the Indian education sector: perspectives of teachers on online teaching and assessments. *Interactive Technology and Smart Education*. Retrieved on September 8, 2021 from https://www.emerald.com/insight/content/doi/10.1108/ITSE-06-2020-0087/full/html

Katz, V. S, Jordan, A. B, & Ognyanova, K. (2021). Digital inequality, faculty communication, and remote learning experiences during the COVID-19 pandemic: A survey of U.S. under graduates. PLoS ONE *16*(2). e0246641. https://doi.org/10.1371/journal.pone.0246641

Kintu, M.J., Zhu, C., & Kagambe, E. (2017). Blended learning effectiveness: the relationship between student characteristics, design features and outcomes. *Int J Educ Technol High Educ, 14* **(**7), 1–20. https://doi.org/10.1186/s41239-017-0043-4

Limniou, M., Varga-Atkins, T., Hands, C., & Elshamaa, M. (2021). Learning, Student Digital Capabilities and Academic Performance over the COVID-19 Pandemic. *Education Sciences*. *11*(7)*,* 361.

Malecka, B., Boud, D., & Carless, D. (2020). Eliciting, Processing and Enacting Feedback: Mechanisms for Embedding Student Feedback Literacy within the Curriculum. *Teaching in Higher Education*. . https://doi.org/10.1080/13562517.2020.1754784.

Muthuprasad, T., Aiswarya, S., Aditya, K. S., & Jha, G. K. (2021). Students' perception and preference for online education in India during COVID -19 pandemic. *Social Sciences & Humanities Open, 3*(1), 100101. https://doi.org/10.1016/j.ssaho.2020.100101

Rotas, E. E., & Cahapay, M. B. (2020). Difficulties in remote learning: Voices of Philippine university students in the wake of COVID-19 crisis. *Asian Journal of Distance Education,* 15(2), 147-158. ISSN 1347-9008. https://www.asianjde.org.

Soegoto, E. S. & Tjokroadiponto, S. (2018). Effect of internet on student's academic performance and social life. *IOP Conf. Series: Materials Science and Engineering, Volume 407, International Conference on Informatics, Engineering, Science and Technology (INCITEST)* doi:10.1088/1757-899X/407/1/012176.

Sturman, M. C. (1999). Multiple Approaches to Analyzing Count Data in Studies of Individual Differences: The Propensity for Type I Errors, Illustrated with the Case of Absenteeism Prediction. *Educational and Psychological Measurement, 59*(3),414–430. https://doi.org/10.1177/00131649921969956

UNESCO. (2020, March 19). Half of world's student population not attending school: UNESCO launches global coalition to accelerate deployment of remote learning solutions. https://es.unesco.org/news/half-worlds-student-population-not-attending-school-unesco launches-global-coalition-accelerate

Vargas, A. R., Macías, A. A. M., Soto, K. C. A, Lopez, Y. B., Gutiérrez, C. T., & Escobedo, H. G. (2020). The Impact of Environmental Factors on Academic Performance of University Students Taking Online Classes during the COVID-19 Pandemic in Mexico. *Sustainability*, *12*. https://doi.org/10.3390/su12219194.

Wooldridge, J. M. (2002). Econometric Analysis of Cross Section and Panel Data. Cambridge, USA: MIT Press.

Yan, Z., & Carless, D. (2021).Self-assessment is about more than self: the enabling role of feedback literacy. *Assessment & Evaluation in Higher Education*. https://doi.org/10.1080/02602938.2021.2001431.

Yehia, E. G. (2021). Power of Overdispersion Tests in Zero-Truncated Negative Binomial Regression Model, *American Journal of Theoretical and Applied Statistics*,*10*(3),152–157. . https://doi.org/10.11648/j.ajtas.20211003.13

Yirga, A. A., Melesse, S. F., Mwambi, H. G., & Ayele, D. G. (2020*).* Negative binomial mixed models for analyzing longitudinal CD4 count data. *Sci Rep, 10***,** 16742. https://doi.org/10.1038/s41598-020-73883-7.

Corresponding author: Willington Onuh
Email: willingtonoonuh@dlsud.edu.ph

Appendix 1

Modeling count data, starts with the most commonly used model, Poisson regression. Following Greene (2003), the Poisson distribution with observation *i* can be expressed as:

$$\Pr(Y_i = y_i \mid x_i) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!},\ y_i = 0,1,2... \qquad [1]$$

where, y_i refers to missed assessment by each student in a semester, $y_i!$ is y factorial, and λ_i is lamda which accounts for the mean incidence rate of missed assessments. The most prominent assumption of Poisson is that the conditional mean is equal to the conditional variance. The variance-mean equality of Poisson distribution implies, var(y/x) = *E*(y/x). The mean parameter λ_i is related to (that is, a function of) regressors, x_i as each y_i is drawn from a sample, which is assumed to be random (i.e., independent and identically distributed). A common mean function, following Wooldridge (2003) and Greene (2003), is the loglinear model:

$$\begin{aligned}\ln \lambda_i &= x_i'\beta \\ &= \beta_0 + \beta_1 x_{i1} + ... + \beta_k x_{ik} = \beta_0 + \sum_{j=1}^{k} \beta_j x_{ij}\end{aligned} \qquad [2]$$

since from equation 1

$$\lambda_i = \exp(x'\beta) \quad i = 1,...,n$$

Equation 2 models each student's number of missed assessments as having a Poisson distribution where the expected number (λ) is a function of regressors and the summation sign, $\sum_{j=1}^{k}$ indicates the sum of missed assessments by all students. Equations 1 and 2 shows that Poisson model is related to negative binomial and for the most part regarded as a special form of Poisson model.

Negative Binomial (Poisson-gamma) Regression Model

The main attraction of negative binomial (NB) is its flexibility allowing for the possibility for the variance of missed assessment to be independent of the mean, which is not possible with Poisson regression model. Thus, it allows for a scale parameter to be added in the formulation to account for overdispersion in a count data (Yehia, 2021). The NB is modelled typically as a generalization of Poisson model by allowing for unobserved effect into the conditional mean. This additional parameter allows the conditional variance to be greater than the conditional mean, which accounts for overdispersion. This can be accomplished by adding an error term to the conditional mean μ, so that the variance will be greater than the mean (Greene, 2003) as:

$$\ln \mu_i = x_i'\beta + \varepsilon_i = \ln \lambda_i + \ln u_i, \quad (u_i = \varepsilon_i) \qquad [3]$$

where ε_i a random error or unobserved variables that is typically assumed in classical regression model, that is, error is assumed to be uncorrelated with x. The conditional distribution remains Poisson-like in the sense that the distribution of y_i conditioned on x_i and u_i with conditional mean (λ_i) and variance (μ_i):

$$f(y_i \mid x_i, u_i) = \frac{e^{-\lambda_i u_i}(\lambda_i u_i)^{y_i}}{y!} \quad [4]$$

Equation 4, is a Poisson variable with mean (λ_i) and error term ($u_i=exp(\varepsilon_i)$) assumed to follow a Gamma distribution. The Poisson-Gamma mixture model is assumed to have a mean of 1.0 (Hilbe & Greene, 2007). The main idea of Poisson-Gamma mixture is to allow for the variance to be greater than the mean by adding an error to the mean ($\lambda_i u_i$) or to technically account for overdispersion inherent in count data. This means that the unconditional distribution of $f(y_i \mid x_i, u_i)$ can be derived by integrating u_i out of the density (Greene, 2003; Hilbe & Greene, 2007):

$$f(y_i \mid x_i) = \int_0^{\infty} \frac{e^{-\lambda_i u_i}(\lambda_i u_i)^{y_i}}{y!} g(u_i) du_i \quad [5]$$

The error term, u_i, defines the choice of distribution and takes the gamma type error distribution. The $g(u_i)$ from equation 5, is a two-parameter gamma distribution (Greene, 2003), written out as:

$$g(u_i) = \frac{\theta^{\theta}}{\Gamma(\theta)} \exp(-\theta u_i) u_i^{\theta-1} \quad [6]$$

where $\Gamma(.)$ is a gamma function. The unconditional distribution for y_i (Greene, 2003) can be written as:

$$f(y_i \mid x_i) = \int_0^{\infty} \frac{\exp(-\lambda_i u_i)(\lambda_i u_i)^{y_i}}{\Gamma(y_i+1)} \frac{\theta^{\theta}}{\Gamma(\theta)} \exp(-\theta u_i) u_i^{\theta-1} du_i, \quad y_i = 0,1,... \quad [7]$$

where the y factorial, $y! = \Gamma(y_i + 1)$. From equation 6, the mean of gamma distribution is θ/θ and variance θ/θ^2. Constraining the mean to one implies setting $\theta = \theta$, which results in one parameter gamma variance, where $\theta/\theta^2=1/\theta$. This expression explains why the variance is a quadratic function of the mean. The term $1/\theta$ is the overdispersion parameter of Negative binomial. The smaller the value of θ the higher the overdispersion allowing the mean and variance to be different, unlike the Poisson model. The negative binomial presents a more realistic model for estimating and understanding missed assessments by students. Missed assessments by students are by nature events that are positively correlated by the frequency occurrences which in turn induces larger variance. Applying properties of gamma's integral (Greene, 2003) in equation 7, yields:

$$f(y_i \mid x_i) = \frac{\theta^{\theta}\lambda_i^{y_i}\Gamma(\theta+y_i)}{\Gamma(y_i+1)\Gamma(\theta)(\lambda_i+\theta)^{\theta+y_i}} \quad [8]$$

Using the same properties of gamma function, Hilbe & Greene (2007) provided a convenient version of equation 8, as:

$$f(y_i \mid x_i) = \frac{\Gamma(y_i+\theta)}{\Gamma(y_i+1)\Gamma(\theta)} \left(\frac{\theta}{\lambda_i+\theta}\right)^{\theta} \left(\frac{\lambda_i}{\lambda_i+\theta}\right)^{y_i}, \quad y_i = 0,1,... \quad [9]$$

Dividing equation 9 through by θ yields:

$$f(y_i \mid x_i) = \frac{\Gamma(y_i + \theta)}{\Gamma(y_i + 1)\Gamma(\theta)} \left(\frac{1}{1 + (\lambda_i / \theta)} \right)^{\theta} \left(1 - \frac{1}{1 + (\lambda_i / \theta)} \right)^{y_i}, \quad y_i = 0,1,... \qquad [10]$$

Redefining the dispersion parameter obtained above as $\alpha = 1/\theta$, and plugging it back to equation 10, yields a density that is commonly recognized in the literature (Cameron & Trivedi,1999; Hilbe & Greene, 2007):

$$f(y_i \mid x_i) = \frac{\Gamma(y_i + 1/\alpha)}{\Gamma(y_i + 1)\Gamma(1/\alpha)} \left(\frac{1}{1 + \alpha\lambda_i)} \right)^{1/\alpha} \left(\frac{\alpha\lambda_i}{1 + \alpha\lambda_i} \right)^{y_i}, \quad y_i = 0,1,... \qquad [11]$$

Empirical Specification of Model

To examine the effect of internet connectivity and other students' characteristics on missed assessments, we adopt equation 12, for estimation. Estimation of the NB model parameters (β,α) is very straight forward using software packages such as, Stata, SAS, etc. The likelihood function can be set up from equation 11, as:

$$\lambda = \exp(x_i'\beta)$$

$$L(\beta, y_i, \alpha) = \sum_{i=1}^{n} \left\{ y_i \ln \left(\frac{\alpha \exp(x_i'\beta)}{1 + \alpha \exp(x_i'\beta)} \right) - \left(\frac{1}{\alpha} \right) \ln(1 + \alpha \exp(x_i'\beta) + \ln \Gamma \left(y_i + \frac{1}{\alpha} \right) - \ln \Gamma(y_i + 1) - \ln \Gamma \left(\frac{1}{\alpha} \right) \right\}$$

[12]

Differentiating equation 12, with respect to coefficients and equating to zero yields likelihood equations as follows:

$$\frac{\partial \log L}{\partial \beta} = \sum_{i=1}^{N} \left(\frac{y_i - \exp(x_i'\beta)}{1 + \alpha \exp(x_i'\beta)} \right) x_i = 0 \qquad [13]$$

The likelihood equation of Poisson is similar to NB equation 13, but the estimates differ due to the denominator term. However, as the parameter (α) gets closer to zero, the NB approaches Poisson model and provides the best possible explanation why the NB is regarded as a special form of Poisson (Hilbe & Greene, 2007).

The Need for Digital Education in the Teaching Profession: A Path Toward Using the European Digital Competence Framework in Albania

Heliona Miço
Epoka University, Albania

Jonida Cungu
Aleksander Xhuvani University, Albania

Abstract

Digital competence is part of 21st Century skills that allow individual teaching professionals to engage in new and flexible ways of learning. Studies have shown that digital competence improves education and equips the teaching staff with expertise on how to use information, communication, and basic problem-solving. The need for digital competence is clearly evident in the current pandemic situation, where digital technologies have taken a more prominent role in communication and education processes. Beyond the digital competence of educators, proper school infrastructure and curricula are needed during pre-service training to help teachers achieve digital competence. To better understand this need, an online survey was developed to analyze digital education in Albania. The survey was designed to analyze the teaching competence of teachers in pre-service and in-service programs, as well as their schools' curricula and infrastructure. Results from the questionnaire highlighted a need for the acquisition of digital knowledge for teachers according to different age groups. The results of the study found that difficulties teachers encountered in the acquisition of digital knowledge were not only due to deficiencies in teacher training but also other issues such as lack of infrastructure. The study concludes by recommending that providing digital education should be in line with European and national policy and legislation, as well as with national and international organizations. The paper reports findings assessing the level of preparedness of Albanian educators in regard to digital education and explores opportunities and identifies challenges for coping with enhancing digital development.

Keywords: Albania, digital competence in education, educational legislation, pre-university education, teachers, teacher survey, students

Society is rapidly digitalizing. Digital devices are used by preschool children and advanced learners to perform a variety of tasks such as playing, communicating, and gathering information. The use and application of digital devices by children has been growing, as well as their access to digital knowledge (Caena & Redecker, 2019; OECD, 2019). The United Nations has accepted that digital technologies have advanced rapidly than any other innovation in the last two decades (United Nations, 2018). Digitalization has led to many technological, economic, social and education changes in society (Gabsalamov et al., 2020; Garzón-Artacho et al., 2021). According to the European Parliament resolution of 2021, digital transformation is shaping the labor market, where as much as 90% of jobs are expected to require some form of digital skills. As a result, advanced digital skills are in high demand.

In order to address digitalization, the European Parliament recommended key competences for lifelong learning. These competences highlight *digital competence* as one of the key competencies necessary. Thus, it is important to focus on education as a tool to equip children, youths and adults with digital skills and literacy. According to several studies, the digitalization of education involves a multifaceted approach which includes replacing traditional teaching approaches with virtual teaching and learning skills. This requires high-quality software in educational institutions, information systems that provide access to educational resources, the introduction of information technologies, online learning and developing learning and evaluating knowledge through digital pedagogy (Strokov, 2020; Anderson & Mattsson, 2020; Yehya, 2021).

In their studies, Pettersson (2020) and Glover et al., (2016) emphasized the importance of intertwining digitalization in pedagogical processes. Teaching methods that do not involve digitalization can fail to transform practice and enhance students' learning. This approach is also supported by the European Digital Competence Framework (2013), which was updated in 2016 (Redecker, 2017). This updated framework provides the mechanisms to understand digital competences. In addition, it offers a variety of initiatives on European, national and regional levels meant to help young people develop digital competence. According to Ferrari (2013), the European Digital Competence Framework is an umbrella for current frameworks, initiatives, curricula and certifications. However, teachers' digital competencies alone are not enough to digitize education. Their competencies need to be accompanied by appropriate education policies, investments, and infrastructure. Digital transformation requires the attention of different layers of society and must be supported by several organizations (Pettersson, 2018; Babaheidari & Svensson, 2014).

Digital competencies in education, and the need for the development of information and communications technology (ICT) in education, are seen as necessities for the development of public education in Albania (Duda & Golubeva, 2013; UNESCO, 2017; European Commission, 2021). Despite steps taken towards the digitalization of the Albanian education system, there is a lack of adequate teacher training and practices to ensure effective online learning. Moreover, the COVID-19 pandemic caught the education system unprepared, with students unable to follow online classes due to unavailability of devices, lack of internet connection or quality support (European Commission, 2021). The inclusion of information technology in the Albanian education system, not just in the curriculum, needs a multifaceted analysis. Such an analysis will evaluate the infrastructure of schools in their location. The analysis would assess the possibility that traditional classrooms are being replaced by smart classes equipped with audio and visual systems, schools are equipped with information systems that provide access to educational resources, teachers have the digital competencies needed to understand their adaptability to digital changes, and financial resources are available. Such an

analysis should be accompanied by the legal framework and the necessary standards compatible with European education systems to enable its implementation by both teachers and students.

This study contributes to a portion of this larger analysis by assessing the digital competencies of teachers, the curriculum in pre-service education and continuous educational training, and the resources of schools in the service of digital education in Albania. An online survey was completed by 365 teachers of different pedagogical profiles employed in different schools located in the city as well as in the countryside. The aim of this study was to assess the need of educators in the area of digital education and to identify approaches toward meeting those needs.

Theoritical Framework

For a teacher to serve the development of society, it is necessary to be equipped with knowledge and skills so they can be transmitted to students. The range of competences epitomized in 21st Century skills include critical thinking, problem solving, creativity, meta-cognition, communication, and digital and technological literacy (American Association of Colleges of Teacher Education, 2010; Dede, 2010; Kim et al., 2019). Such skills must be understood by teachers in order to meet the demands of a global economy. In addition, new ways of learning need to be explored for a society that is becoming increasingly mobile and digital (Council of the European Union, 2018). For example, the European Union requires increasing attention towards improving the level of digital competencies at all stages of education and training, across all segments of the population.

Technical knowledge is an important dimension of digital competence (Monteiro, 2015). Aspects of teaching qualifications and professionalism, including the technical qualities of teachers, were recognized by the 1966 International Labour Organization (ILO) UNESCO recommendation concerning the Status of Teachers as below:

> It should be recognized that advance in education depends largely on the qualifications and ability of the teaching staff in general and on the human, pedagogical and technical qualities of the individual teachers. [p. 79]

This position is also supported by the United Nations (UN) Special Rapporteur on the right to education (UN, 2016), which emphasized the need for governments to take measures to regulate online educators and develop national qualification frameworks and standards to allow learners to receive quality education. According to Monteiro (2015), education system performance has to be seen in the context of other systems in society, for example, health, environmental, legal, governmental, economic and technological. Hereto, the 2030 Agenda for Sustainable Development (UN, 2015; UNESCO, 2018), adopted by the UN General Assembly, emphasizes ICT as a means through which a range of targets will be achieved. These targets include quality education (Goal 4); gender equality (Goal 5); infrastructure (Goal 9); reduced inequalities within and across countries (Goal 10); peace, justice and strong institutions (Goal 16); and partnerships for the goals (Goal 17). Contemporary societies are increasingly based on information and knowledge and the comprehensive presence of technologies (UNESCO, 2018). Teachers need to be equipped to guide the next generation to embrace and achieve these goals. The most complete acquisition of digital knowledge is done from the education system, where teacher competences play a significant role (European Commission, 2013; König et al., 2020; Redecker, 2017).

ICTs and "blended learning" are new paths to learning and require various skills by teachers. Digital competence is crucial in all aspects of the teaching profession such as reflecting, researching, communicating, modelling and teaching (European Commission, 2013; Garzón-Artacho et al., 2021). According to Schola Europaea (2018), digital competence involves the confident, critical and responsive use of, and engagement with, digital technologies for learning, at work, and for participation in society. It includes information and data literacy, communication and collaboration, digital content creation (including programming), safety, (including digital well-being and competences relating to cyber security), and problem-solving. The European Framework for the Digital Competence of Educators (Redecker, 2017) has further conveyed the development of teachers' digital competences, highlighting the need for educators to possess a set of competences. The competences have been divided into educator professional competences, educator pedagogic competences, and learner competences (Redecker, 2017).

However, despite the fact that teacher training is a top priority for digital competencies, it is important to combine professional, pedagogical, technological and organizational capacities to enable these competencies to be realized (Kullaslahti et al., 2019). According to Lorente et al. (2020), a combination of measures make digital education feasible. These measures fall into three categories: (a) basic and computer infrastructure and equipment, as well as Internet access in educational centers to deal with their total or partial closure; (b) the preparation and means of teaching staff to develop teaching-learning models based on distance education; and (c) the measures and resources implemented by countries to provide continuity for educational processes. In addition, educator training has to be accompanied by technological infrastructure, along with software and technical support and maintenance, which require significant financial support from the State (UN, 2016; UN & UNESCO, 2012).

Albania has made some progress promoting a knowledge-based society. This progress is reflected in the introduction of ICT in teacher education and training. Starting from 2012, there was a legislative framework regarding the fundamental competences on education (On Pre-university Education System in the Republic of Albania Law of 2012, Pub. L. No. 69/2012). Digital competence is considered one of the basic competencies of pre-university students. However, this competence does not correspond to the annual distribution of subjects at each level of the pre-university education curriculum. The inclusion of information technology is limited to lower secondary education classes only (Miço et al., 2020). Nevertheless, the application of ICT education systems, starting from pre-school, elementary, high school, university, and professional education is supported by Albania's "Digital Agenda Strategy and Action Plan 2022-2026" (Albanian Council of Ministers, 2022).

As in other countries, Albania lacks legislative regulations for combining technology with improving the teaching process, incentives for teachers to use digital competences, and the pedagogical changes needed to integrate ICT into the teaching process (European Commission, 2013). In addition, school textbooks, teaching materials and the proper infrastructure, particularly in the area of ICT, are integral parts of digital reform (UNESCO, 2017). Hence, digital competencies are necessary for both students and teachers. Studies show that the existing Albanian teacher competence frameworks do not acknowledge digital competences (European Education and Culture Executive Agency, 2019). Even though the use of digital technology has been included in the recent undergraduate curricula at faculties of education, further changes are needed to be implemented in pedagogy to encourage the integration of ICT and multimedia in teaching and learning (Duda & Golubeva, 2013).

Methodology

The researchers employed the survey method to gain insight into the level of digital competence of Albanian teachers and their need to develop competence according to current advancements in technology. As noted in the literature, the survey method is used to collect information from a sample of individuals through their responses to questions (Check & Schutt, 2012). Further still, surveys are important in education research because they can provide quantitative descriptions of the characteristics, behaviors, and attitudes of students, teachers, principals, parents, district leaders, and other specific populations (Walston et al., 2017). The study collected data through a questionnaire designed to measure the level of recognition of digital competence by the staff of the Albanian education system. The questionnaire was administered online using Google Forms. The questionnaire was organized with 18 multiple choice questions. The answers to these questions provided information about the teaching staff's level of knowledge about digital competence. The questionnaire also included open-ended questions designed to identify difficulties encountered during online teaching, as well as the participants' needs for professional development in the field of digital education. The questionnaire was completed by 365 teachers who belonged to the nine-year education cycle and secondary education. Data collection took place during January 2022. The data collected from the questionnaire served to reflect on the legal framework of Albanian education regarding digital competence. They were also used to provide recommendations for changes needed in order for the Albanian education system to embrace digital technology.

Participants and Their Demographics

The questionnaire was completed by 365 Albanian teachers working in pre-university education. Participants were randomly selected from basic and secondary schools. The schools were located both in city and rural areas. According to the demographic data collected through the questionnaire, participants included young and experienced teachers of different genders. The participants held various positions within the schools.

It is important to highlight that the questionnaire was completed by teachers of a special school, who are engaged in teaching children with special needs. Teachers of artistic Lyceum, who are engaged in teaching musical instruments, were included as well. Consequently, the questionnaire was filled out by teachers representing a comprehensive spectrum of Albanian teaching profiles.

The questionnaire was filled-out individually by teachers online, without any possibility of intervention. The questionnaire ensured the preservation of confidentiality and informed participants' that the data of the questionnaire would be valid only for study purposes. In the sections below, questions from the questionnaire are indicated by the abbreviations Q1 for Question 1, Q2 for Question 2, and so forth.

Demographically, the participants varied. With regard to years of experience (Q1), 19.3% of respondents had five years of work experience or fewer, 12.1% had 5 - 10 years, 37.5% had 10-20 years, 8.8% had 20-25 years, and 22.3% had over 25 years of work experience. In terms of gender (Q2), 282 (77.3%) participants were female and 83 (22.7%) were male (Q2). Regarding the location of the participants' educational institutions (Q12), 133 (36.5%) participants reported working in a city, 51 (14%) in the suburbs, and 181 (49.5%) in administrative units and rural areas. Finally, the participants were involved in different subject

areas (Q3), with 241 (69.5%) participants in linguistics and social sciences, 102 (29.3%) the natural sciences, and 4 (1.2%) computer sciences.

Instrumentation

A questionnaire consisting of 18 questions, developed by the research team for this study, was administered to identify teachers' level of knowledge of digital competence. In addition, the questionnaire assessed participants' understanding of the role digital competence plays in the teaching and learning process. There were multiple-choice questions, where participants had the possibility of selecting more than one option and provide comments on the answer in case they were reqiured to interpret their position. The questionnaire was sent to teachers via email invitation. Completing the questionnaire created the possibility for each participant to be identified by email address. Consequently, the data obtained from the questionnaire were individual, identifiable, and non-repetitive.

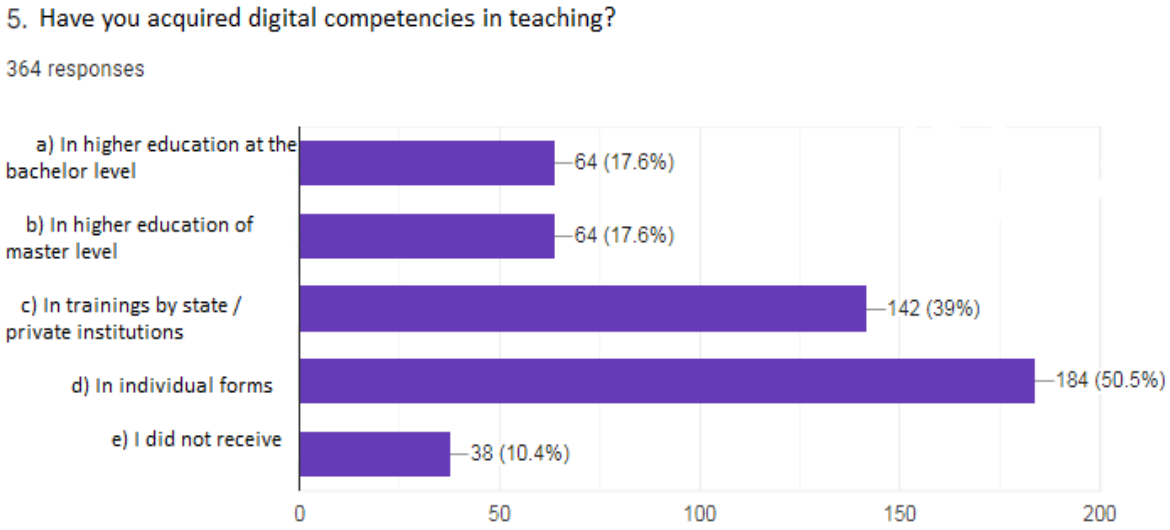
Results

Completion of the questionnaire resulted in quantitative and qualitative data, which helped define the theoretical and explanatory framework of the study. The collected data highlighted the digital knowledge teachers have, which differed according to age group and educational background. The deficiencies encountered served as an indicator of the work needed to complete the digital competencies of teachers in the field of education. At the same time, these data are related to digital competences for teachers according to six separate areas of educators' professional activities. Each question of the questionnaire contained an issue to discuss and analyze in relation to digital education.

Facing an unusual pandemic situation forced teachers to adapt quickly to a new form of technology-based teaching. In the context of this immediate need, there was a lack of in-depth information regarding the acquisition of digital knowledge by the the teachers in Albania's pre-university education system. Hence, the researchers addressed this issue in the questionnaire by asking (Q4), "*Did your university education have a subject on computer knowledge?"*Response to this question varied and 233 (63.8%) participants reported receiving computer knowledge during university training while 132 (36.2%) did not. This is explained by the fact that "computer knowledge" as a course was introduced after the 1990s curriculum. Given that 112 (30.6%) of the participants had more than 20-25 years of work experience (Q1), their lack of computer knowledge may be explained by the lack of this course before 1990. Such an indicator is sufficient to create the possibility that adapting the knowledge of this group of teachers to the new form of online learning process could be difficult and with debatable productive effect.

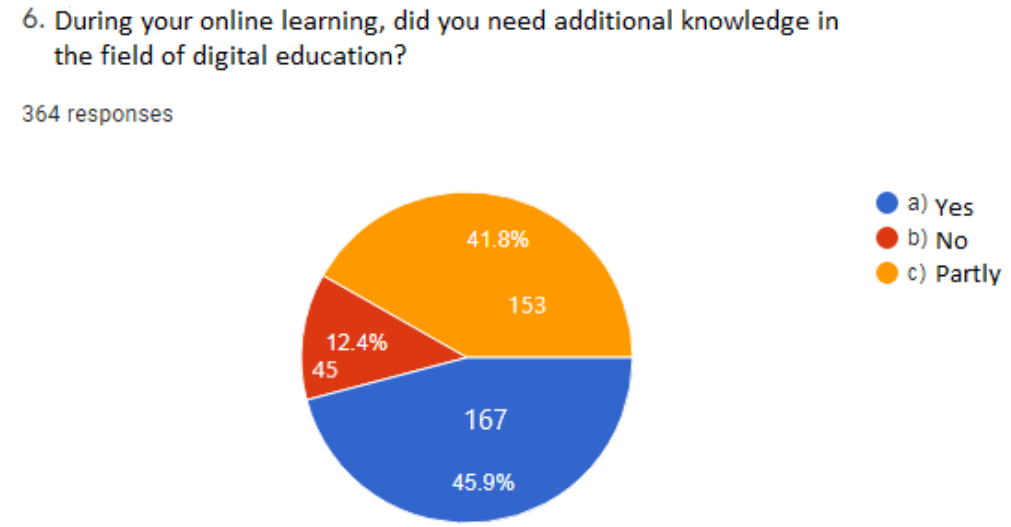
The above result is supported by the Q5: *"Have you acquired digital competencies during teacher training?"* For this question, participants were able to select more than one response. As shown in Figure 1, 64 (17.6%) of participants claimed to have acquired knowledge on digital competence during their Bachelor's program and/or Master programs. One hundred forty-two (39%) of participants stated they developed this competence from trainings received from state or independent institutions. Still another 184 (50.5%) reported they developed digital competence individually and another 28 (10.4%) claimed they had not been able to acquire digital competence. Such indicators expressed the variation in teachers' level of digital competence.

Figure 1
Source of Participants' Digital Competence Education



Another question (Q6) sought to obtain information on the needs of teachers for additional knowledge in the area of digital education. Specifically, the question asked, *"During the learning that you develop/have developed online, did you need additional knowledge in the field of education digital?"* As shown in Figure 2, 45 (12.4%) participants claimed to have *not* needed additional knowledge in the field of digital education. In contrast, 167 (45.9%) participants stated they needed further knowledge and 153 (41.8%) reported needing partial knowledge. When combined, 319 (87.7%) participants reported needing to improve and gain additional knowledge in the field of digital education.

Figure 2
Participants' Need for Additional Digital Education Knowledge



The next quesiton (Q7) asked, "*Do you think that you have consolidated knowledge in the field of technology in order to integrate it in your course?*" Interestingly, 153 (43.8%) of participants stated they had consolidated knowledge of technology which enabled them to integrate it with the subject they tuaght. This is a useful result, given that the cirriculum in Albania's pre-

university education is based on basic competencies. This result indicates the level of technology integration in pre-university education subjects. In comparison, 182 (49.9%) participants claimed to have partial knowledge of technology enabling to infuse it into the subject they teach. Only 23 (6.3%) participants stated they did not have to reinforce knowledge on subject integration with technology.

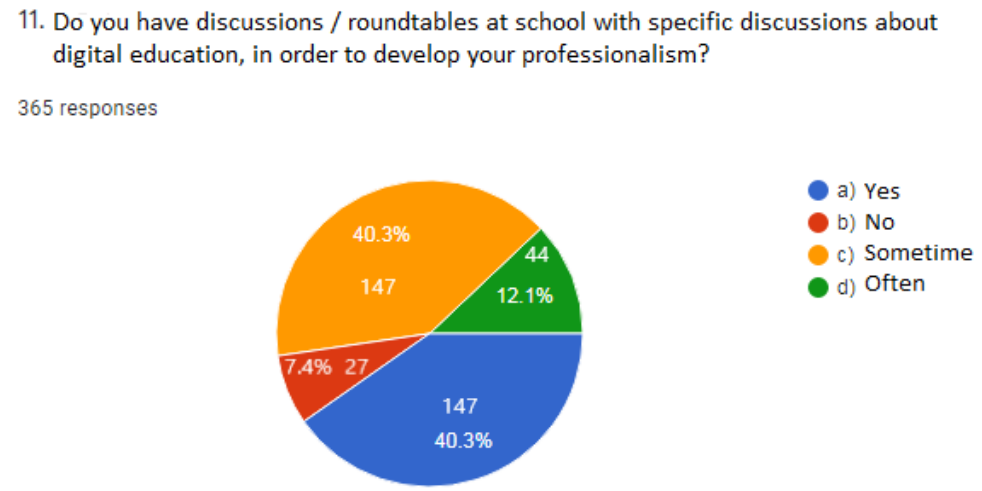
The answers to Q8 provided data on the extent of development of subject competencies during online learning: *"Have you managed to develop each subject competence through the topics covered during online learning?"* Only 136 (37.3%) participants stated they managed to develop every subject competence through the topics covered while teaching online. These data are of particular importance as a positive indicator of the realization of basic competencies through online learning. However, 24 (6.6%) of participants stated they were *not* able to develop subject competencies and 205 (56.2%) claimed to have developed only partial comptencies.

In order to understand how much time technology occupied when teaching in the classroom, Q9 asked: *"Does the application of technology find a place during the current period that learning takes place physically?"* For this question, 182 (50%) of participants answered positively, 37 (10.2%) answered negatively, and 145 (39.8%) answered only partly.

Another question (Q10) aimed to evaluate the impact of teachers' digital competence in increasing their interest towards scientific innovations: *"Has digital competence enabled you to be in coherence with the latest scientific innovations?"* The vast majority of participants (249 or 68.2%) confirmed the impact of digital competence on their interest towards scientific innovations. Another 109 (29.9%) participants responded that it enabled them only in part while only 7 (1.9%) reponded negatively.

The answer to Q11, *"Do you hold discussions / roundtables on specific topics for digital education at school, for the purpose of your professional development?"* provided similar results. As shown in Figure 3, 147 (40.3%) of the participants answered yes and another 147 (40.3%) answered sometimes. On the other hand, 27 (7.4%) participants stated there was a lack of the development of specific topics on digital education and 44 (12.1%) stated these topics were often addressed.

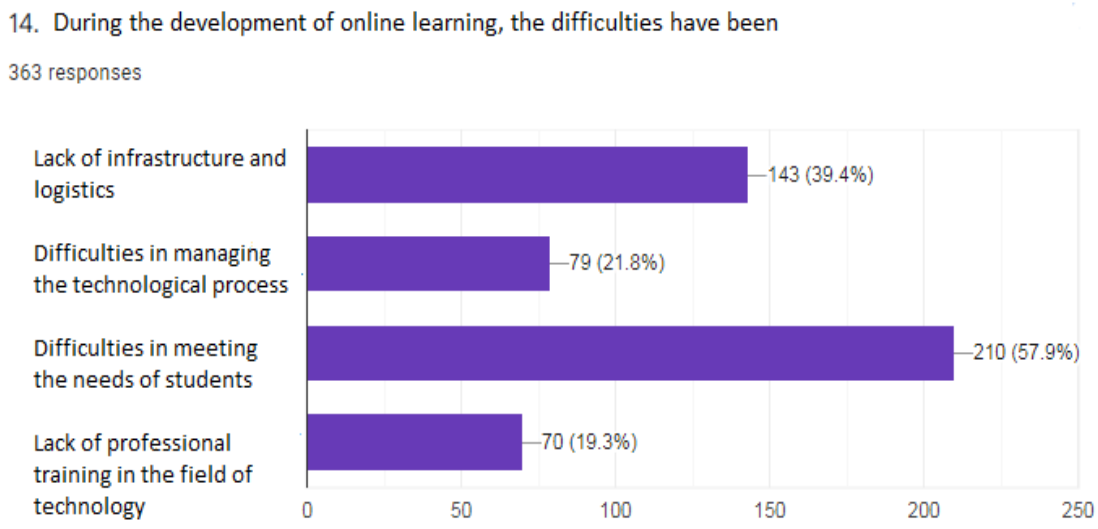
Figure 3
Participants' Discussions on Digital Education



Another question (Q13) asked participants about the readiness of their schools in terms of infrastructure to cope with online learning. This question asked, *"Is your school prepared to cope with online learning in terms of infrastructure?"* In answer, 50 (13.7%) participants confirmed that their schools were in good condition, 221 (60.8%) indicated schools were only partly prepared, and 93 (25.5%) participants stated that their school did not have optimal conditions for coping with online learning.

When asked about *difficulties they encountered in developing online learning* (Q14), 143 (39.4%) participants reported deficiencies in infrastructure and logistics. Another 79 (21.8%) participants reported difficulties managing the technological process, 210 (57.9%) reported difficulty meeting the needs of students, and 70 (19.3%) reported lacking relevant training in the field of technology. Figure 4 shows the type of problems encountered by teachers during online learning and their assessment on the level of difficulty encountered. For this question, the participants had the opportunity to select more than one answer.

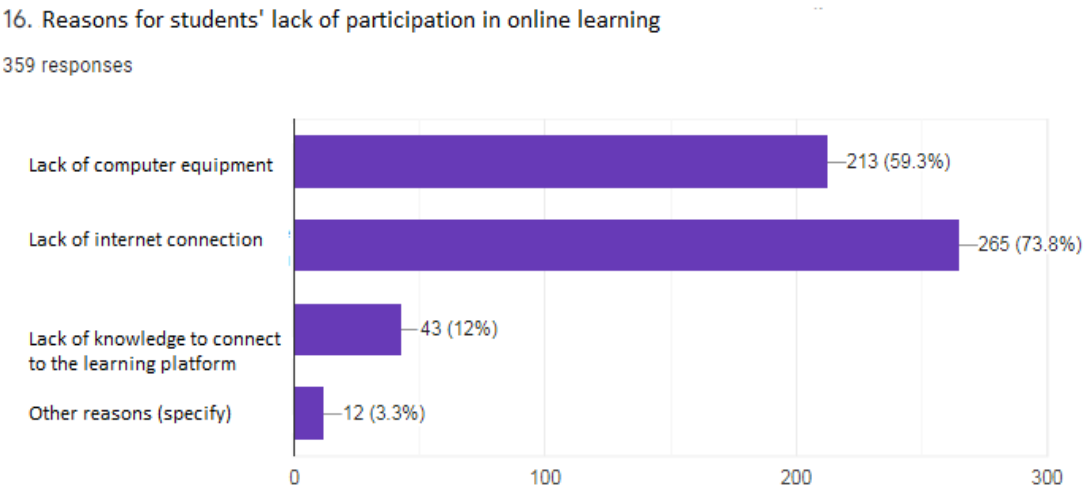
Figure 4
Difficulties Encountered During Online Learning



Another survey question (Q15) asked about *students participation in online learning*. For this question, 81 (22.2%) of the participants reported full participation by students during online learning, another 243 (66.6%) reported that more then half of their class attended, 39 (10.7%) stated that less then half of the class attended, and 2 (0.5%) stated that the students did not attend.

Participants were asked to provide reasons for their answers to the previous question (Q16). As shown in Figure 5, 213 (59.3%) participants mentioned a lack of computer equipment, 265 (73.8%) associated the lack of students' presence to a lack of internet connection, 43 (12%) suggested a lack of student knowledge related to connecting to digital learning platforms, and 12 (3.3%) stated other reasons without further specifying them. For this question, participants had the opportunity to select more than one response.

Figure 5
Reasons for a Lack of Student Participation in Online Teaching



Teachers were also asked about the *alternatives they would consider necessary for improving digital competencies* (Q17). For this question, 15 (4.2%) particpants indicated a need for profound pedagogical changes, 39 (10.8%) suggested reviewing access to curricula and assessment, 17 (4.7%) indicated a need for organizational changes to the school, 138 (38.5%) pointed to a more effective use of school facilities and teaching aids, and 152 (41.8%) indicated all these alternatives were required at once.

In the final question (Q18), particpants were asked to comment on *the difficulties encountered in managing teaching time due to technology management*. In answer, 157 (43.4%) participants acknowledged difficulty managing teaching time. Thirty-two (8.8%) particpants reported not showing problems in time management and 173 (47.8%) stated they had partial difficulties with time management, mostly as a result of inefficient technology management.

Overall, the results of the questionnaire show that teachers may not be prepared for digital competence. Digital knowledge is mostly obtained individually, which means that the level of ability for this individually acquired knowledge is informal and not standardized (Jong & Ferguson-Hessler, 1996).

The majority of teachers felt the immediate need for additional training, as they were insecure in the competencies they possessed. According to Figure 2, the development of digital competence in teachers is presented as an urgent need in order to achieve course integration. It is one of the main elements for the development of teaching and learning process. Failure to perform basic competencies due to a lack of digital skills is a critical issue, which raises questions about the learning provided during the pandemic. Given that a high percentage of participants, as evidenced in Q8, indicated that they managed to only *partly* cover subject competencies, the skills students acquired during the class are concerning if subject competencies were not fully realized.

The discontinuation of online learning and the return to physical classrooms have helped integrate the teaching process with technology application. According to Q10, most teachers claimed that digital competence helped them to be in coherence with the latest scientific knowledge by boosting their professional level. Professional development is a focus of teaching staff, where the topics of digital education are among the most selected, showing a tendency of teaching staff to improve this competence. On the other hand, the use of technology during the teaching process brings difficulties in time management.

Although the questionnaire was completed by teaching staff, 37% of which are part of schools located in the city, only 13% of the participants claimed that their schools had optimal conditions for the development of online learning. More than 80% of participants said that educational institutions did not have the conditions to develop the online learning process, due to inefficient internet connection. The results illustrated in Q13 and Q14 indicated that the greatest difficulties during the development of online learning were encountered in meeting the needs of students and in the deficiencies of school infrastructure and logistics (Figure 4). The answers provided underscore that online learning did not reach a significant number of students, who could not be a part of online class likely due to a lack of infrastructure (Figure 5). To summarize, improving digital competence requires pedagogical change, the revision of the curricula, and the effective use of school facilities and teaching aids.

Discussion

ICT knowledge is one of the core competences of 21st Century Skills needed for students, educators, school reformers, college professors, employers, and others. This competence is applicable to all academic subject areas, and in all educational, career, and civic settings throughout a learner's life. Yet, challenges with adapting education to technology and better-preparing teacher education students is a long-standing issue (Falloon, 2020). To help address this issue, the European Digital Competence Framework aims to describe digital competencies for teachers, focusing on six separate areas of educators' professional activities (Redecker, 2017). These areas are summarized in Table 1.

Table 1
Study Results Corresponding to the Six Areas of Educator Professional Activities

Number	Area Description	Study Findings
Area 1	Professional Engagement. *Using digital technologies for communication, collaboration and professional development.*	320 (87.7%) participants needed to improve and gain additional knowledge in the field of digital education (Figure 2)
Area 2	Digital Resources Sourcing. *Creating and sharing digital resources*	The majority of respondents (60.8%) reported that school infrastructure was only partially prepared to cope with online learning, while 25.5% reported a complete lack of optimal school conditions for digital education (Q13)
Area 3	Teaching and Learning. *Managing and orchestrating the use of digital technologies in teaching and learning*	56.2% of participants claimed that they did not have reinforced knowledge on subject integration with technology, or had only partial knowledge of technology that enabled them to infuse technology into the subject they taught (Q7).
Area 4	Assessment. *Using digital technologies and strategies to enhance assessment.*	210 (57.9%) particpants reported that one of the most frequently encountered difficulties during online learning was meeting the needs of students (Figure 4).
Area 5	Empowering Learners. *Using digital technologies to enhance inclusion, personalization and learners' active engagement.*	Obstacles for the active participation of students during online learning were a lack of computer equipment (59.3%) and poor internet connection (73.8%) [Figure 5].
Area 6	Facilitating Learners' Digital Competence. *Enabling learners to creatively and responsibly use digital technologies for information, communication, content creation, wellbeing and problem-solving*	The teachers emphasized the need to acquire additional knowledge in the following areas: pedagogical changes, revision of curricula and assessment, organizational changes of the school, and the effective use of school facilities and teaching aids (Q17).

The areas of professional skills mentioned in the European Digital Competence Framework are related to Albania's legal framework for education. However, although documents such as: "Professional standards of teachers," "Competency-based curricular framework" or "Law on pre-university education in the Republic of Albania" are outlined, it seems that the sustainable development of digital competencies is a continuous effort to get closer to the standards of the regional and European countries. The development of digital competence for educational staff in Albania requires an integration of technology training with teacher preparation programs (Sutton, 2011).

The first area, which is related to professional development, describes the use of digital technologies for communication and collaboration with colleagues, students, parents and others. In addition, it emphasizes the importance of teachers' reflection, individually and collectively, on their teaching practices, as well as critically evaluating the effectiveness and appropriateness of their digital teaching strategies by actively developing them (Caena & Redecker, 2019). The data obtained from this study identified shortcomings in the professional engagement of teachers in order to meet the indicator of Digital Competence of Educators (DigCompEdu). The need of teachers for additional digital competences and knowledge on digital education, particularly during online learning, shows that the motivation to improve digital competencies may come as a personal request of the teacher rather than as encouragement from educational institutions.

The second area focuses on the selection and management of digital resources in education, including knowledge on the protection and security of data disseminated in digital resources. The Albanian legal framework does not allow educational institutions to choose or manage digital platforms. Educational institutions do not have the right level of financal and managerial autonomy in order to be accountable for this aspect. Since educational institutions in Albania are not considered budgeted units in financial policies, they do not have separate budgets, and, consequently, every educational institution is administratively dependent on local and central government (On Pre-university Education System in the Republic of Albania Law of 2012, Pub. L. No. 69/2012; European Commission, 2018).

Data collected for this study found that participants reported their schools were not in optimal condition for the development of online learning. This was due to lack of infrastructure and logistics. According to the report of the United Nations Rapporteur on the right to education, technological infrastructure, along with software, technical support, teacher training and maintenance requires significant support from the state (UN, 2016).

Meanwhile, digital resources that make the right to education accessible do not find themselves sufficiently in the Albanian legal provisions in force. The legal framework that includes ICT in pre-university education is incomplete. Moreover, the strategy for pre-university education has found the use of ICT in educational institutions limited, as well as equipment that serves this purpose, to be obsolete in most cases (Albanian Council of Ministers, 2016). According to the UNESCO analysis of education policies in Albania, many of the 15,731 computers and 1,631 laptops in pre-university schools are not functional. Laboratory computers, in addition to being connected to the Internet, are not equipped with curricula or subject-related content applications (UNESCO, 2017).

The third area focuses on the management and use of technology in the learning process. Technology can improve and develop teaching and learning strategies in a variety of ways (Redecker, 2017). The questionnaire data showed that more than half of the participants had difficulty integrating technology with the content of the curricula, casting doubt on the effectiveness of teaching and learning strategies using technology. The assertion that the lack of knowledge in technology impacts teachers' management lessons, causing difficulties, is another indication that the development of the teaching process through technology takes considerable time to be realized and adapted. The comparison of the survey data used in this study with the information collected from the Online Learning Survey 2 conducted by the Agency for Quality Assurance in Pre-University Education shows a deep discrepancy in the level of digital competence of teachers. The state survey found that 98% of teachers nationwide were effective in linking subject topics to online teaching. In contrast, the data from this study

revealed that 87.7% of participants needed to *improve* and *gain additional knowledge* in the field of digital education.

The fourth area is related to assessment and addresses the concrete use of technology for assessing learning needs (Caena & Redecker, 2019). Although the information received from teachers belongs to a period when online teaching is no longer taking place, teachers admitted that one of the main difficulties they encountered during online teaching was related to the shortcomings in meeting student needs. Throughout the curriculum and its breakdown into textbooks, digital education poses a fundamental challenge to the education system. Moreover, digital competence is one of the basic competencies to be integrated in the new Albanian curricular framework. Currently, the first steps have been taken through the introduction of digital textbooks in the pre-university educational institutions of secondary education that have tablet laboratories for the integration of e-learning platforms (Albanian Ministry of Education and Sports, 2016). However, the adaptation of the right to education in Albania with the development of digital competences and the effective use of ICT in school requires not only the drafting and strengthening of the legal framework in force in pre-university education, but above all, investments by the state to meet the needs for the comprehensive deployment of ICT, both in infrastructure, technology, curricula and textbooks, as well as in training and qualification of the teaching staff.

The fifth area emphasizes the importance of creating learning activities and experiences that address student needs and allows them to actively develop their learning process by helping to improve digital competence (Caena & Redecker, 2019). Teacher statements in the survey emphasized the lack of affecting all students during the development of online learning due to limited computer equipment and poor internet connections.

The sixth area relates to teachers' efforts to facilitate their students' digital competence, enabling them to manage risks and use digital technologies safely and responsibly (Caena & Redecker, 2019). This aspect is related to digital education that teachers should possess at satisfactory levels. In this study, particpants expressed having an immediate need to obtain additional knowledge in the field of digital education.

Recommendations

Preparing teachers with digital knowledge requires a great commitment from all faculties that offer teaching programs in education. It also requires multidisciplinary coordination with support from state policies in the field of education. The inclusion of digital knowledge in higher education curricula requires the same legal support as pedagogy and psychology courses pursued in teaching programs. The necessity of having digital knowledge for teacher training needs to be emphasized. Moreover, it requires broad-based support from all faculties of education that will engage in the preparation of the relevant courses. This knowledge obtained in the faculties of education should be reinforced through continuous teacher training, keeping teachers up-to-date with changes in digital knowledge (Falloon, 2020).

The knowledge acquired by teachers must be supported by well-organized digital systems, which require investment by the state in hardware and software infrastructure. Investing in infrastructure in education firstly requires the drafting of a real strategy. This will involve making a map of the education system and understanding the relevant investments needed in each level and school. Secondly, the investment in the school infrastructure should be accompanied by the provision of a good digital network, extending throughout Albania.

Moreover, the construction of suitable software for pre-university education schools is important as it will be used to distribute each school's information regarding student personal information, assessments, relevant school subjects, the curriculum of each subject, tests, and the work of students in each subject, as well as the coordination with parents or guardians for students' learning progress. Thirdly, investment in school infrastructure is also related to equipping schools with computers, smartboards, and other digital devices to facilitate the teaching process. These changes will help make the teaching process intertwined with digital technology to collect and transmit information in real-time.

The construction of the digital infrastructure will also ensure the integration of technology in school curricula, interweaving the knowledge of the subject with the communication and distribution of information to facilitate the teaching process. Teachers must be trained to use digital software/programs and to use this knowledge in the content and development of the subjects they teach.

The digital platforms built and implemented in schools will also be used for assessing learning needs as well as for measuring students' digital competence. Students today must acquire digital competence. This will impact teaching and evaluation in order to find ways to improve this competence. Additionally, the digital platforms should have an all-inclusive approach, enabling all users to use it, thus promoting inclusion, individual engagement, and student involvement.

For this policy to continue, it is necessary for the establishment of a national training network focusing on the development of teachers' digital competence. This network will support implementing the curriculum. The national training network can be developed and supported by higher education institutions as a continuous qualification after initial training. This will help build a decentralized approach from central institutions for professional development. Following these steps will serve to implement the European Digital Competence Framework in equipping teachers with digital competencies.

Conclusion

The need to address digital competencies has become evident not only from international analysis in the Albanian education sector, but was also clearly identified during the COVID-19 pandemic. For a variety of reasons, Albanian educators encountered difficulties with online teaching. This study indicates a need to strengthen digital competency in education in terms of teaching competence, pre-service teaching programs, in-service training, curricula, and infrastructure. The goal is a holistic approach towards a functional, productive and effective educational system that exists within an increasingly digital society. The study highlighted the fact that the digital competence of teachers is interconnected with the digitalization of the whole education system, and it is embedded in all aspects of the teaching profession including reflecting, researching, communicating, modelling and teaching. Given that the Albanian education system continues to be centralized both politically and financially, the need for investment in digital education must be met by the government in parallel with curricular changes in pre-service and in-service training. To facilitate this, mechanisms should be built not only to promote and improve teachers' knowledge in digital competence, but to introduce ways of incorporating digital applications, platforms and programs that support everyday knowledge creation and distribution. The results of this study further reveal the need to adopt the European Framework, to include it into educational policy and legislation, and to break it down into concrete areas of the teaching profession. The results of this study can provide a

focal point for policy reflection on the part of the state, with the goal of increasing investment in education to facilitate the digitalization of the system.

In addition, this study may increase awareness among faculties and universities that offer pre-service teaching programs to enable different courses with a focus on improving digital competence of graduating teachers about to enter future classrooms. Finally, the study seeks to provide a voice for governmental institutions developing educational policies in Albania to provide ongoing training for teachers in the field of digital competencies.

References

Albanian Ministry of Education and Sports. (2016, May 30). "*On the procedures of competition, approval, ordering, distribution and sale of digital textbooks in educational institutions of the pre-university education system that have laboratories with tablets for the integration of e-learning platform*", Ministry of Education and Sports, Instruction no. 9, dated 30.05.2016. Official Gazette no. 113, year 2016. https://arsimi.gov.al/tekstet-mesimore/

Albanian Council of Ministers. (2022, June 01). "On the approval of the intersectoral strategy "Digital Agenda of Albania" and action plan 2022-2026". Decision no. 370, dated 01.06.2022, of the Council of Ministers. https://akshi.gov.al/wp-content/uploads/2022/06/vendim-2022-06-01-370.pdf

Albanian Council of Ministers. (2016, January 11). "*On the approval of the strategy for the development of pre-university education for the period 2014-2020*". Decision no. 11, dated 11.01.2016 of the Council of Ministers. https://arsimi.gov.al/strategjia-e-zhvillimit-te-arsimit-parauniversitar-2014-2020

Albanian Quality Assurance Agency in Pre-university Education. (2020). *Sondazh i mësimit online 2. Perceptime te nxënësve, prindërve dhe mësuesve.* https://arsimi.gov.al/wp-content/uploads/2020/04/1586552308063_Sondazhi-i-m%C3%ABsimit-online-2.pdf

American Association of Colleges of Teacher Education, Partnership for 21st Century Skills. (2010). *21st Century Knowledge and Skills in Educator Preparation*. Retrieved from https://files.eric.ed.gov/fulltext/ED519336.pdf

Anderson, P., & Mattsson, L. (2020). Future digitalization of education after COVID-19. In M. Carlsson-Wall, G. Lindqvist, & S. Rosengren, A. Werr, & F. Wijkström (Eds.), *Sweden through the crisis.* Stockholm School of Economics Institute for Research.

Babaheidari, S., & Svensson, L. (2014). *Managing the Digitalization of Schools: an exploratory study of school principals' and IT managers' perceptions about ICT adoption and usefulness.* Conference Paper E-Learn 2014 - New Orleans, LA, United States, October 27-30, 2014. https://doi.org/10.13140/2.1.4707.8083. Retrieved from https://www.learntechlib.org/primary/p/148768/

Brewer, E. (2009). *Conduction survey research in education.* Handbook of Research on E-Learning Applications for Career and Technical Education: Technologies for Vocational Training. https://doi.org/10.4018/978-1-60566-739-3.ch041.

Caena, F., & Redecker, C. (2019). Aligning teacher competence frameworks to 21st century challenges: The case for the European Digital Competence Framework for Educators (Digcompedu). *European Journal of Education*. Wiley. No. 54. 356–369. https://doi.org/10.1111/ejed.12345.

Check, J., & Schutt, R. K. (2012). *Research methods in education*. Thousand Oaks, CA: Sage. DOI: https://dx.doi.org/10.4135/9781544307725

Council of the European Union. (2018). *Recommendation of 22 May 2018 On key competences for lifelong learning (2018/C 189/01)*. Official Journal of the European Union. C 189/1. 04.06.2018. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018H0604(01)&rid=7

Dede, C. (2010). Comparing frameworks for 21st century skills. In J. Bellance, & R. Brandt (Eds.), *21st century skills: Rethinking how students learn* (pp. 51–76). Bloomington, IN: Solution Tree Press.

Duda, A., & Golubeva, M. (2013). *Teacher education and training in the Western Balkans: report on: Albania.* European Commission, Directorate-General for Education, Youth, Sport and Culture. Skikos, H.(editor), Publications Office, 2013. https://data.europa.eu/doi/10.2766/62639

European Commission. (2021). *Albania 2021 Report.* Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions 2021 Communication on EU Enlargement Policy. Strasbourg 19.10.2021 Retrieved from https://ec.europa.eu/neighbourhood-enlargement/albania-report-2021_en

European Commission. (2013). *Supporting Teacher Competence Development for Better Learning Outcomes*. Brussels: European Commission Education and Training UE. Retrieved from https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SWD:2012:0374:FIN:EN:PDF

European Parliament, & Council of European Union. (2006). *On Key competences for lifelong learning.* Recommendation 2006/962/EC. Official Journal of the European Union L 394/10 30.12.2006. Retrieved from https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:394:0010:0018:en:PDF

European Parliament resolution. (2021). *On shaping digital education policy. 2020/2135(INI).* Retrieved from https://www.europarl.europa.eu/doceo/document/TA-9-2021-0095_EN.html

European Commission. (2019). *Eurydice Report, Digital Education at School in Europe.* Luxembourg, Publications Office of the European Union. Retrieved from https://eacea.ec.europa.eu/national-policies/eurydice/content/digital-education-school-europe_en

European Education and Culture Executive Agency, Eurydice. (2019). *Digital education at school in Europe*. Publications Office, 2019. https://data.europa.eu/doi/10.2797/763

European Commission. (2018). *Commission Staff Working Document, Albania 2018 Report*. Strasbourg, 17.04.2018, p. 49. https://ec.europa.eu/neighbourhood-enlargement/system/files/2020-10/20180417-albania-report.pdf

Falloon, G. (2020). *From digital literacy to digital competence: the teacher digital competency (TDC) framework.* Educational Technology Research and Development 68, 2449-2472. https://doi.org/10.1007/s11423-020-09767-4

Ferrari, A. (2013). Report of the European Commission. *DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe.* Luxemburg. Publications Office of the European Union. https://op.europa.eu/en/publication-detail/-/publication/a410aad4-10bf-4d25-8c5a-8646fe4101f1/language-en

Gabsalamov, A., Akhmetshin, E., Bochkareva, T., Vasilev, V. (2020). "Digital Era": Impact on the Economy and the Education System (Country Analysis). *Utopía y Praxis Latinoamericana, 25*(10), 170–186. https://doi.org/10.5281/zenodo.4155437

Garzon-Artacho, E., Sola-Martínez, T., Romero-Rodríguez, J., Gomez-García, G. (2021). Teachers' perceptions of digital competence at the lifelong learning stage. *Heliyon* 7, 2021, e07513. https://doi.org/10.1016/j.heliyon.2021.e07513

Glover, I., Hepplestone, S., Parkin, H., Rodger, H., Irwin, B. (2016). Pedagogy first: Realizing technology enhanced learning by focusing on teaching practice. *British Journal of Educational Technology*, 47(5), 993–1002. https://doi.org/10.1111/bjet.12425

ILO & UNESCO. (2016). *The ILO/UNESCO Recommendation concerning the Status of Teachers (1966) and the UNESCO Recommendation concerning the Status of Higher-Education Teaching Personnel (1997) –* Revised edition 2016, International Labour Office, Sectoral Policies Department, Geneva, ILO, 2016. ISBN: 978-92-2-131311-3 (print) Retrieved http://portal.unesco.org/en/ev.php-URL_ID=13084andURL_DO=DO_TOPICandURL_SECTION=201.html

Jong, T., & Ferguson-Hessler, M. (1996). Types and qualities of knowledge. *Educational Psychologist*, 31(2), 105–113. http://search.epnet.com/login.aspx?direct=true&db=pbh&an=9612021864

Kim, Sh., Riza, M., Seidman, E. (2019). Improving 21st-century teaching skills: The key to effective 21st Century learner. *Comparative & International Education*, *14*(1) 99–117. https://doi.org/10.1177/1745499919829214.

König, J., Biela, D., Glutsch, N. (2020). *Adapting to online teaching during COVID-19 school closure: teacher education and teacher competence effects among early career teachers in Germany.* European Journal of Teacher Education, *43*(4), 608–622, https://doi.org/10.1080/02619768.2020.1809650.

Kullaslahti, J., Ruhalahti, S., & Brauerm, S. (2019). Professional Development of Digital Competences: Standardised Frameworks Supporting Evolving Digital Badging Practices. *Journal of Siberian Federal University. Humanities & Social Sciences*, *12*(2), 175–186. https://doi.org/10.17516/1997-1370-0387

Lorente, L., Arrabal, A., & Pulido-Montes, C. (2020). The Right to Education and ICT during COVID-19: An International Perspective. *Sustainability 2020*, 12, 9091; https://doi.org/.3390/su12219091.

Miço, H. (2019). *"An overview of the right to education in Albania. The performance of this right in accordance to European legislation.*" (Unpublished Doctoral Dissertation). Institute of European Studies, University of Tirana. Albania. Retrieved from http://www.doktoratura.unitir.edu.al/2020/01/nje-veshtrim-i-pergjithshem-mbi-te-drejten-per-arsim-ne-shqiperi-ecuria-e-kesaj-te-drejte-ne-perputhje-me-standardet-nderkombetare-dhe-legjislacionin-evropian/

Miço, H., & Zaçellari, M. (2020). "Online learning as a means toward achieving an adaptable right to education in Albania". *Knowledge-International Journal*, 2020, 42(2) 293–298. ISSN online 2545-4439 https://ikm.mk/ojs/index.php/KIJ/article/view/4672/4459

Monteiro, A. (2015). *The teaching profession present and future*. Springer. ISSN 2211-193X (electronic). https://doi.org/10.1007/978-3-319-12130-7.

On Pre-University Education System in the Republic of Albania, Pub. L. No. 69/2012, 21.06.2012. https://arsimi.gov.al/wp-content/uploads/2019/02/Permbledhje-parauniversitari-8-Tetor-2020.pdf

OECD. (2019). *Impacts of technology use on children: Exploring literature on the brain, cognition and well-being.* Education Working Paper No. 195. EDU/WKP (2019)3. Retrieved from https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=EDU/WKP%282019%293&docLanguage=En

Pettersson, F. (2018). Digitally Competent School Organizations – Developing Supportive Organizational Infrastructures. *International Journal of Media, Technology & Lifelong Learning*, *14*(2), 132–143. https://www.diva-portal.org/smash/get/diva2:1260178/FULLTEXT02.

Pettersson, F. (2020). Understanding digitalization and educational change in school by means of activity theory and the levels of learning concept. *Education and Information Technologies* (2021) 26:187–204. https://doi.org/10.1007/s10639-020-10239-8

Redecker, C. (2017). *European Framework for the Digital Competence of Educators: DigCompEdu*. Punie, Y. (ed). EUR 28775 EN. Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-73494-6. http://dx.doi.org/10.2760/159770

Schola Europaea. (2018). *Key Competences for Lifelong Learning in the European Schools.* Ref.: 2018-09-D-69-en-1. Retrieved from https://europeanschooluxembourg2.eu/wp-content/uploads/Key-Competences-for-Lifelong-Learning-in-the-European-Schools.pdf

Sutton, S. (2011). The preservice technology training experiences of novice teachers. *Journal of Digital Learning in Teacher Education*, *28*(1), 39–47. https://doi.org/10.1080/21532974.2011.10784678

UNESCO. (2017). *Albania. Educationa policy review; Issues and Recommendations*. Paris, April 2017, p. 24. Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000247993

UNESCO. (2018). *UNESCO ICT Competency Framework for Teachers.* Published in 2018 by the United Nations Educational, Scientific and Cultural Organization, 7, place de Fontenoy, 75352 Paris 07 SP, France. ISBN 978-92-3-100285-4.

United Nations. (2018). The 2030 Agenda and the Sustainable Development Goals: An opportunity for Latin America and the Caribbean (LC/G. 2681-P/Rev. 3), Santiago, 2018. https://repositorio.cepal.org/bitstream/handle/11362/40156/S1801140_en.pdf?sequence=25&isAllowed=y

United Nations. (2016). *Report of the Special Rapporteur on the right to education.* A/71/358. 29 August 2016. Retrieved from https://www.right-to-education.org/sites/right-to-education.org/files/resource-attachments/UNSR_RTE_Report_Lifelong_Learning_2016_En.pdf

United Nations. (2015). *Transforming our world. The 2030 Agenda for Sustainable Development* A/RES/70/1. Retrieved from https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

United Nations. (2016). *Report of the Special Rapporteur on the right to education.* A/HRC/32/37. 6 April 2016. Retrieved from https://undocs.org/A/HRC/32/37

UN., & UNESCO. (2012). *ICT in Primary Education Analytical Survey*. Volume 1 Exploring the origins, settings and initiatives. Retrieved from https://iite.unesco.org/pics/publications/en/files/3214735.pdf

Walston, J., Redford, J., Bhatt, M. (2017). *Workshop on Survey Methods in Education Research: Facilitator's guide and resources* (REL 2017–214). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Midwest. Retrieved from http://ies.ed.gov/ncee/edlabs

Yehya, F. M. (2021). Promising Digital Schools: An Essential Need for an Educational Revolution. *Pedagogical Research, 6*(3), em0099. https://doi.org/10.29333/pr/11061

Corresponding author: Heliona Miço
Email: heliona.bellani@gmail.com

Using Computational Thinking to Facilitate Language Learning: A Survey of Students' Strategy Use in Austrian Secondary Schools

Marina Rottenhofer
Johannes Kepler University Linz, Austria

Lisa Kuka
Johannes Kepler University Linz, Austria

Sandra Leitner
Johannes Kepler University Linz, Austria

Barbara Sabitzer
Johannes Kepler University Linz, Austria

Abstract

After Jeanette Wing in 2006 described computational thinking (CT) as a fundamental skill for everyone just like reading or arithmetic, it has become a widely discussed topic all over the world. Computational thinking is a problem-solving skill set that is used to tackle problems in computer science. However, these skills, such as pattern recognition, decomposition, abstraction, generalization, and algorithmic thinking, are useful in other domains, as well. This study focuses on the use of CT skills to approach complex linguistic learning tasks in the foreign language classroom. To foster these problem-solving skills, an innovative method is used. The authors take advantage of computer science (CS) models (e.g. Unified Modeling Language – UML) and transform them into a teaching and learning tool. This paper describes the design and implementation of a survey used to detect students' use of learning strategies that are linked to computational thinking. This survey is an instrument used in a multiple-case study and was administered at the beginning of the interventions. The participants of the study were learners of English and Spanish (n=66) from two secondary schools. Results indicated that the students were medium to low users of learning strategies that demand problem-solving skills related to computational thinking. Differences by gender were also found, with females reporting higher use of learning strategies than males. To conclude, the study showed a low use of strategies among students and highlighted the importance of introducing students to learning strategies and fostering skills needed for future professional life.

Keywords: computational thinking, digital literacy, foreign language learning, learning strategy, modeling, visualization

Fast technological development shapes our future and has an impact on our personal, social as well as professional lives. For this reason, schools are confronted with high demands to equip students with knowledge and skills that help them to cope with the challenges of the future. According to the Future of Jobs Report 2020 (World Economic Forum, 2020), the top skills required in 2025 are divided into four groups: problem-solving, self-management, working with people, and technology use and development. Analytical thinking, active learning, and learning strategies as well as complex problem-solving are at the very top of this ranking. One problem-solving skill set, which has the potential to prepare students for future demands is computational thinking (CT).

Since 2006, CT has gained considerable attention as one of the core skills next to reading, writing, as well as arithmetic (Wing, 2006) and has already become part of compulsory education in many countries, including Austria (BMBWF, 2018). With this transformation, CT and CS models have found their way into the foreign language classroom as well. In our multiple case study that is based on Yin's model (2009), diagrams from the field of computer science (CS) are implemented as a teaching and learning strategy to foster computational thinking in foreign language education. In computer science, on the other hand, diagrams based on the UML (Unified Modeling Language) [Seidl et al., 2015] or Chen notation (Chen, 1976) are used to visually depict software systems or database structures. With the use of these diagrams in a different context as a teaching and learning strategy, the authors reach several goals at once. Firstly, many years of implementation and research have shown that modeling with CS diagrams is a useful visualization strategy for learners of all ages, is easy to acquire for teachers and students, and is applicable in all subjects (Demarle-Meusel et al., 2020; Rottenhofer et al., 2021; Sabitzer & Pasterk, 2015). Secondly, learners get in contact with a repertoire of static and dynamic CS diagrams outside computer science lessons which may help them to familiarize themselves with this field, spark their interest, and introduce basic computer programming concepts. Thirdly, depicting learning content with a model requires cognitive flexibility and fosters computational thinking skills such as abstraction, generalization, pattern recognition, and algorithmic thinking. To summarize, learners do not only get in touch with computer science concepts but also receive a useful learning tool that they can apply in different learning settings to solve complex tasks and memorize information long term. In the current research, CS models are implemented as graphic organizers in several foreign language learning settings. This paper presents the results of a survey that learners received at the beginning of the intervention. This survey aimed to examine to what extent the participants use learning strategies that are connected to computational thinking. For this, a survey on learning strategies had been modified from the two German questionnaires LSN – *Learning Strategy Use* (Martin & Nicolaisen, 2015) and LIST – *Learning Strategies at University* (Wild & Schiefele, 1994) by linking it to the areas of computational thinking.

Literature Review

In the 1980s, computational thinking (CT) was first mentioned by Papert (1980) in his work on teaching computer literacy at an early age where he saw CT as the result of his constructionist learning theory. Twenty-six years later, the term was boosted by Jeanette Wing as "a universally applicable attitude and skill set everyone, not just computer scientists, would be eager to learn and use" (2006, p. 1). Since then, much research has been done and numerous definitions emerged, many of which focus on programming, leading to the assumption that programming is a necessary tool to teach CT (Voogt et al., 2015). However, everyone should acquire CT, not only programmers (National Research Council, 2010) and students should get exposed to CT long before programming (Lu & Fletcher, 2009). To date, several researchers

have investigated the integration of CT in foreign language learning (FLL) [Barr & Stephenson, 2011; Hsu & Liang, 2021; Lu & Fletcher, 2009; Parsazadeh et al., 2021]. However, to the best of the authors' knowledge, none of them have investigated hands-on approaches to foster CT in FLL in depth.

In this study, computer science (CS) models are used as a form of graphic organizer (GO) to foster CT skills and get students engaged with computer science concepts outside the CS lessons. GOs originally derive from Ausubel's cognitive learning theory (1962), where he applied them as advance organizers at the beginning of the learning process. A graphic organizer is defined as a "visual and graphic display that depicts the relationships between facts, terms, and or ideas within a learning task" (Hall & Strangman, 2002, p. 2). According to Willis (2007, p. 315), this creative approach "coincides with the brain's style of patterning" and allows students to connect the information to previously stored memories, cluster information, discover patterns, and sort and store new data. This description is well-aligned with CT and demonstrates the usefulness of using models to foster these problem-solving skills. Furthermore, according to research, the use of GOs is particularly useful for students with learning difficulties (Dexter & Hughes, 2011; Kim et al., 2004; Sousa, 2017). These results confirm the authors' experiences of the benefit of modeling, especially for pupils with learning deficits. A major cause of learning difficulties in FLL such as dyslexia lies in struggles with recognizing and using language patterns in the new language. Even if pupils suffer from dyslexia, they may still have good intellectual abilities. However, they may not be able to notice similarities and differences between vocabulary and word formation patterns (i.e. semantic processing) in the foreign language compared to their native language (Schneider & Crombie, 2012).

The difficulties in recognizing language patterns make learning difficult. However, modeling with CS diagrams can support these pupils in their learning process. By teaching with appropriate diagrams in common FLL environments, all pupils, but especially pupils with learning difficulties, benefit as they acquire learning content easier and thereby learn to speak the foreign language more effectively. The following sub-section presents learning theories connected to graphic organizers and computational thinking.

Modeling, Computational Thinking, and Theories of Learning

The use of CS models as GOs is a teaching method that combines cognitivist and constructivist learning theories and computer science concepts to foster computational thinking skills.

Cognitivism emerged in the late 1950s and, in comparison to behaviorism that is based on the stimulus-response theory, relied on cognitive sciences by focusing on cognitive processes (Ertmer & Newby, 2013). Several cognitive learning theories support the use of GOs such as the subsumption theory, schema theory, dual coding theory, and cognitive load theory. According to Ausubel's (1962) subsumption theory on meaningful learning, learning and retention are facilitated when new information is related to already existing cognitive structures. To achieve this, he suggested the use of advance organizers. Anderson and Pearson (1988) claimed that the subsumption theory is consistent with his schema theory, where a person has understood a text when they have found a mental "home" for the information in the text, or else "that he or she has modified an existing mental home in order to accommodate that new information" (Anderson & Pearson, 1988, p. 2). The dual coding theory postulates that there are two systems, verbal and imagery, for processing information (Clark & Paivio, 1991). In other words, when information is presented in both forms, e.g. verbally and visually with a

model, chances of retrieval are increased. Lastly, the cognitive load theory by Sweller et al. (1998) assumes that the working memory has a limited capacity and can therefore only deal with a limited amount of information at a certain time. Used appropriately, GOs can reduce cognitive load and lead to better learning outcomes (Rahmat, 2020).

Constructivism is often considered a branch of cognitivism. However, the main difference is that constructivist psychologists believe "that the mind filters input from the world to produce its own unique reality" (Ertmer & Newby, 2013, p. 55). In other words, what we know of the real world is constructed personally with our own interpretations—"humans create meaning as opposed to acquiring it" (Ertmer & Newby, 2013, p. 55). Out of Piaget's constructivism, Papert developed the learning theory constructionism, where the focus shifts "from universals to individual learners' conversation with their own favorite representations, artifacts, or objects-to-think with" (Ackermann, 2001, p. 4). According to Ali and Yahaya's systematic review, constructivist learning theory is primarily used in computational thinking focusing on primary and secondary school levels, followed by constructionism (2020). However, they also claim that there are many studies on CT that do not focus on learning theories at all. Bellettini et al. postulate a social-constructivism approach to informatics and CT where the teacher's role is to "support the construction of knowledge through setting up contexts and scaffolding material favoring the activation of the learning process, in which the ultimate actor is the learner itself" (2018, p. 4). This means that teachers should motivate students to use active techniques in their learning process.

Computational Thinking and Language Learning

This section describes the core elements of computational thinking that are the focus of the current study. In the literature, CT is represented with different manifestations, core concepts, and skills. The Joint Research Center (JRC) from the European Commission (Bocconi et al., 2016) conducted a literature review and analyzed the skills emerging from the most prominent papers on CT. As a result, they developed a list of core elements, which are abstraction, algorithmic thinking, automation, decomposition, debugging, and generalization. In this study, the authors refer to the elements proposed by the JRC, extend them with pattern recognition (Curzon et al., 2019), and link them to foreign language teaching. Additionally, this section gives best practice examples on how to use modeling and CT as techniques that support students in creating new knowledge and engaging them actively in the learning process.

Decomposition

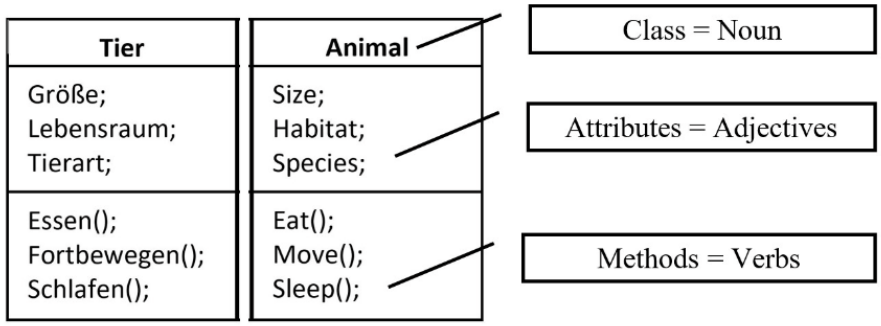
Decomposition is the process of dividing a bigger problem into smaller sub-problems (Barr & Stephenson, 2011). This divide-and-conquer strategy helps to facilitate the understanding of a problem and, thus, can be solved systematically as well as individually. In language education, this is a skill widely used. For example, when writing a paper only a few people would write it straight from the beginning to the end. Usually, the structure of it is well thought-through and headlines like "introduction", "methodology", "conclusion", and so forth. are created first. Then, additional arguments or topics are found for the main body. The introduction and conclusion are also known to be written last. This process illustrates decomposition at its best.

Abstraction

Abstraction describes the process of reducing complexity by omitting unnecessary details. Thus, the main characteristics of a problem or item are defined. Everyone handles abstract

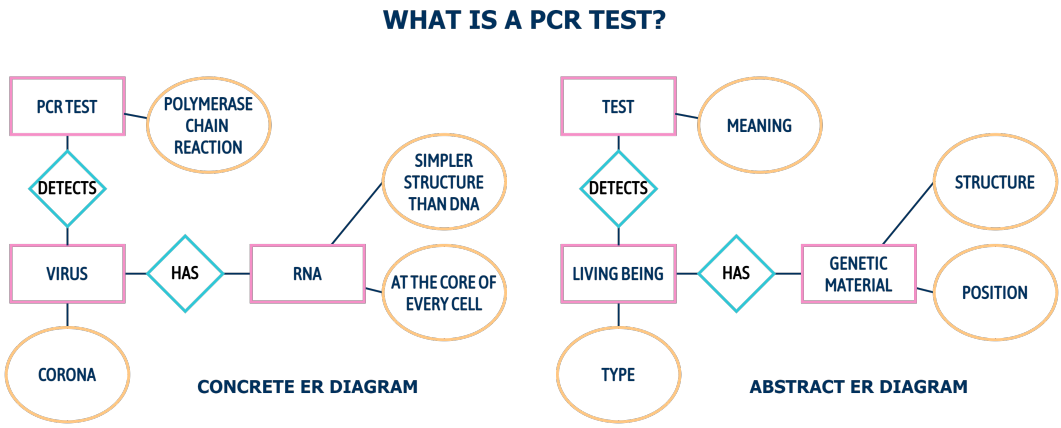
objects daily, for example, when using a map. Every map is a simplified presentation of reality. When learning about giving directions in the language classroom, subway maps are a common tool taken from real life. Another example is writing a summary. A summary is characterized by leaving out unnecessary details and concentrating on the most important information. Hence, training on writing summaries and encouraging students to take notes or highlight important information in a text, also helps to strengthen computational thinking skills. In computer science, class and object diagrams are used to visualize various components of a system and their relations (Seidl et al., 2015). Whereas class diagrams describe the abstract model of a system (e.g. animal), object diagrams illustrate concrete objects (e.g. cats and dogs). In the language classroom, these models can be used to develop new vocabulary about specific topics, illustrate relations and hierarchies, and categorize these items. Figure 1 shows a simple example of one class. As can be seen, the name of a class is always a noun, attributes are seen as adjectives, and methods as verbs. Thus, students can also practice the difference between these word classes and word formation.

Figure 1
Class Diagram



Another model, which is used in computer science frequently, is the entity-relationship model (ER model) [Chen, 1976]. It consists of three elements – rectangles as “entity-types” that are used as nouns, diamond shapes as “relationship types”, and the ellipses as “attributes” that describe the characteristics of the nouns. The ER model can be used as an intermediate step when writing summaries, supporting especially students with learning difficulties when writing texts. Figure 2 shows a model where elements of a text on COVID-19 were transformed into an ER diagram with concrete and generalized terms. Usually, in computer science, the ER diagram only uses generic terms instead of specific terms since it represents a type of a system and not an instance (Bagui & Earp, 2003). However, in the language classroom, this can be adapted by using concrete terms of a text and/or abstract terms.

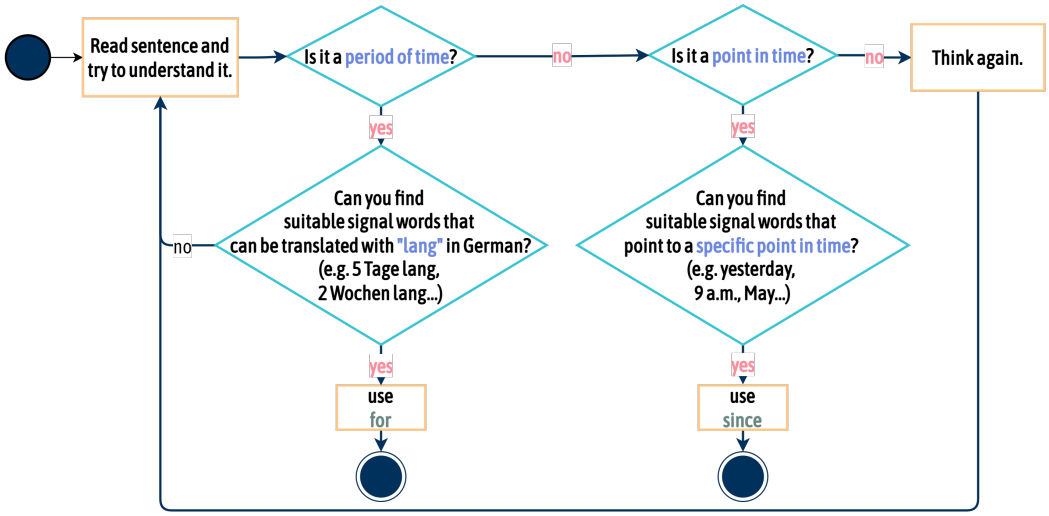
Figure 2
Entity-Relationship Diagram



Pattern Recognition and Generalization

Finding patterns is something inherently human, and the brain can remember patterns more easily (Grabmeier, 2018). As soon as patterns, similarities, and connections are found, a generalization of these can be done, and already known problem-solving strategies which worked for a similar scenario can be re-used. Also, in many cases, it is possible to draw conclusions from a part or general to the whole. Every language educator who used an inductive method is already familiar with pattern recognition and generalization. For example, the teacher provides various grammatical items such as sentences in the past tense using regular verbs. Subsequently, the students have to find grammatical rules based on the examples given. Figure 3 illustrates how the use of an activity diagram can visualize the grammatical rules, such as the use of "for" and "since" in English. Also, it can function as a step-by-step guide.

Figure 3
Activity Diagram showing the Use of For and Since in English



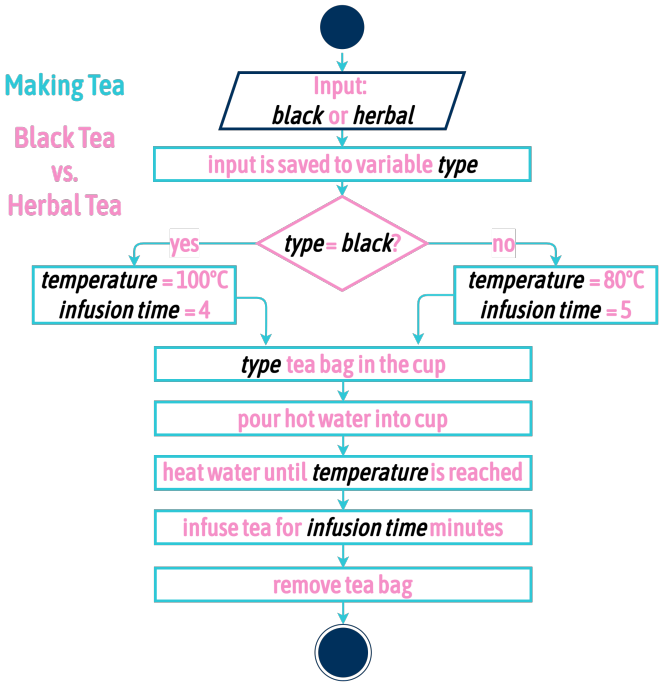
Another example in which generalization in the language classroom is used is by giving examples and prompts in which generalized terms like genre, title, author, and so on, are used.

The students then have to find the actual genre, title, and author of the presented text, that is, gothic novel, Frankenstein, and Mary Shelley.

Algorithmic Thinking

An algorithm is often described as a step-by-step guide comparable to a recipe. Teaching students to write good recipes can be compared to writing an algorithm. Not only is it important to be precise in its formulation, but also to think systematically about which step comes after the other. How long do you have to beat the eggs to make your cake heavenly fluffy? Usually, teachers give the exercise to simply write a recipe, but for students with learning difficulties, it may be a good idea to sketch the information at first via an activity diagram. With this intermediate step, they not only have the structure first but also the key vocabulary needed for the exercise. Figure 4 shows an example of an activity diagram created for a recipe.

Figure 4
Algorithm for Making Tea



Testing and Debugging

It is not enough to find solutions for problems; it is also necessary to systematically analyze these solutions using skills such as testing, tracing, as well as reasoning. Based on this accurate analysis, errors can be fixed and results predicted and verified. In the language classroom, students can be trained to achieve this by correcting (one's own) errors, for example, in a filling the gap exercise or when learning how to give feedback.

Automation

Automation is a work-saving process in which a machine or computer is instructed to perform a series of repetitive tasks quickly and efficiently compared to the processing power of a human. This is the only skill that usually is not very common in the language classroom,

although there would be possibilities to include programming as well, for example, with the use of the programming language Scratch or exercises from machinelearningforkids.com.

Methods

Background

In the school year 2020/21, a multiple case study (Yin, 2009) on modeling as a teaching and learning strategy to foster computational thinking was conducted. The subjects of the case studies were partner schools of the COOL (computer sciences-supported, cross-curricular, and cooperative open learning) Lab at the Johannes Kepler University in Linz. The JKU COOL Lab is an innovative teaching and learning lab for teachers, children of all ages, and university students. It focuses on computer science, computational thinking, and digital literacy. The lab has many offerings including workshops, weekly clubs for gifted students, theater shows on digital education, teacher training, and so forth. In addition to offerings for all interested parties, the lab works intensively with several partner schools where projects are implemented and researched over a longer period. In the multiple case study, modeling was implemented in four foreign language classes of two partner schools to find out more about (1) teachers' and students' perceptions of modeling as a teaching and learning strategy, (2) the chances and challenges of the implementation of modeling and (3) computational thinking as a problem-solving strategy. This paper focuses on computational thinking as a problem-solving strategy and presents the results of a survey administered to all the participants of the multiple case study at the beginning of each of the interventions. This survey aimed to find out more about students' use of learning strategies that are related to computational thinking. In particular, the following research questions were explored:

1. Is there a connection between learning strategies and the areas of computational thinking as a problem-solving strategy?
    a. If yes, what strategies are associated with computational thinking?
2. Do students use strategies associated with computational thinking to better understand and process learning content?
3. Does the use of learning strategies differ by gender?

Participants

The questionnaire was administered to a total of 66 students ($n_f = 31$, $n_m = 35$) from two partner schools (PS_n) of the JKU COOL Lab. In those partner schools, several teachers collaborated intensively with the researchers and two of them were willing to participate in this study. Thus, random sampling was not possible. Before conducting the study, written permission was obtained from the school principals as well as the parents of the participants. Both groups of PS1 (English class) and PS2 (Spanish class) were involved in the multiple case study for several months working with models as a teaching and learning strategy to foster computational thinking skills. To get an insight into students' computational thinking strategy use, the survey was administered at the beginning of the intervention. In the English group composed of 51 students, there were 29 males and 22 females with a mean age of 14.25 and a standard derivation of 1.369. The Spanish group consisted of 15 students, 6 males, and 9 females with a mean age of 13.27 and a standard deviation of 1.981. At the beginning of the study, none of the students were familiar with modeling and the concept of computational thinking. The demographic information of the participants is presented in Table 1.

Table 1
Participants in the Study

School	Subject	N	Male	Female	Mean Age	SD
PS1	English	51	29	22	14.25	1.369
PS2	Spanish	15	6	9	13.27	1.981

Instrument

In this study, a paper-based questionnaire on learning strategies was administered, consisting of 37 Likert-formatted items. For this survey, the authors adopted items from the LSN (*Learning Strategy Use*) questionnaire from Martin and Nicolaisen (2015) and combined it with four items from the LIST (*Learning Strategies at University*) questionnaire (Wild & Schiefele, 1994) bringing it up to 37 items.

The four LIST items were the following:

1. I try to organize the material so that I can easily remember it.
2. I visualize the material to be learned.
3. I learn key terms by heart to help me remember important areas of content.
4. I memorize a self-made overview with the most important terms.

The frequency was measured with a five-point Likert scale ranging from 1 (very rarely) to 5 (very often). The questionnaire was issued in German and was translated for this paper.

Procedure

The questionnaire was administered to the students at the beginning of the multiple case study in their regular language lessons. The participants of the study had no previous knowledge of modeling and computational thinking. The survey had no time limit to make sure the students were not under any pressure and could think deeply about their answers. The students needed approximately 10-15 minutes to respond to all the items of both Part 1 and Part 2 of the questionnaire.

To identify which learning strategies are used that relate to CT skills and visualization, three experts independently analyzed the first part of the questionnaire and filtered out the items (1-37) that can be assigned to the CT skills mentioned in section 2 on the one hand and to visualization strategies on the other. After this analysis, the experts discussed the respective selection and decided on the items used and their assignment to the respective categories. The statistical analysis was then conducted using the statistical software IBM SPSS Statistics 23.

Findings

Learning Strategies Related to Computational Thinking

The first research question sought to answer whether there is a connection between learning strategies and the core elements of computational thinking and if yes, which ones. The expert analysis has shown that a total of 22 Likert items can be related to computational thinking and visualization strategies. Specifically, 18 items from the Martin and Nicolaisen questionnaire

(2015) relate to computational thinking, and two items each of the LIST relate to visualization and CT (Wild & Schiefele, 1994). Table 2 shows an overview of the remaining items and the allocation to the individual areas. Since all the CT skills are intertwined, some items have multiple assignments. From the core CT skills proposed in section 2, all the skills except "automation" could be associated with items in the questionnaire.

Use of Strategies Related to Computational Thinking

The second research question investigated whether students use strategies associated with computational thinking to better understand and process learning content. To find out which of the CT skills according to the learning strategies are used the most, descriptive statistics, including means and standard deviation of the six CT categories as well as the category related to visualization was used. As illustrated in Table 3, three categories are above the middle of the Likert scale and four are below it. Testing and debugging strategies are used most frequently (M= 3.28; SD= .76), closely followed by decomposition strategies (M= 3.10; SD= .78) and algorithmic thinking (M= 3.03; SD= .79). On average, the categories below the mid point are: generalization (M= 2.88; SD= .90), abstraction (M= 2.83; SD=.89), pattern recognition (M=2.78; SD= .87) and lastly, visualization (M= 2.39, SD=1.09). According to Table 3, all categories had a mean score at the medium or low level. None of the categories had a mean value at a high level above 4.0.

Besides the descriptive analysis of the seven categories mentioned above, individual items were also ranked and highlighted as the five most and least commonly used learning strategies. As seen in Table 4, the most common strategy is to use the internet or dictionary when words are unclear (M=3.91; SD=1.32), whereas the least common strategy (see Table 5) is to create drawings or sketches to better see how things belong together (M=1.95; SD=1.07). Looking at all 22 items, none of the items has a mean value at a high level above 4.0. Half of the items (N=11) have a mean score at the medium level above 3.0, whereas 10 items are above 2.0 and only one item below.

Table 2
Survey Part 1: Likert-Items

Nr.	Item	Category
1	When I have to study for an exam, I make a short summary.	AB
2	I often do drawings or sketches to better see how things belong together.	V
3	I underline the important passages in the textbook.	AB
4	I try to organize the material so that I can easily remember it.	AL
5	I visualize the material to be learned.	V
6	When I learn something new, I try to figure out what to do with that knowledge (what is the practical use?).	GE
7	I wonder how what I am learning relates to what I have known so far.	AB
8	I wonder if what I am learning or hearing is logical.	TD
9	I wonder if there could be other explanations for what I read or hear.	GE, TD, PR
10	Instead of studying for a long time, I spread the work over several days.	DC
11	I repeat things (such as foreign language vocabulary) in small portions, but regularly (e.g. every day for 10-15 min).	DC, AL, PR
12	I learn key terms by heart to help me remember important areas of content.	AB, GE
13	I memorize a self-made overview with the most important terms.	AB, GE
14	When my learning is not going well, I try to change something and see if it goes better.	TD
15	Before I start to work, I set myself clear goals.	DC
16	While studying, I check whether I am still on the right track.	TD
17	When I stop working, I check whether I have achieved my goals.	TD
18	When I study, I make a realistic schedule.	AL, DC
19	I make sure that I have enough time the day before an exam to review all of the material again.	DC
20	Before an exam or a lecture, I think about what to do if things do not go well.	AL
21	I look for more information in books or on the Internet if something is not quite clear to me.	TD
22	If I do not understand words, I look them up on the Internet or in a dictionary.	TD

Abbreviations: DC Decomposition, PR Pattern Recognition, AB Abstraction, AL Algorithmic Thinking, GE Generalization, TD Testing & Debugging, V Visualization

Table 3
Descriptive Statistics – Computational Thinking Skills. N= 66

	Minimum	Maximum	Mean	Std. Deviation
Decomposition	1.40	5.00	3.1010	.77854
Pattern Recognition	1.00	4.67	2.7778	.86791
Abstraction	1.00	4.75	2.8258	.89224
Algorithmic Thinking	1.25	5.00	3.0253	.79124
Generalization	1.00	4.50	2.8750	.90219
Testing & Debugging	1.29	4.86	3.2835	.75696
Visualization	1.00	4.50	2.3939	1.09374

Table 4
Top 5 of the Most Commonly Used Learning Strategies. N= 66

	Nr.	Category	Min.	Max.	Mean	Std. Dev.
1. If I do not understand words, I look them up on the Internet or in a dictionary.	22	TD	1	5	3.91	1.321
2. I wonder if what I am learning or hearing is logical.	8	TD	1	5	3.73	1.089
3. I make sure that I have enough time the day before an exam to review all of the material again.	19	AL	1	5	3.46	1.251
4. I try to organize the material so that I can easily remember it.	4	AL	1	5	3.41	1.265
5. Before I start to work, I set myself clear goals.	15	DC	1	5	3.38	1.034

Abbreviations: DC Decomposition, AL Algorithmic Thinking, TD Testing & Debugging

Table 5
Top 5 of the Least Commonly Used Learning Strategies. N= 66

	Nr.	Category	Min.	Max.	Mean	Std. Dev.
1. I often do drawings or sketches to better see how things belong together.	2	V	1	5	1.95	1.073
2. When I have to study for an exam, I make a short summary.	1	AB	1	5	2.52	1.099
3. When I study, I make a realistic schedule.	18	AL, DC	1	5	2.61	1.341
4. I wonder how what I am learning relates to what I have known so far.	7	AB	1	5	2.65	1.295
5. While studying, I check whether I am still on the right track.	16	TD	1	5	2.73	1.103

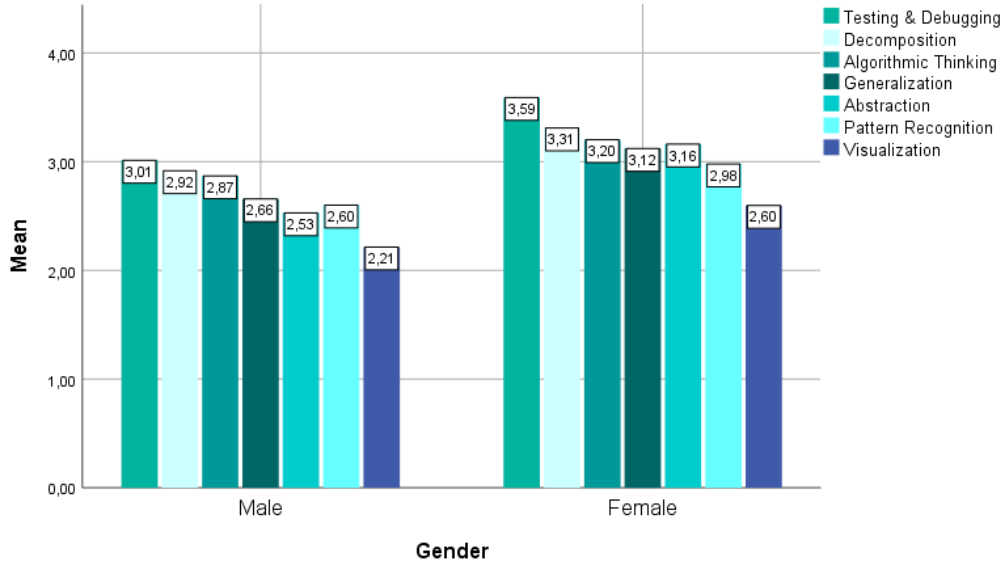
Abbreviations: DC Decomposition, AB Abstraction, AL Algorithmic Thinking, TD Testing & Debugging, V Visualization

Learning Strategies, Computational Thinking, and Gender

The last research question sought to answer whether strategy use related to CT differs by gender. The independent Sample T-Test revealed that female students reported statistically more frequent use of learning strategies related to CT than male students did. Female students have a higher mean score in relation to all learning strategies (M_f= 3.31; SD_f= .58, M_m= 2.80; SD_m= .63, p<.05) as well as in the different CT categories (see Figure 5). However, when looking at the single CT categories, only decomposition, abstraction, generalization, and testing and debugging were found to be statistically different (P<.05).

Figure 5

Mean Score of CT Strategy Use Related to Gender. N=66



A Pearson correlation coefficient was computed to assess the linear relationship between gender and CT categories, as well as overall strategy use. As reported in Table 6, there is a statistically positive correlation between gender (1=male, 2=female) and decomposition, abstraction, generalization, and testing and debugging as well as the overall strategy use.

Table 6

Pearson Correlation Coefficient between Gender and Strategy Use. N= 66

		gender	DC	PR	AB	AT	GE	TD	V	SUM
gender	Pearson Correlation	1	.254*	.219	.357**	.211	.259*	.384**	.176	.393**
	Sig. (2-tailed)		.039	.077	.003	.088	.036	.001	.158	.001
	N	66	66	66	66	66	66	66	66	66

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Discussion

This research sought to investigate the connection between learning strategies and the areas of computational thinking as well as students' use of the respective strategies. The results of the survey indicate that the participants were medium to low users of learning strategies that demand problem-solving skills related to computational thinking. These findings are consistent with previous studies on learning strategy use. For example, Aslan (2009) investigated language learning strategies and also found a medium level of strategy use regardless of gender. However, he found that higher-achieving students use more learning strategies. The low use of learning strategies, in general, may have several reasons. One explanation may be that students do not know which strategies are effective (Morehead et al., 2016). Korenell and Bjork (2007), on the other hand, found that many students' goal is to pass exams and not to store information long-term. Another possible explanation for the rare use of learning strategies could be the time factor. Previous studies have shown that many students do not split learning content over a longer period, but rather wait until just before an exam, often until the last day (Blasiman et al., 2017; Susser & McCabe, 2013; Taraban et al., 1999). There are similarities between the attitudes expressed by the participants of this study and those mentioned above. It is apparent from Tables 4 and 5 that many students make sure to have enough time the day before the exam (Item 19) and pay less attention to making a realistic schedule (Item 18) or checking whether they are still on the right track (Item 16). Hence, it could be hypothesized that the lack of time is the reason why students prefer quick searches for information (Item 22) rather than time-consuming strategies (Items 1, 2). Time constraints could also be the reason why students are less concerned about linking new information to prior knowledge (Item 7). However, it seems that students still organize their work, try to set goals (Items 4, 15), and question the new information (Item 8).

The results also demonstrate a statistically significant difference in learning strategy use by gender and correlate well with previous studies in the context of language learning where females surpassed males. In his work on language learning, Oxford reports on females "using more varied strategy types and employing strategies more frequently than males" (1993, p. 85). Furthermore, he claims that when students are not explicitly asked by the teacher to use a certain L2 learning strategy, they tend to use those favoring their learning style. For example, analytic learners (often males) prefer strategies involving logic, whereas the global learner (often females) prefer to use social strategies including searching for the main idea and intuitively guessing. In a study on gender and language learning strategies in learning English, Aslan (2009) also found a significant difference in strategy use, indicating that females, on average, employed more strategies than males in all domains and subscales investigated.

Although a great amount of literature reports a significant gender difference proposing that females generally use more learning strategies than males, few studies came to the opposite conclusion. For instance, Tercanlioglu (2004) conducted a study on foreign language learning strategies with 184 pre-service teachers from Turkey, showing a gender difference favoring males. According to her, the cultural background could be one of the reasons that the results are not consistent with many previous studies.

Limitations

This survey helped to illuminate strategy use of students and served as the basis for the implementation of CS modeling in foreign language learning to foster computational thinking skills. Nevertheless, the study also has its limitations. One of them includes the self-selection

bias resulting from the collaboration with the partner schools of the JKU COOL Lab. Another limitation of this study is the sample size. Further research and wider trials are needed to be able to generalize the results and to determine which other factors besides gender influence strategy use. Moreover, to be able to fully understand this phenomenon, the use of further data-gathering instruments such as interviews is also advisable, so that the case can be viewed from different angles leading to richer results and conclusions. A major reason why only the questionnaire was used at the time of the study was due to the difficult circumstances caused by the COVID-19 pandemic. Therefore, further investigations with interviews are planned to get a more holistic picture.

Recommendations and Conclusion

This survey aimed to investigate the use of learning strategies that can be linked to the core elements of computational thinking (CT). For this, an expert group analyzed and identified items of the two German questionnaires LSN (*Learning Strategy Use*) [Martin & Nicolaisen, 2015] and LIST (*Learning Strategies at University*) [Wild & Schiefele, 1994], and developed a list of learning strategies related to computational thinking. By analyzing the degree of strategy use among students, this study established that all participants in the study were only medium to low degree strategy users. Furthermore, results show that females reported statistically higher use of learning strategies related to CT than male students. When looking at the six CT skills as well as visualization strategies, testing and debugging strategies marked the highest usage, closely followed by decomposition strategies and algorithmic thinking. The category of visualization skills occupied the last place in the ranking. Concerning individual strategies, item 22 (If I do not understand words, I look them up on the Internet or in a dictionary) was the most frequently used strategy, and item 2 (I often do drawings or sketches to better see how things belong together) was the least frequently used strategy.

These results indicate that although students are generally medium to low users of strategies, they prefer fast strategies like researching information online to techniques that are more time-consuming, such as visualization strategies. It is also possible that students are not aware of the effectiveness of various strategies, especially for retaining information long-term. CT skills such as decomposition, abstraction, pattern recognition, and algorithmic thinking are essential for future professional life. Thus, an important implication is that teachers should raise strategy awareness and offer students opportunities to gain these skills by providing suitable activities such as modeling. With this approach, students' interest in more time-consuming visualization strategies can be increased as they might see long-term benefits that outweigh expenditure of time.

The results of this survey work as the basis for the implementation of computer science models as a teaching and learning strategy to foster CT skills. The experience and research on modeling and CT in language teaching and other subjects have shown promising results in recent years. Nevertheless, future work is planned to investigate the reasons behind the low use of strategies generally and visualization techniques in particular. Moreover, further studies could shed more light on the contribution of higher CT strategy use on learning achievement. To conclude, with modeling as an innovative teaching and learning strategy and other appropriate activities, the authors hope to foster students' CT skills, reduce cognitive load, and promote strategy use and sustainable learning.

References

Ackermann, E. (2001). Piaget's constructivism, Papert's constructionism: What's the difference. *Future of Learning Group Publication*, *5*(3), 438. Retrieved from: http://www.sylviastipich.com/wp-content/uploads/2015/04/Coursera-Piaget-_-Papert.pdf

Ali, W. N. A. W., & Yahaya, W. A. J. W. (2020). A Systematic Review of Learning Theory on Computational Thinking. *Journal of Human Development and Communication*, *9*(1), 11–22. Retrieved from: https://www.researchgate.net/profile/Wan-Nor-Ashiqin-Wan-Ali/publication/349074436_A_Systematic_Review_of_Learning_Theory_on_Computational_Thinking/links/601e4d3a92851c4ed54fa95f/A-Systematic-Review-of-Learning-Theory-on-Computational-Thinking.pdf

Anderson, R. C., & Pearson, P. D. (1988). A schema-theoretic view of basic processes in reading comprehension. In P.L. Carell, J. Devine, & D. E. Eskey (Ed.). *Interactive Approaches to Second Language Reading*, 37–55. Cambridge, England: Cambridge University Press. https://doi.org/10.1017/CBO9781139524513.007

Aslan, O. (2009). *The role of gender and language learning strategies in learning English* [Master thesis, Middle East Technical University]. OpenMETU Academic Archive. https://open.metu.edu.tr/handle/11511/18929

Ausubel, D. P. (1962). A subsumption theory of meaningful verbal learning and retention. *The Journal of General Psychology*, *66*, 213–224. https://doi.org/10.1080/00221309.1962.9711837

Bagui, S., & Earp, R. (2003). *Database design using entity-relationship diagrams*. New York, NY:Auerbach Publications.

Barr, V., & Stephenson, C. (2011). Bringing computational thinking to K-12: What is involved and what is the role of the computer science education community? *Acm Inroads*, *2*(1), 48–54. https://doi.org/10.1145/1929887.1929905

Bellettini, C., Lonati, V., Malchiodi, D., Monga, M., & Morpurgo, A. (2018). Informatics and Computational Thinking: A Teacher Professional Development Proposal Based on Social-Constructivism. International Conference on Informatics in Schools: Situation, Evolution, and Perspectives (pp. 194–205). Springer, Cham. https://doi.org/10.1007/978-3-030-02750-6_15

Blasiman, R. N., Dunlosky, J., & Rawson, K. A. (2017). The what, how much, and when of study strategies: Comparing intended versus actual study behaviour. *Memory*, *25*(6), 784–792. https://doi.org/10.1080/09658211.2016.1221974

BMBWF. (2018). *Digitale Grundbildung: Änderung der Verordnung über die Lehrpläne der Neuen Mittelschulen sowie der Verordnung über die Lehrpläne der allgemein-bildenden höheren Schulen.* Bundesministerium für Bildung, Wissenschaft und Forschung. Retrieved from: https://www.ris.bka.gv.at/Dokumente/BgblAuth/BGBLA_2018_II_71/BGBLA_2018_II_71.html

Bocconi, S., Chioccariello, A., Dettori, G., Ferrari, A., Engelhardt, K., Kampylis, P., & Punie, Y. (2016). Developing computational thinking in compulsory education. *European Commission, JRC Science for Policy Report*, *68*. Retrieved from: https://komenskypost.nl/wp-content/uploads/2017/01/jrc104188_computhinkreport.pdf

Chen, P. P.-S. (1976). The entity-relationship model—toward a unified view of data. *ACM Transactions on Database Systems (TODS)*, *1*(1), 9–36. https://doi.org/10.1145/320434.320440

Clark, J. M., & Paivio, A. (1991). Dual coding theory and education. *Educational Psychology Review*, *3*(3), 149–210. https://doi.org/10.1007/BF01320076

Curzon, P., Bell, T., WAITE, J., & Dorling, M. (2019). Computational thinking. In S. A. Fincher, & A. V. Robins (Ed.). *The Cambridge Handbook of Computing Education Research*, 513–546. Cambridge, England: Cambridge University Press. https://doi.org/10.1017/9781108654555.018

Demarle-Meusel, H., Rottenhofer, M., Albaner, B., & Sabitzer, B. (2020). Educational Pyramid Scheme – A Sustainable Way Of Bringing Innovations To School. *2020 IEEE Frontiers in Education Conference (FIE).* IEEE. (pp. 1–7). https://doi.org/10.1109/fie44824.2020.9274172

Dexter, D. D., & Hughes, C. A. (2011). Graphic Organizers and Students with Learning Disabilities: A Meta-Analysis. *Learning Disability Quarterly*, *34*(1), 51–72. https://doi.org/10.1177/073194871103400104

Ertmer, P. A., & Newby, T. J. (2013). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly*, *26*(2), 43–71. https://doi.org/10.1002/piq.21143

Grabmeier, J. (2018, May 31). *This is your brain detecting patterns: It is different from other kinds of learning, study shows.* Ohio State University. Retrieved from: https://www.sciencedaily.com/releases/2018/05/180531114642.htm

Hall, T., & Strangman, N. (2002). Graphic organizers. *National Center on Accessing the General Curriculum*, 1–8. Retrieved from: https://www.northernhighlands.org/cms/lib5/NJ01000179/Centricity/Domain/18/Graphic_Organizers_2008.pdf

Hsu, T.-C., & Liang, Y.-S. (2021). Simultaneously improving computational thinking and foreign language learning: Interdisciplinary media with plugged and unplugged approaches. *Journal of Educational Computing Research*, *59*(6), 1184–1207. https://doi.org/10.1177/0735633121992480

Kim, A.-H., Vaughn, S., Wanzek, J., & Wei, S. (2004). Graphic organizers and their effects on the reading comprehension of students with LD: A synthesis of research. *Journal of Learning Disabilities*, *37*(2), 105–118. https://doi.org/10.1177/00222194040370020201

Kornell, N., & Bjork, R. A. (2007). The promise and perils of self-regulated study. *Psychonomic Bulletin & Review*, *14*(2), 219–224. https://doi.org/10.3758/BF03194055

Lu, J. J., & Fletcher, G. H. (2009). Thinking about computational thinking. *Proceedings of the 40th ACM technical symposium on Computer science education (pp. 260-264).* https://doi.org/10.1145/1508865.1508959

Martin, P.-Y., & Nicolaisen, T. (2015). *Lernstrategien fördern: Modelle und Praxisszenarien*. Weinheim, Germany: Beltz Juventa.

Morehead, K., Rhodes, M. G., & DeLozier, S. (2016). Instructor and student knowledge of study strategies. *Memory*, *24*(2), 257–271. https://doi.org/10.1080/09658211.2014.1001992

National Research Council. (2010). *Report of a workshop on the scope and nature of computational thinking*. Washington, DC: National Academies Press.

Oxford, R. L. (1993). Instructional implications of gender differences in second/foreign language (L2) learning styles and strategies. *Applied Language Learning*, *4*(1-2), 65–94.

Papert, S. (1980). *Children, computers, and powerful ideas.* United Kingdom: Harvester Press

Parsazadeh, N., Cheng, P.-Y., Wu, T.-T., & Huang, Y.-M. (2021). Integrating computational thinking concept into digital storytelling to improve learners' motivation and performance. *Journal of Educational Computing Research*, *59*(3), 470–495. https://doi.org/10.1177/0735633120967315

Rahmat, N. H. (2020). Information Processing as Learning Strategy: The Case of Graphic Organisers. *European Journal of Education Studies*, *0*(0). https://doi.org/10.46827/ejes.v0i0.3023

Rottenhofer, M., Sabitzer, B., & Rankin, T. (2021). Developing Computational Thinking Skills Through Modeling in Language Lessons. *Open Education Studies*, *3*(1), 17–25. https://doi.org/10.1515/edu-2020-0138

Sabitzer, B., & Pasterk, S. (2015). Modeling: A computer science concept for general education. *2015 IEEE Frontiers in Education Conference (FIE).* IEEE. https://doi.org/10.1109/fie.2015.7344062

Schneider, E., & Crombie, M. (2012). *Dyslexia and Modern Foreign Languages* (0th ed.). Taylor and Francis. https://doi.org/10.4324/9780203458709

Seidl, M., Scholz, M., Huemer, C., & Kappel, G. (2015). *UML@ classroom*. Switzerland: Springer Cham. https://doi.org/10.1007/978-3-319-12742-2

Sousa, D. A. (2017). *How the brain learns* (Fifth edition). London, United Kingdom: Sage Publishing Company.

Susser, J. A., & McCabe, J. (2013). From the lab to the dorm room: metacognitive awareness and use of spaced study. *Instructional Science*, *41*(2), 345–363. https://doi.org/10.1007/s11251-012-9231-8

Sweller, J., van Merrienboer, J. J. G., & Paas, Fred G. W. C. (1998). Cognitive Architecture and Instructional Design. *Educational Psychology Review*, *10*(3), 251–296. https://doi.org/10.1023/A:1022193728205

Taraban, R., Maki, W. S., & Rynearson, K. (1999). Measuring study time distributions: Implications for designing computer-based courses. *Behavior Research Methods, Instruments, & Computers : A Journal of the Psychonomic Society, Inc*, *31*(2), 263–269. https://doi.org/10.3758/BF03207718

Tercanlioglu, L. (2004). Exploring gender effect on adult foreign language learning strategies. *Issues in Educational Research*, *14*(2), 181–193. Retrieved from: http://www.iier.org.au/iier14/tercanlioglu.html

Voogt, J., Fisser, P., Good, J., Mishra, P., & Yadav, A. (2015). Computational thinking in compulsory education: Towards an agenda for research and practice. *Education and Information Technologies*, *20*(4), 715–728. https://doi.org/10.1007/s10639-015-9412-6

Wild, K.-P., & Schiefele, U. (1994). Lernstrategien im Studium: Ergebnisse zur Faktorenstruktur und Reliabilität eines neuen Fragebogens. *Zeitschrift Für Differentielle Und Diagnostische Psychologie*, *15*(4), 185–200. Retrieved from: https://psycnet.apa.org/record/1996-85746-001

Willis, J. (2007). Review of Research: Brain-Based Teaching Strategies for Improving Students' Memory, Learning, and Test-Taking Success. *Childhood Education*, *83*(5), 310–315. https://doi.org/10.1080/00094056.2007.10522940

Wing, J. M. (2006). Computational thinking. *Communications of the ACM*, *49*(3), 33–35. https://doi.org/10.1145/1118178.1118215

World Economic Forum. (2020). *The Future of Jobs Report 2020*. Retrieved from: https://www.voced.edu.au/content/ngv:88417

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). *Applied Social Research Methods: Vol. 5*. Thousand Oaks, CA: SAGE Publications

Corresponding author: Mag. Marina Rottenhofer
Email: marina.rottenhofer@jku.at

A Comprehensive Community of Inquiry Framework for Exploring Technology Enhanced Language Learning

Irum Alvi
Rajasthan Technical University, Kota, India

Abstract

The use of technology for second language (L2) acquisition has become ubiquitous, but little thought has been given to the factors that impact the language learning experience. This study aims to use the Community of Inquiry (CoI) framework to propose and validate a more comprehensive model for investigating the influence of *presence* on learners' L2 learning experience using Technology Enhanced Language Learning (TELL). Data were collected from a sample of language learners (n = 129) studying in the State of Rajasthan, India using an e-questionnaire. To scrutinize the effect of various forms of *presence*, descriptive and inferential analyses were conducted. The findings suggest strong, positive, and statistically significant associations exist between the original CoI elements (teaching presence, cognitive presence and social presence), the newly added elements (learning presence, emotional presence, and technological presence), and learning experience. These results confirm the idea that *presence* can hinder and/or enhance L2 learning experiences. No association was found between technical barriers and learning experience. The findings have theoretical and practical implications. The results suggest the value of expanding the CoI framework, scrutinizing the learners' experience, analyzing the influence of *presence*, and enriching the application of the technology for language learning. Such results may ensure TELL courses are designed as vigorous learning environs which facilitate language acquisition.

Keywords: community of inquiry, learning experience, teaching, cognitive and social presence, learning, emotional and technological presence

The COVID-19 pandemic had a significant influence on the learning experiences of learners (Yu et al., 2022). During this turbulent time, *Technology Enhanced Language Learning* (*TELL*) became the only means of learning. TELL refers to a teaching methodology, which requires electronic resources (e-resources) for promoting teaching and learning of a second language (L2). TELL deals with the manner in which technology affects the instruction and acquisition of a L2. Technology has been useful in enhancing input quality, authenticating communication, and giving quick and pertinent feedback, for the development of all language abilities, including listening, writing, reading, speaking, grammar, and vocabulary. The adoption of technology for learning assists learners in acquiring new knowledge and skills (Wood & Shirazi, 2020); it also opens new vistas for research (Rasheed et al., 2020). Instead of the most frequent language learning approaches used in higher education (e.g., face-to-face, blended/hybrid, flipped), TELL has emerged as one of the most important means of language learning in India. This change has been accompanied with a shift from teacher-centered to learner-centered approaches to learning, as learners become involuntarily dependent on technology (Dhawan, 2020) as part of the new normal (Zhou et al., 2022). Previous research looked into how learners accepted diverse forms of technologies including social networking tools (Alvi, 2021a) such as WhatsApp (Kaur et al, 2021), learning management systems (Camilleri & Camilleri, 2021), artificial intelligence for integrated learning (Mageira et al., 2022), and feedback (Alvi, 2021b). Based on these studies, learners' perceptions and acceptances emerged as central factors in shaping their learning experience (LE), in a technology-supported learning environment (Huang & Liaw, 2018).

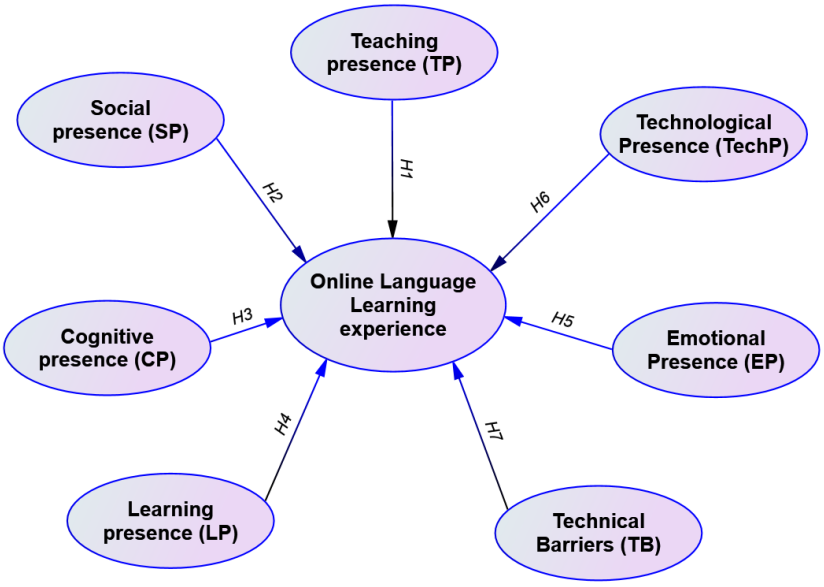
Peirce and Dewey introduced the concept of community of inquiry (CoI) and linked it to the inquiry stage of knowledge acquisition describing the essential elements of a successful learning experience (Garrison, 2017) in higher education. Several researchers have used the CoI model based on social constructivism theory to examine LE (Junus et al., 2022; Yu & Li, 2022). The CoI model is broadly defined as a learning procedure or setting where learners learn together in an environment where they can make enquiries to overcome complicated problems or learn new information. According to social constructivism, all knowledge is created through language use and social interaction, making it a shared rather than a private experience. Social constructivism explains how people learn and gain information. Moreover, the goal of an educational community is to create a setting where learners participate together to better grasp or experience the required skills.

The current study uses the CoI framework (Garrison et al., 2000) to investigate factors influencing learning English as a L2. CoI offers a conceptual model for e-learning experiences. The original model consists of three main constructs: *social presence* (SP), *teaching presence* (TP), and *cognitive presence* (CP) (Kozan & Caskurlu, 2018). Initially, utilized to investigate how e-forums produce intellectual and social community, the CoI framework has been successfully used for e-learning/blended learning (Kilis & Yıldırım, 2018). Despite its strengths, numerous studies suggest the CoI framework can be enhanced by adding new *presences* to account for important factors of effective e-learning (Cleveland-Innes & Campbell, 2012; Kozan & Caskurlu, 2018). The present study posits that the addition of new *presences,* namely *learning presence*, *emotional presence,* and *technological presence* to the CoI framework, may provide more insight into how students perceive their learning experiences in L2 classrooms. Because research on the CoI framework and its application remain relatively recent, there are no in-depth studies investigating them in the context of TELL, particularly in the Indian context. To address this gap in research, this study aims to investigate the influence of *presence* on learners' L2 learning experience using TELL. The

study addresses two research questions: 1) What factors impact the TELL learning experience in India? And 2) What level of *presence* influences the TELL experience?

The main objective of this research is to look into learners' LE with two main objectives. The main goal is to create a comprehensive and inclusive version of the CoI framework to better understand the factors impacting LE in the context of TELL in India. The second goal is to experimentally and analytically validate the proposed CoI based framework. As such, the present study extends and validates the modified model using raw data and empirical tests in the context of TELL. As illustrated in Figure 1, the study modifies and extends the CoI model for assessing the TELL of language learners in India. In short, the study's rationale is to scrutinize language learners' LE and to offer an all-inclusive framework for investigating and enhancing their experiences. The rest of the paper discusses of the CoI framework, in the context of L2, which provides a solid, descriptive theoretical foundation. Then, it proposes a modified model grounded on the existing CoI model, which investigates the critical elements for an effective e-learning experience based on social constructivism (Dewey, 1959). Finally, it validates the model using data collected from language learners.

Figure 1
Conceptual Model Based on an Extended CoI Framework



Literature Review and Hypotheses Development

Language learning is closely connected to language use. It develops through social interaction, and is a social process which requires sustained communication. TELL provides learners with the opportunity to engage in several ways using diverse online language learning tools. The CoI framework, which includes three elements called *presences*, has been successfully used for investigating the use and implementation of technology for L2 learning (Wang et al., 2022). The term *presence* refers to a social situation that arises from interactions between students and teachers (Picciano, 2017). This feeling of *presence* is needed for enhancing language learners' performance and language acquisition. Interactive environments enabled by modern technologies are beneficial for L2 learning. Within an epistemic engagement pedagogical approach, the CoI model may be regarded as an exemplary model to understand e-learning

(Shea & Bidjerano, 2010). This is particularly true for integrated, team-based e-learning (Parrish et al., 2021). The CoI model captures not only the most important aspects of learning (teaching, cognitive, and social), but also the dynamics of the e-learning environment (Garrison et al., 2010). As such, many academics have endorsed the CoI framework (Wang et al., 2022), while others have pointed out its limitations by criticizing it for lacking representation of diverse educational areas (Annand, 2019). Prior research has also called for more empirical research to test the efficacy, scalability, and feasibility of CoI in different contexts (Annand, 2019). As such, the current study aims to fill this research gap.

Cognitive Presence

Cognitive presence (CP) denotes the ability of learners to confirm/construct significance based on continued consideration and reflection (Garrison et al., 2001). Researchers have concentrated extensively on socio-cognitive assessments of e-learning for collaborative interaction (Park & Shea 2020). Much of this research has focused on CP, considering it a significant measure of the quality of learner experience as it entails genuine methodologies grounded on constructing understanding in an e-environment (Garrison et al., 2017). CP consists of four phases: *triggering events, resolution, exploration*, and *integration*. *Triggering events* refer to tasks, inquiries, or stimuli, which encourage a sense of mistrust, wonder, bewilderment, and uncertainty in learners. Such experiences enhance the need for inquiry because it motivates the learner to address their cognitive conflict. Triggering events encourage learners to use their inductive reasoning to overcome the lack of existing awareness and comprehend any new information, which leads to *resolution*. The third phase called *exploration* refers to learners' efforts to overcome their cognitive dissonance by reconstructing knowledge and by searching for new information. In these phases, learners discuss facts and information among themselves, share ideas and recommendations, and prior experiences, and investigate concepts. *Integration* is the final phase wherein learners connect the material gathered in the earlier stages to reach tentative solutions or reasons. This stage is crucial for learners to build higher-order thinking skills (Garrison & Arbaugh, 2007). Based on the extant literature on CP, it can be argued that it has a significant effect on the learners. Thus, the first hypothesis for this study (H1) stated that there is a statistically significant positive relationship between CP and LE among language learners.

Teaching Presence

Teaching presence (TP) refers to the design, expedition, and direction of social and cognitive process for realizing meaningful academic learning. Teaching presence begins with curriculum and course planning and design. It then continues throughout the delivery of the content of the course/program to promote active learning through the use of appropriate teaching tactics and assessments. Design and organization, nurturing conversation, and uninterrupted instruction influence the learner experience. Organization and design are related to course preparation and scheme, assimilating assessment, exercises, quizzes, and assignments, along with the administrative aspects of education. Facilitating discourse, the second category, tries to retain learner interest, motivation, and participation in an active learning environment. It takes control of connecting material to occasions wherein learners interact and socialize. Direct instruction is another aspect of TP. According to Anderson et al. (2001), direct instruction occurs when the teacher provides scholarly and academic leadership. Based on the above literature, the study's second hypothesis (H2) postulated that there is a statistically significant positive relationship between TP and LE among language learners.

Social Presence

Social presence (SP) is an important element in e-learning. It refers to the learners' ability to present their ideas publicly and to interact in their learning environment by building inter-personal relationships and expressing their personalities (Garrison & Arbaugh, 2007). SP is connected with the use of technology for learning purposes and it controls how social interactions unfold in online environments (Song & Yuan, 2015). It also affects learning outcomes. It is a crucial affective component as well as an important construct influencing the intensity of communication and efficacy of learning in e-learning (Mykota, 2017). It is identified as a system of personal relationships engrained in groups by roles and responsibilities, principles and expectations, and mind-sets and requirements (Annand, 2011). In workgroups, it is a system of personal relations and is linked to sociability and space. The study's third hypothesis (H3) stated that there is a statistically significant positive relationship between SP and LE among language learners.

Learning Presence

Learning presence (LP) is a cyclical process, wherein the learner plans for a language learning activity, monitors his performance, and reflects upon the consequences. The cycle recurs as the learner adjusts and prepares for the next activity. Recent studies propose the inclusion of LP as the fourth element in the CoI framework as a way to denote learner self-regulation (Wertz, 2022). Researchers maintain extant studies on self-regulation offer a solid ground for the inclusion of LP for enhanced appreciation of the LE (Huang et al., 2019). Hunag et al. (2019) proposed that factors such as behavioral, cognitive, and motivational concepts and self-efficacy encourage e-learner experience. In this context, self-efficacy is regarded as a subjective estimate of the ability to learn. It accentuates the boundaries between cognition and motivation, being a personal judgment of learners' competence level in performing tasks/acts (Shea & Bidjerano, 2010). Relatedly, self-regulation refers to perseverance and the aptitude for confronting setbacks in the completion of tasks about learning (Shea & Bidjerano, 2010). LP was utilized to evaluate learners' opinions of their efficacy and effort, giving e-learning a more "self-directed" impression; Self-efficacy and self-regulation were added as additional scales for this purpose (Wertz, 2022). Self-regulation denotes the extent to which learners feel they are motivationally, metacognitively, and psychologically dynamic contributors to the learning process (Zimmerman, 2008). To effectively complete language-related team projects, learners self-regulate their activities, divide duties, manage time, and set goals. As such, LP plays a significant part in enhancing the LE of learners using TELL. Thus, this study's fourth hypothesis (H4) stated that there is a statistically significant positive relationship between LP and LE among language learners.

Emotional Presence

Following an extensive review of the literature on the experiences of learners, *emotional presence* (EP) was added to the CoI framework's conceptual aspects. According to Cleveland-Innes and Campbell (2012), emotion is experienced by learners as a distinct *presence*. This *presence* refers to much more than just an affective response to social presence as it enhances the overall e-learning experience. EP denotes the external manifestation of feeling, affect, and sentiment in a CoI framework as learners communicate and interrelate with e-learning tools, content, peers, and teacher (Cleveland-Innes & Campbell, 2012). Emotion remains central to learning as it offers attention, interest, motivation, and social connection. When emotions are not properly regulated, learners may fail to express, assess, or modulate their approach, thus

impeding other cognitive experiences causing emotional hijacking (Cavanagh, 2016). Based on this information, the study's fifth hypothesis (H5) stated that there is a statistically significant positive relationship between EP and LE among the language learners.

Technological Presence

The present research adds one more *presence* to the CoI framework: *technological presence* (TechP). Technology is an essential influence in scientific and social progress. This concept implies that technology has both potentiality and actuality. In terms of potentiality, technology provides potential actions through which learners may realize specific actions and, more importantly, themselves. It is through TechP that learners may become familiar with their prospects to be in, and act in, the technology enhanced environment. As such, instead of focusing only on the actual use of technology, its influence must be explored through the notion of TechP. TechP "offers us opportunities, possibilities, and reveals to us potential actions, potential forms of life, and potential ways of relating to our social and physical surroundings" (Kiran, 2012, p. 93). TechP requires competence/self-efficacy, which is imperative for an effective learning environment based on technology. It is similar to Bigné et al.'s (2019) Digital Competence Framework.

In the present study, TechP denotes language learners' perceptions of their ability to use technology-related sites and tools to perform e-learning activities and tasks to attain desired learning outcomes. Researchers have found that technical knowledge has a strong beneficial impact on adoption and use of technology (Celik & Yesilyurt, 2013). TechP may be used as an indicator of an individual's intent to use technology (Kiran, 2012). Language learners need to be digitally competent for the completion of learning tasks and activities; as such, they also need to possess information and data literacy, digital content comprehension, and problem-solving. Learners with higher technological knowledge are more likely to be persistent, as they do not give up easily and try to attain their language learning objectives both inside the classroom and beyond (Lai, 2013). Language learners' TechP will be echoed in their technological skills while performing technology-based tasks (Mew & Honey, 2010), and it may significantly influence their intent to utilize e-learning facilities and applications. Thus, TechP may indicate learners' opinions of technology as beneficial and simple to use, and consequently their desire to utilize it for self-directed learning (Lai, 2013). Based on this literature, the study's sixth hypothesis (H6) stated that there is a statistically significant positive relationship between TechP and LE among language learners.

Technical Barriers

Researchers regard technical issues to be critical for e-learning (Kauffman, 2015). Technical issues and problems have been identified as *technical barriers* (TB). Internal barriers include things like attitudes and beliefs, while external barriers include time, technical and institutional support, and infrastructure. The lack of these elements as well as want of suitable communication strategies for their implementation has been identified as a reason for poor technology implementations (Alvi, 2022). Therefore, TB may refer to any existing belief that restrains usage intentions and promotes rejection of technology (Cenfetelli & Schwarz, 2011). Learners' perceived technological intricacy, which refers to the quality/state of being complex or being problematic/difficult to use, can also be highlighted as a barrier (Ali et al., 2018). Thus, while technology might help students learn more effectively, it can be a hindrance in some cases (Lane, 2019). Therefore, the study's seventh hypothesis (H7) stated that there is a statistically significant positive relationship between TB and LE among language learners.

Research Methodology

Instrument Design

To collect information from language learners, an e-questionnaire was drafted. This online questionnaire was separated into two sections. The first section collected student demographic information such as gender, age, and the standard /class in which the learners were enrolled. The second section of the e-questionnaire consisted of 59 items for assessing and quantifying forms of presence. The CoI measurement scale (TP, CP, and SP) was based on studies by Arbaugh (2008) and Swan et al. (2008). The existing scale was extended by adding five new constructs based on existing literature, namely LP (Wei et al. 2020), TechP (Tetri & Juujärvi, 2022), TB (Akhter et al., 2022), EP (Cavanagh, 2016), and LE (Woodcock et al., 2015). All of the items were adapted, adopted and modified for the current study. The items were based on a five-point Likert-scale where 1 indicated "strongly disagree" and 5 "strongly agree".

Participants and Research Design

The study's population included learners enrolled in language learning courses during the 2021–2022 academic year. The potential participants were all undergraduate students, studying in the first semester at an institute in Rajasthan, India. They had been using technology for language acquisition for at least six months. Data was collected from learners after seeking approval for the study from the ethics committee for the study of human subjects. As the study's research methodology is cross-sectional, a quantitative technique using an e-questionnaire was employed to obtain responses from language learners.

Statistical software (G*power 3.1.9) was used to calculate an adequate sample size (Faul et al., 2007) for correlation analysis. The following settings were utilized for a two-tailed test for medium effect size: α err prob = 0.05, power (1-β err prob) = 0.80 and correlation ρ H1 value = 0.3. As per the results, the minimal sample size for the investigation was 84 with an error probability of 0.05 and a confidence level of 80 percent. Based on these findings, the sample size of 129 was considered sufficient for the present study. The sample was chosen using a random sampling procedure, which ensured all learners in the population had an equal chance of being selected. The sample comprised of approximately 70% males and 30% females. The average age was 18 (*SD* = 1.87). The participants came from diverse backgrounds with nearly 60% from urban parts of Rajasthan and 40% from rural regions.

Analysis of Data

Data analysis used descriptive statistics to calculate frequency, distribution, percentage, mean, and standard deviation. Statistical analyses were carried out for verifying scale and instrument reliability. Validity of the instrument was checked by considering both the rationality and accuracy of each question's wording (how well and accurately it conveys the intended message) and the validity of the responses it elicits (how well it captures respondents' true ideas). The study used well-proven instruments. Moreover, a pilot study was conducted using 20 respondents to test the research instrument. The accuracy of the items was checked and a few minor changes were made to ensure the accuracy and validity of the instrument based on feedback received from the respondents. Finally, inferential statistics were used for hypotheses testing.

Results

The first step in the process was to use Cronbach's alpha (CA) to measure the instrument reliability. The total reliability of the instrument was above 0.90, which indicated the scale used had excellent overall reliability. The values of CA for TP, CP, SP, EP, LP, TechP, TB, and LE are presented in Table 1. The results affirm the constructs were reliable as all CA values' were above 0.83. Next, the study sought to scrutinize the level of TP, CP, SP, LP, EP, TechP, and TB among language learners in India. The mean score, called the average score, was obtained by totaling the sum of the data sets divided by the number of items for each construct. As shown in Table 1, the mean scores ranged from the lowest for TB (2.97) to the highest for TP (4.47). The standard deviation, Std.D, which refers to the average amount of variability in the dataset, was also calculated. Next, skewness, which denotes the degree of imbalance in the frequency distribution, and kurtosis, which denotes the degree of tailed-ness in the frequency distribution, were observed. The values for kurtosis and asymmetry ranged between -2/+2 which are taken as satisfactory (George & Mallery, 2010). As seen, these values ranged from fairly symmetrical for TB (between -0.5 and 0.5) to moderately skewed (0.5 and 1/-0.5 and -1) for most of the constructs, to highly skewed (greater than -1) for LP. Means, standard error, standard deviations, and Cas for the constructs are summarized in Table 1.

Table 1
Means, Standard Error, Standard Deviations, and Cronbach Alphas for the Constructs

	CA	Mean	Std. Error	SD	Skewness	Kurtosis
Teaching Presence	0.93	4.47	0.05	0.53	-0.84	0.01
Social Presence	0.89	4.10	0.06	0.68	-0.50	-0.47
Cognitive Presence	0.89	4.31	0.05	0.58	-0.59	-0.48
Learning Presence	0.84	4.44	0.06	0.64	-1.02	0.13
Emotional Presence	0.83	4.33	0.05	0.61	-0.67	0.20
Technological Presence	0.93	4.30	0.05	0.59	-0.61	-0.39
Technical Barriers	0.84	2.97	0.12	1.38	-0.01	-1.39
Learning Experience	0.88	4.38	0.05	0.57	-0.76	0.27

Table 2 reports the item-level means, errors, standard deviations, skewness, and kurtosis. The mean for items ranged from 2.81 for TB6 to 4.53 for TP10.

Table 2
Item-Level Means, Errors, Standard Deviations, Skewness, and Kurtosis

Construct	Item	Mean	Std. Error	SD	Skewness	Kurtosis
Teaching Presence (TP)	TP1	4.52	0.06	0.63	-1.14	1.17
	TP2	4.50	0.06	0.64	-0.90	-0.24
	TP3	4.49	0.06	0.64	-0.87	-0.28
	TP4	4.47	0.06	0.65	-0.82	-0.38
	TP5	4.42	0.06	0.68	-0.91	0.27
	TP6	4.44	0.07	0.74	-1.04	0.05
	TP7	4.49	0.06	0.70	-1.15	0.56
	TP8	4.40	0.06	0.69	-0.85	0.13
	TP9	4.39	0.07	0.78	-1.10	0.49
	TP10	4.53	0.06	0.69	-1.73	4.54

	TP11	4.50	0.06	0.68	-1.18	0.79
Social Presence (SP)	SP1	4.23	0.07	0.77	-0.52	-0.81
	SP2	4.31	0.06	0.73	-0.55	-0.93
	SP3	4.26	0.08	0.87	-1.18	1.22
	SP4	3.93	0.10	1.16	-1.05	0.41
	SP5	3.97	0.10	1.10	-1.07	0.58
	SP6	4.06	0.09	1.05	-0.95	0.02
	SP7	3.95	0.08	0.88	-0.53	-0.08
	SP8	4.12	0.07	0.79	-0.89	1.37
	SP9	4.07	0.08	0.91	-0.96	0.88
Cognitive Presence (CP)	CP1	4.26	0.07	0.79	-0.70	-0.42
	CP2	4.36	0.07	0.82	-1.53	3.17
	CP3	4.40	0.06	0.72	-0.89	-0.07
	CP4	4.26	0.07	0.82	-0.87	0.06
	CP5	4.37	0.07	0.75	-0.96	0.22
	CP6	4.31	0.07	0.76	-0.92	0.41
	CP7	4.37	0.06	0.73	-0.95	0.41
	CP8	4.23	0.07	0.78	-0.84	0.38
	CP9	4.33	0.07	0.76	-1.27	2.46
	CP10	4.24	0.06	0.73	-0.40	-1.02
	CP11	4.28	0.07	0.79	-0.83	-0.02
	CP12	4.32	0.06	0.68	-0.65	-0.06
Learning Presence (LP)	LP1	4.46	0.07	0.74	-1.09	0.13
	LP2	4.46	0.07	0.76	-1.53	2.85
	LP3	4.42	0.06	0.73	-0.96	0.01
Emotional Presence (EP)	EP1	4.41	0.06	0.65	-0.64	-0.57
	EP2	4.30	0.06	0.73	-0.66	-0.36
	EP3	4.28	0.06	0.73	-0.86	0.65
Technological Presence (TechP)	TP1	4.40	0.07	0.73	-1.28	2.40
	TP2	4.33	0.06	0.70	-0.55	-0.82
	TP3	4.32	0.06	0.68	-0.50	-0.79
	TP4	4.34	0.06	0.66	-0.49	-0.69
	TP5	4.40	0.06	0.67	-0.68	-0.60
	TP6	4.19	0.07	0.81	-0.55	-0.75
	TP7	4.16	0.07	0.84	-0.56	-0.71
	TP8	4.35	0.06	0.68	-0.57	-0.74
	TP9	4.30	0.07	0.81	-1.15	1.51
	TP10	4.21	0.07	0.83	-0.75	-0.22
Technical Barriers (TB)	TB1	3.09	0.13	1.47	-0.12	-1.41
	TB2	2.95	0.13	1.50	-0.03	-1.46
	TB3	2.88	0.13	1.42	-0.04	-1.34
	TB4	3.09	0.13	1.48	-0.12	-1.41
	TB5	3.03	0.13	1.48	-0.05	-1.42
	TB6	2.81	0.14	1.56	0.24	-1.50
Learning Experience (LE)	LE1	4.41	0.05	0.61	-0.50	-0.62
	LE2	4.44	0.06	0.67	-0.96	0.43
	LE3	4.40	0.06	0.70	-0.87	0.06
	LE4	4.42	0.06	0.68	-0.75	-0.57

	LE5	4.24	0.07	0.79	-0.75 -0.12

Next, the Shapiro-Wilk multivariate normality test was conducted to assess the data's normality assumption (Shapiro-Wilk value = 0.89). There was no normal distribution for any of the significant outcomes ($p < 0.001$), indicating that the normality assumption was violated. Finally, the Spearman's Rank Correlation test, which is a gauge of how well variables are related, was conducted. The strength of the link between the respondents' perceptions and their experience was measured utilizing Spearman's Rho (ρ). Positive correlations are signified by a positive value in Spearman's Rho analysis, with stronger correlations being closer to one. Negative correlations, on the other hand, are signified by a negative number, with stronger correlations being closer to a negative one. If the result is zero, there is no correlation between the variables. Statistical significance was also examined within each variable pairing. The 'α' was set to 0.05, meaning the confidence level was 0.95.

Table 3

Hypotheses Testing Using Spearman's Rho

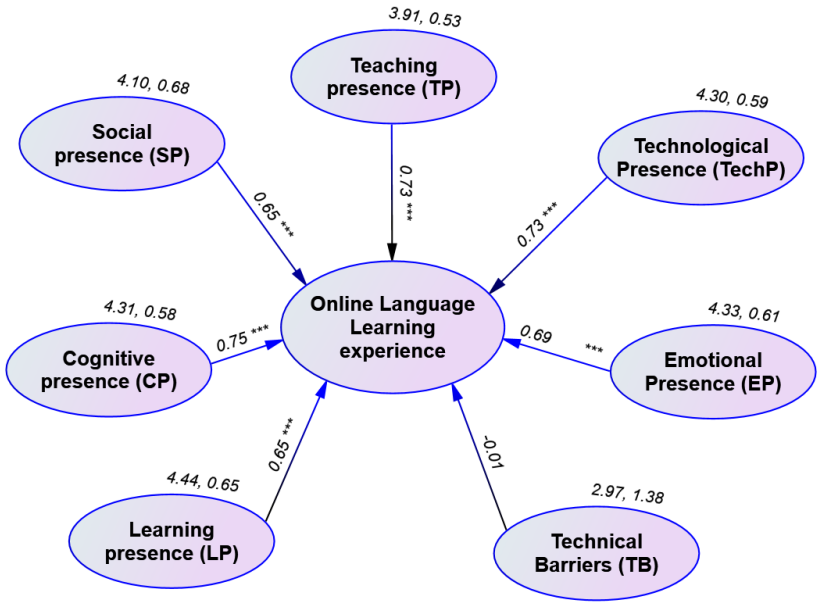
Hypotheses	Spearman's rho ρ	*p*
H1: Teaching Presence →LE	0.67**	< .001
H2: Social Presence →LE	0.65**	< .001
H3: Cognitive Presence →LE	0.75**	< .001
H4: Learning Presence →LE	0.65**	< .001
H5: Emotional Presence →LE	0.70**	< .001
H6: Technological Presence →LE	0.73**	< .001
H7: Technical Barriers →LE	-0.01	0.89

** $p < .001$

The results of the study's hypotheses are presented in Table 3. Of the study's seven hypotheses framed, postulating that there should be a statistically significant positive relationship between various presence and LE, six were validated. H1: TP and LE (ρ=0.67, p <0.001); H2: SP and LE (ρ=0.65, p <0.001); H3: CP and LE (ρ=0.75, p <0.001); H4: LP and LE (ρ=0.65, p <0.001); H5: EP and LE (ρ=0.70, p <0.001); H6: TechP and LE (ρ = 0.73, p <0.001). These hypotheses were accepted based on the outcome of the Spearman's correlation analysis. However, the findings revealed no significant relationship between TB and LE. Although the relationship between TB and LE was negative (as anticipated), it was not statistically significant (ρ = -0.01, p = 0.89). Based on these results, H7 was rejected. These results are summarized in Figure 2.

Figure 2

Research Model Showing Construct Means, Standard Deviations, and Associations with LE



Discussion

The current study sought to scrutinize the factors that impact LE in the context of TELL in India. More specifically, it examined the level of TP, CP, SP, LP, EP, TechP, and TB among Indian undergraduate language learners. Comprehending the level of these variables is important as they influence the LE and ensure language learning communities offer a secure, encouraging atmosphere without inhibitions for learners.

Based on descriptive statistics, the average mean obtained by totaling all items of each construct, confirmed that the level ranged from lowest for TB to highest for LP. Moreover, the levels were relatively high for all forms of presence. The findings revealed that language learners perceive LP as the most significant presence, followed by other forms, while TB was perceived as the least significant among the selected variables. The study also affirmed the associations between the three original factors in the CoI framework, thereby augmenting prior studies (Dempsey & Zhang, 2019).

Next, the study confirmed the comprehensive and inclusive proposed framework by extending the CoI framework. Additionally, it experimentally and analytically validated the proposed framework in the context of language acquisition. It was discovered that TP may contribute positively to LE, implying that TP is vital for improving language learners' learning experiences. TP denotes the significance of course content, activities, and mentorship (Caskurlu, 2018). The findings suggest that each aspect of TP, which includes course content, activities, and mentorship, is critical for ensuring L2 learning is made easy for learners. The results also suggest that TP contributes to the LE because language teachers play a key role in triggering learning through appropriate course conception, topic covering, and efficient feedback and communication mechanisms (Caskurlu, 2018).

SP was found to be considerably related to LE. As such, it may aid in the development of interaction among the learners which further enhances their interpersonal relationships (Zhou, 2016). This happens by increasing learners' engrossment and contribution in the learning

environment and collaborating with their peers for a mutual objective (Hilliard & Stewart, 2019). These findings imply language learners can express discrepancies, exchange opinions, study contrasts, and acknowledge support and encouragement from peers and teachers through their SP. In other words, language skills relevant to their cultures have to be acquired to enable them to debate and defend their viewpoints. These abilities can be honed through supportive dialogue and the creation of a positive learning environment by the teachers. For this objective, course design and facilitation are important since they ensure learners feel more engaged in learning and improve their critical thinking (Chang et al., 2015). In short, SP delivers prominence to communication and collaboration (Shea & Bidjerano, 2009).

In the context of Indian students, the study discovered that among the select constructs, CP had the strongest association with the language LE. This implies that students prefer to learn through cognition. Language teachers may ensure CP by utilizing interactive activities based on real or virtual scenarios in the language course. CP specifies an inquiry-learning process, comprising identifying the problem, coalescing ideas, and scrutinizing conceivable solutions. These findings contradict the results of some prior researchers who found a weak correlation between CP and learning (Martin et al., 2022). Since CP aids in the discovery and understanding of learners' identity depending on their needs, it is important for language learners. To improve performance, learners use their reflection on subjective experiences (subjectification) for producing action (pragmatic). This shows that students' inherent conscious intelligence to learn may outweigh the effect of external factors on their intellect. Thus, TP, SP, and CP in the CoI framework emphasize the e-learning progression and concentrate on LE. Group cohesion, collaboration, and communication play a significant role, as parts of SP (Garrison & Arbaugh, 2007; Kreijns, 2022). In this view, the learner needs to stay cognitively involved and endeavor to learn efficiently in the social space in which the teacher plays a substantial role. The cumulative influence of all of these elements provides the learners with an influential LE (Arbaugh et al., 2008). As such, the interrelationship between the original three variables was investigated and the results affirmed prior research, which was based on undergraduate and post-graduate data (Heilporn & Lakhal, 2020; Garrison, 2010; Dempsey & Zhang, 2019).

Further, the findings indicate strong, positive, and significant associations between the newly added constructs (LP, EP, and TechP), with the exception of TB. This suggests that students in online language learning courses are knowledgeable in e-learning technologies, have requisite technical abilities, and feel relaxed in e-learning environments. LP emerged as a key predictor of LE, demonstrating that it must be addressed by the teachers in the context of language learning. Further, the learning experience needs to be made interesting and entertaining to ensure learner involvement and engagement, which confirms previous studies (Wertz, 2022). The association between LP and LE was positive and significant; the findings affirm Ma et al.'s (2017) study. The findings also confirm Lin et al.'s (2015) study indicating that LP, which is tantamount with self-efficacy, plays an important part in CoI.

EP was found to be empirically linked with learning. It has also been found to be linked with cognition (Thomas et al., 2017). As a learning environment induces constructive or disparaging sentiments in learners, EP may influence the quality of LE. Negative feelings can confuse learners (Cleveland-Innes & Campbell, 2012), and adversely influence their LE. Therefore, teachers need to be wary of the presence of any negative feelings among language learners. In order to enhance EP, teachers may offer motivation, care, and understanding to learners (Green & Batool, 2017). Ideally, this will make them feel safe and appreciated, ensuring they also feel connected, which may boost their confidence.

TechP represents the learners' attitude towards the use of technology and is the learners' affective response to e-learning while demonstrating their experience related to its use. In this study, TechP represented learners' affective response to using technology for language acquisition. It was found to be positively associated with LE. However, it must be noted that TechP may differ according to field of study. Nevertheless, learners' abilities to speak and understand English may offer them more understanding and efficiency in e-learning environments.

To summarize, the present study empirically tested and validated the CoI framework concerning language learners in India. It confirmed that *presence* contributes to LE (Caskurlu, 2018). It emphasized the multi-dimensionality of the CoI elements, and established fundamental relations between them using a correlational model. This study extended the CoI framework by delivering an improved framework for studying and investigating language learners' experiences. This was done by including four more constructs (learning presence, emotional presence, technological presence, and technical barriers). The extended and modified framework, which depicts the many facets of the learning process that make up the LE, suggests that meaningful and substantial learning occurs when learners' expectations concerning all forms of *presence* are satisfied. Finally, the results of the study may ensure TELL courses are designed as vigorous learning environments and communities in which students, and teachers, exchange knowledge and views, besides ideas and experiences (Picciano, 2017).

Theoretical and Practical Recommendations

The findings of this study have a number of implications. Firstly, the study provides teachers, administrators, and policymakers guidance on how to recognize the elements that affect language learners' perceptions and experiences. This information can be used to enhance learner satisfaction and experience by applying the CoI framework to TELL. The proposed extended CoI model explains how learners experience *presence* and the associations between various constructs. This research has theoretical implications as it adds to the body of knowledge about e-learning courses and learner experience. To the best of the author's knowledge, it is the only investigation to incorporate four contextual elements (LP, EP, TechP, and TB) into the CoI framework. The research reveals how these factors influence LE for language learning purposes, thereby playing a critical role. It shows that CP, SP, and TP have an impact on LE, proving the validity of the CoI framework. The comprehensive CoI model is further extended and validated using raw data from language learners; thus, it contributes significantly to the extant literature on LE. This work has significant theoretical implications because the findings elucidate learners' perceptions of utilizing CoI. The modified comprehensive and inclusive model results in a more powerful illustrative model, thereby adding to the extant studies encompassing CoI by experimentally investigating LE. It fills the research gap and addresses a significant area of investigation about e-learning and language learning. However, the findings contrast with previous research, indicating that TB isn't an obstacle in the perception of language learners in India (Pillai, 2020). Further research is needed to address this discrepancy using larger and more varied samples, as well as more advanced statistical and inferential methodologies. As such, the results should not be overly generalized.

Finally, the present research has practical implications as it reveals the significance of CP, SP, TP, LP, EP, and TechP, for ensuring students' LE through e-learning, course gamification, interaction, and blended learning. All of these course formats combine virtual and real engagement for enhanced LE. Both SP and TP are vital, so instructors may ensure language

content is engaging enough for the learners and provide them with ample opportunities to engage in team activities, for promoting a more satisfying experience. Another major point raised in this study is the importance of LP and TechP. Learners must feel satisfied and content. They must feel joy, excitement, and playfulness and be technically competent. Instructors may guarantee learner satisfaction by introducing more communicative activities. In the context of a developing nation like India, instructors may pay more attention to the course design and its delivery to cater to the needs and demands of a diverse population of language learners. These results may also aid teachers, administrators, policymakers, and governments, as well as private organizations, in providing better facilities and resources for language learners in India. As such, academics, policymakers and researchers may find the CoI framework a useful tool for further study of L2 learning using technology, in various contexts.

Conclusion

The present investigation makes numerous contributions to the CoI literature. The study assessed the associations between CP, SP, LP, EP, TP, TechP, and TB. A comprehensive CoI model incorporating seven variables in the context of language learning was proposed and validated. In addition, it used a different methodology by using Spearman's rank correlation coefficient to validate seven hypotheses about the association between these constructs and LE. The proposed model may be useful for identifying the factors affecting learners' experiences and may provide valuable implications and recommendations for enhancing LE for language learners. However, the findings may be further tested using more advanced statistical and analytical techniques, including qualitative methods such as interviews or open-ended questions. Such methods would provide more in-depth coverage of learners' experiences, since language learning experiences may be more suitable for qualitative methods. The instrument also needs to be validated in other contexts using larger sample sizes and more advanced analytical methodologies. Moreover, the generalizability of the results can't be done without skepticism, as the results may differ based on context or culture. Another limitation of the study is that it is based on self-reported data which depends on the respondents' willingness to respond accurately. Learners may not be eager to respond accurately, which might bias the results. Lastly, the information was collected from learners only. Future studies may focus on other stakeholders like policymakers, government officials, and teachers. To conclude, the findings of the study have significant reference value for expanding the inquiry community's framework, comprehending the learners' experience, analyzing the influence of presence, and enriching the application of the CoI framework, thereby confirming that presence can reduce or enhance the learning experience. The results also may ensure TELL courses are designed as vigorous learning environs which facilitate language acquisition.

References

Akhter, H., Rahman, A. A. A., Jafrin, N., Saif, A. N. M., Esha, B. H., & Mostafa, R. (2022). Investigating the barriers that intensify undergraduates' unwillingness to online learning during COVID-19: A study on public universities in a developing country, *Cogent Education, 9*(1), 1–20. https://doi.org/10.1080/2331186X.2022.2028342

Ali, S., Uppal, M. A. & Gulliver, S. R. (2018). A conceptual framework highlighting e-learning implementation barriers. *Information Technology & People, 31*(1), 156–180. https://doi.org/10.1108/ITP-10-2016-0246

Alvi, I. (2021a). College students' reception of social networking tools for learning in India: an extended UTAUT model. *Smart Learning Environment, 8*(1), 19. https://doi.org/10.1186/s40561-021-00164-9

Alvi, I. (2021b). Effects of Technology-based Feedback on Learning. In Gupta, S. L., Kishor, N., Mishra, N., Mathur, S., & Gupta, U. (Ed.) *Transforming Higher education through Digitalization: Insight, Tools and Techniques* (pp. 203-221). Boca Raton, Taylor & Francis Group: CRC Press. https://doi.org/10.1201/9781003132097

Alvi, I. (2022). Effect of Communication Strategies for Implementation of IT-based Educational Innovation During COVID-19 Pandemic on Students' Motivation, Attitude, and Intent. *IIMS Journal of Management Science, 13*(1), 55–73. https://doi.org/10.1177/0976030X211051096

Anderson, T., Rourke, L., Garrison, D. R., & Archer, W. (2001). Accessing teaching presence in a computer conferencing context. *Journal of Asynchronous Learning, Networking, 5*(2),1–17. https://doi.org/10.24059/olj.v5i2.1875

Annand, D. (2019). Limitations of the Community of Inquiry Framework. *International Journal of E-Learning & Distance Education, 34*(2), 1–15. https://eric.ed.gov/?id=EJ1242715

Annand, D. (2011). Social Presence within the Community of Inquiry Framework. *International Review of Research in Open and Distributed Learning, 12*(5), 40–56. https://doi.org/10.19173/irrodl.v12i5.924

Arbaugh, J. B., Cleveland-Innes, M., Diaz, S. R., Garrison, D. R., Ice, P., Richardson, J. C., & Swan, K. P. (2008). Developing a community of inquiry instrument: Testing a measure of the Community of Inquiry framework using a multi-institutional sample. *Internet and Higher Education, 11*(3–4), 133–136. https://doi.org/10.1016/j.iheduc.2008.06.003

Bigné, E., Badenes-Rocha, A., Ruiz, C., & Andreu Simó, L. (2019). Development of a Blended Course for Online Teaching: Process and Outcomes. *Journal of Management and Business Education, 2*(2), 108-126. https://doi.org/10.35564/jmbe.2019.0010

Camilleri, M. A., & Camilleri, A. C. (2021). The Acceptance of Learning Management Systems and Video Conferencing Technologies: Lessons Learned from COVID-19. *Technology, Knowledge and Learning*, *8*, 1–23. https://doi.org/10.1007/s10758-021-09561-y

Caskurlu S., Maeda Y., & Richardson J. C., & Lv, J. (2020). A meta-analysis addressing the relationship between teaching presence and students' satisfaction and learning. *Computers & Education, 157*, 103966. https://doi.org/10.24059/olj.v26i1.2604

Cavanagh A. J., Aragón, O. R., Chen, X., Couch, A., Durham, F., Bobrownicki, A., Hanauer, D. I., & Graham, M. J. (2016). Student Buy-In to Active Learning in a College Science Course. *CBE: Life Sciences Education, 15*(4):ar76. https://doi.org/10.1187/cbe.16-07-0212.

Celik, V., & Yesilyurt, E. (2013). Attitudes to technology, perceived computer self-efficacy and computer anxiety as predictors of computer supported education. *Computer Education, 60*, 148–158. https://doi.org/10.1016/j.compedu.2012.06.008

Cenfetelli, R. T., & Schwarz, A. (2011). Identifying and testing the inhibitors of technology usage intentions. *Information Systems Research, 22*(4), 808–823. http://www.jstor.org/stable/23207664

Chang, R. I., Hung, Y. H. & Lin, C. F. (2015). Survey of learning experiences and influence of learning style preferences on user intentions regarding MOOCs. *British Journal of Educational Technology, 46*(3), 528–541. https://doi.org/10.1111/bjet.12275

Cleveland-Innes, M., & Campbell, P. (2012). Emotional presence, learning, and the online learning environment. *International Review of Research in Open and Distance Learning, 13*(4), 269–292. https://doi.org/10.19173/irrodl.v13i4.1234

Dempsey, P. R., & Zhang, J. (2019). Re-examining the construct validity and casual relationships of teaching, cognitive, and social presence in community of inquiry framework. *Online Learning, 23*, 62–79. https://doi.org/10.24059/olj.v23i1.1419

Dewey, J. (1959). My pedagogic creed. In J. Dewey (Ed.). *Dewey on Education* (pp. 19–32). New York, NY: Teachers College, Columbia University.

Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems, 49*, 5–22. https://doi.org/10.1177/0047239520934018

Faul F., Erdfelder, E., Lang, A.-G., & Buchner A. (2007). G∗Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behaviour Research Methods*, *39*, 175–191. https://doi.org/10.3758/BF03193146

Garrison, D. (2017). *E-learning in the 21st century: A community of inquiry framework for research and practice* (3rd ed). London: Routledge/Taylor and Francis.

Garrison, D. R., & Arbaugh, J. B. (2007). Researching the community of inquiry model: review, issues, and future directions. *Internet Higher Education, 10*, 157–172. https://doi.org/10.1016/j.iheduc.2007.04.001

Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education, 2*(2–3), 87–105. https://doi.org/10.1016/S1096-7516(00)00016-6

Garrison, D. R., Anderson, T., & Archer, W. (2010). The first decade of the community of inquiry model: a retrospective. *The Internet and Higher Education, 13,* 5–9. https://doi.org/10.1016/j.iheduc.2009.10.003

George, D., & Mallery, M. (2010). *SPSS for Windows Step by Step: A Simple Guide and Reference*, Boston. Pearson.

Green, Z., & Batool, S. (2017). Emotionalized learning experiences: Tapping into the affective domain. *Evaluation and Program Planning, 62*, 35–48. https://0-doiorg.aupac.lib.athabascau.ca/10.1016/j.evalprogplan.2017.02.004

Heilporn, G., & Lakhal, S. (2020). Investigating the reliability and validity of the community of inquiry framework: An analysis of categories within each presence. *Computer Education, 145*, 103712. https://doi.org/10.1016/j.compedu.2019.103712

Hilliard, L. P., & Stewart, M. K. (2019). Time well spent: creating a community of inquiry in blended first-year writing courses. *Internet Higher Education, 41*, 11–24. https://doi.org/10.1016/j.iheduc.2018.11.002.

Huang, H. M., & Liaw, S. S. (2018). An analysis of learners' intentions toward virtual reality learning based on constructivist and technology acceptance approaches. The International *Review of Research in Open and Distributed Learning, 1*, 91–115. https://doi.org/10.19173/irrodl.v19i1.2503

Huang, Y. C., Backman, S. J., Backman, K. F. McGuire, F. A., & Moore, D. (2019). An investigation of motivation and experience in virtual learning environments: a self-determination theory. *Education and Information Technologies, 24*, 591–611. https://doi.org/10.1007/s10639-018-9784-5

Junus, K., Santoso, H. B., & Ahmad, M. (2022). Experiencing the community of inquiry framework using asynchronous online role-playing in computer-aided instruction class. *Education and Information Technologies volume, 27*, 2283–2309. https://doi.org/10.1007/s10639-021-10670-5

Kauffman, H. (2015). A review of predictive factors of student success in and satisfaction with online learning. *Research in Learning Technology, 23*(26507), 1–13. https://doi.org/10.3402/rlt.v23.26507

Kaur, D. J., Saraswat, N. & Alvi, I. (2021). Exploring the Effects of Blended Learning using WhatsApp on Language Learners' Lexical Competence. *Rupkatha Journal on Interdisciplinary Studies in Humanities, 13*(4), 1–17. https://doi.org/10.21659/rupkatha.v13n4.60.

Kilis, S., & Yıldırım, Z. (2018). Investigation of community of inquiry framework in regard to self-regulation, metacognition and motivation. *Computers and Education, 126*, 53–64. https://doi.org/10.1016/j.compedu.2018.06.032.

Kiran, A. H. (2012). Technological Presence: Actuality and Potentiality in Subject Constitution. *Human Studies*, 35, 77–93. https://doi.org/10.1007/s10746-011-9208-7

Kozan, K. & Caskurlu, S. (2018). On the nth presence for the community of inquiry framework. *Computers and Education, 122*, 104-118. http://dx.doi.org/10.1016/j.compedu.2018.03.010

Kreijns, K., Xu, K. & Weidlich, J. (2022). Social Presence: Conceptualization and Measurement. *Educational Psychology Review, 34*, 139–170. https://doi.org/10.1007/s10648-021-09623-8

Lane, A. (2019). The impact of technology on the teaching and assessment of 'systems' diagrams in two online environmental management modules. *Open Learning: The Journal of Open, Distance and e-Learning, 34*(1), 61–77.

Lai, C. (2013). A framework of developing self-directed technology use for language learning. *Language Learning and Technology, 17*, 100–122. https://doi.org/10.1017/S0047404513000390

Lin, S., Hung, T. C., & Lee, C. T. (2015). Revalidate forms of presence in training effectiveness: Mediating effect of self-efficacy. *Journal of Educational Computing Research, 53*(1), 32–54. https://doi.org/10.1177%2F0735633115588772

Ma, Z., Wang, J., Wang, Q., Kong, L., Wu, Y., & Yang, H. (2017). Verifying causal relationships among the presences of the community of inquiry framework in the Chinese context. *The International Review of Research in Open and Distributed Learning, 18*, 213–230. https://doi.org/10.19173/irrodl.v18i6.3197.

Mageira, K., Pittou, D., Papasalouros, A., Kotis, K., Zangogianni, P., & Daradoumis, A. (2022). Educational AI Chatbots for Content and Language Integrated Learning. *Applied Science, 12*, 3239. https://doi.org/10.3390/app12073239.

Martin, F., Wu, T., Wan, L., & Xie, K. (2022). A Meta-Analysis on the Community of Inquiry Presences and Learning Outcomes in Online and Blended Learning Environments. *Online Learning, 26*(1). http://dx.doi.org/10.24059/olj.v26i1.2604

Mykota, D. (2017). The impact of learner characteristics on the multi-dimensional construct of social presence. *The Turkish Online Journal of Educational Technology, 16*(2), 137–144.

Park, H., & Shea, P. (2020). A review of ten-year research through co-citation analysis: Online learning, distance learning and blended learning. *Online Learning. 24*(2), 225–44. http://dx.doi.org/10.24059/olj.v24i2.2001

Parrish, C. W., Guffey, S. K. & Williams, D. S., Estis, J. M., & Lewis, D. (2021). Fostering Cognitive Presence, Social Presence and Teaching Presence with Integrated Online—Team-Based Learning, *TechTrends, 65*, 473–484. https://doi.org/10.1007/s11528-021-00598-5.

Picciano, A. G. (2017). Theories and frameworks for online education: Seeking an integrated model. *Online Learning, 21*(3), 166-190. https://doi.org/10.24059/olj.v21i3.1225

Pillai, R. (2020). An empirical study on the online learning experience of MOOCs: Indian students' perspective. *International Journal of Educational Management, 34*(3), 586–609. https://doi.org/10.1108/IJEM-01-2019-0025

Rasheed, R. A., Kamsin, A., & Abdullah, N. A. (2020). Challenges in the online component of blended learning: A systematic review. *Computer and Education, 144*, 103701. https://doi.org/10.1016/j.compedu.2019.103701

Richardson, J. C., Maeda, Y., Lv, J., & Caskurlu, S. (2017). Social presence in relation to students' satisfaction and learning in the online environment: A meta-analysis. *Computers in Human Behavior, 71*, 402-417. https://doi.org/10.1016/j.chb.2017.02.001

Shea, P., & Bidjerano, T. (2009). Community of inquiry as a theoretical framework to foster "epistemic engagement" and "cognitive presence" in online education. *Computer and Education, 52*, 543–553. https://doi.org/10.1016/j.compedu.2008.10.007

Shea, P., & Bidjerano, T. (2010). Learning presence: towards a theory of self-efficacy, self-regulation, and the development of a communities of inquiry in online and blended learning environments. *Computer and Education, 55*, 1721–1731. https://doi.org/10.1016/j.compedu.2010.07.017.

Song, M., & Yuan, R. (2015). Beyond social presence: increasing cognitive presence through meaningful interaction. In Proceedings of *Global learn Berlin 2015: Global conference on Learning and technology* (pp. 731–736). Berlin, Association for the Advancement of Computing in Education (AACE).

Swan, K., Shea, P., Richardson, J., Ice, P., Garrison, D. R., Cleveland-Innes, M., & Arbaugh, J. B. (2008). Validating a measurement tool of presence in online communities of inquiry. *E-Mentor, 2*(24), 1–12. e-mentor.www.e-mentor.edu.pl/eng

Tetri, B., & Juujärvi, S. (2022). Self-Efficacy, Internet Self-Efficacy, and Proxy Efficacy as Predictors of the Use of Digital Social and Health Care Services Among Mental Health Service Users in Finland: A Cross-Sectional Study. *Psychology research and behavior management, 15*, 291–303. https://doi.org/10.2147/PRBM.S340867

Thomas, M., Harris, R., & King-Berry, A. (2017). Creating inclusive online learning environments that build community and enhance learning. In P. Vu, S. Fredrickson, & C. Moore (Eds.), *Handbook of research on innovative pedagogies and technologies for online learning in higher education*. IGI Global. https://doi.org/10.4018/978-1-5225-1851-8.ch014

Wei, L., Hu, Y., Zuo, M., & Luo, H. (2020). Extending the COI Framework to K-12 Education: Development and Validation of a Learning Experience Questionnaire. In *Blended Learning: Education in a Smart Learning Environment*. Springer. https://doi.org/10.1007/978-3-030-51968-1_26

Wertz, R. E. H. (2022). Learning presence within the Community of Inquiry framework: An alternative measurement survey for a four-factor model. *The Internet and Higher Education, 52*, 1096–7516. https://doi.org/10.1016/j.iheduc.2021.100832

Wood, R., & Shirazi, S. (2020). A systematic review of audience response systems for teaching and learning in higher education: the student experience. *Computer and Education, 153*, 103896. https://doi.org/10.1016/j.compedu.2020.103896

Woodcock, S., Sisco, A. & Eady, M. (2015). The learning experience: training teachers using online synchronous environments. *Journal of Educational Research and Practice, 5*(1), 21-34. http://dx.doi.org/10.5590/JERAP.2015.05.1.02

Yu, Z., & Li, M. (2022). A bibliometric analysis of Community of Inquiry in online learning contexts over twenty-five years. *Education and Information Technologies, 5,* 1-20. https://doi.org/10.1007/s10639-022-11081-w

Yu, Z., Xu, W., & Yu, L. (2022). Constructing an online sustainable educational model in the COVID-19 pandemic environments. *Sustainability, 14*(6), 3598. https://doi.org/10.3390/su14063598

Zhou, M. (2016). Chinese university students' acceptance of MOOCs: a self-determination perspective. *Computers and Education, 92-93* (2), 194–203. 10.1016/j.compedu.2015.10.012

Zhou, M., Dzingirai, C., Hove, K., Chitata, T., & Mugandani, R. (2022). Adoption, use and enhancement of virtual learning during COVID-19. *Education and Information Technologies*. https://doi.org/10.1007/s10639-022-10985-x

Zimmerman, B. J. (2008). Self-regulation and motivation: Historical background, methodological developments, and future prospects. *American Education Research Journal, 45*(1), 166–183. https://doi.org/10.3102/0002831207312909

Corresponding Author: Irum Alvi
Email: irumalvi@gmail.com

Immersive Technologies in Physical Education in Malaysia for Students with Learning Disabilities

Nur Azlina Mohamed Mokmin
Universiti Sains Malaysia, Malaysia

Nurul Nabilah Izzati Binti Ridzuan
Universiti Sains Malaysia, Malaysia

Abstract

Physical education (PE) is a compulsory subject in schools that is vital to ensure students stay healthy and fit. It is widely agreed that everyone should have access to education, regardless of physical limitations. However, there is an ongoing debate on how PE has been taught and used to benefit students with learning disabilities (SLD). SLDs may feel excluded from PE due to lack of support systems, low motivation, and unsuitable learning materials. This paper discusses the development of an app that applies immersive technologies to make PE accessible to SLDs. Virtual reality and augmented reality are immersive technologies in which the user can view virtual media to understand objects in the real world. With these technologies, students can freely control their learning progress and choose the content critical to them based on their circumstances, enabling instruction based on their ability. Optimal Motor Learning Theory and Cognitive Theory of Multimedia Learning (CTML) were used to develop the app. The first phase of this two-stage research process involved creating a VR app and getting feedback from the students who used it. Interviews of students who used the VR trainer and secondary data were used to inform the development of an AR book. The authors found that by combining suitable immersive technologies with motor learning theory and multimedia learning principles, appropriate learning material could be created that facilitates the PE learning process.

Keywords: augmented reality, immersive, physical education, sport, strength exercise, virtual reality

Physical Education (PE) is an elementary and secondary school subject focusing on the human body and psychomotor learning (Andrieux & Proteau, 2016). The course develops skills, knowledge, values, and attitudes required to establish and enjoy an active and healthy lifestyle through extensive learning. Face-to-face learning builds students' confidence and ability to face individual, group, or team challenges (WHO, 2020). In the right PE setting, the lessons can engage students, attract distracted learners' attention, and create an environment that cultivates enthusiasm for physical activities.

The COVID-19 outbreak forced many countries to restrict movement and required education to be home-based and/or online. Schools in 194 countries were closed, and many virtual teaching and learning activities were organized to ensure the learning process continued to achieve the targeted learning outcomes. In European countries and the United States, physical education teaching activities were carried out via live streaming, providing students with recorded videos or links to follow on their own (Filiz & Konukman, 2020). However, physical education is a minor subject in Malaysia that gets little government attention. Resources are allocated to mainstream subjects (Tan, 2021), such as compulsory mathematics and science, and included in national exams.

Many educators found that teaching PE online during the current pandemic was challenging to handle (Varea & González-Calvo, 2020). The teaching process became less physical. This approach also made students less healthy and increased sedentary behavior among otherwise active students (Roe et al., 2021). PE needs observational learning and physical instruction, which adds to teachers' difficulties in ensuring the learning process is maintained or mimics that in a typical classroom before the pandemic. Nevertheless, the students' involvement in physical, sports, recreational, and social activities is a must to produce fit and productive students (Lim et al., 2016). However, there is an ongoing debate on how PE has been taught and used to benefit students with learning disabilities (SLD). Roe et al. (2021) suggest that PE teaching and learning can be carried out successfully at a distance with suitable strategies, including personalization, creativity, and inclusiveness. This paper discusses the development of an app that applies immersive technologies to make PE accessible to SLDs.

Background and Literature Review

According to data from the Department of Special Education, 82 percent of students with disabilities (SWD) in Malaysia in 2020 were classified as having a learning disability (LD). The significant number of SWD with learning disabilities raises issues about the inclusivity of SWD in the Malaysian Education system (Nordin et al., 2019). SWDs that have been assessed as having autism, attention deficit hyperactivity disorder (widely known as ADHD), dyslexia, writing disorders, and dysphagia are classified as students with learning disabilities (SLD) [Radzi et al., 2019]. The Ministry of Education uses the term SLD to characterise pupils who cannot learn in a traditional classroom setting. They have poor reading, writing, and arithmetic skills. Intellectual dysfunction, neurological abnormalities, or neurological processing difficulties may cause their learning disabilities (Nordin et al., 2019).

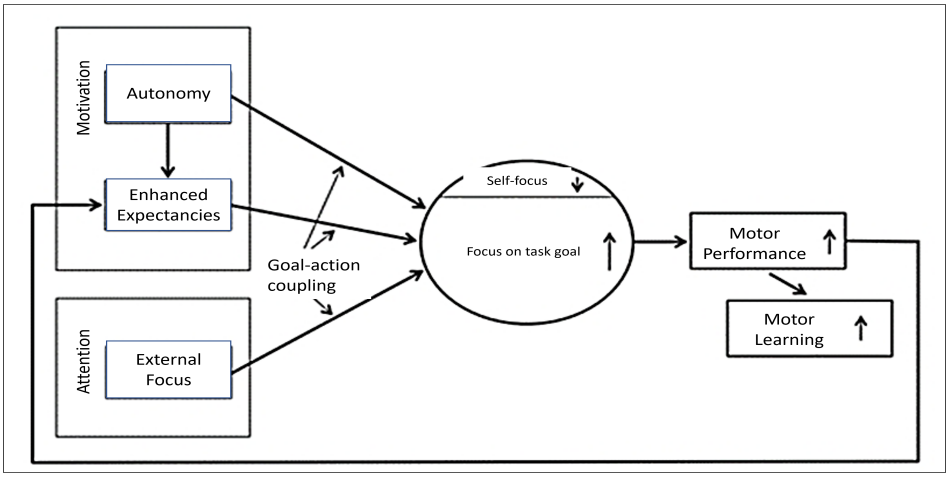
These students also face difficulties during the learning process in PE (Hamizi et al., 2022). According to Di Palma et al. (2018), among the problems are fears of participating, insufficient learning resources, lack of school-based support, and insecurities with others. These difficulties can hinder their true potential in PE and make some learning outcomes impossible to achieve. Therefore, educators should consider the students' unique demands and emphasize improving their concentration and creating a flexible learning environment.

Theories of Motivation and Learning

Wulf and Lewthwaite (2016) introduced the Optimizing Performance Through Intrinsic Motivation and Attention for Learning (OPTIMAL) theory of motor learning, which argued that intrinsic motivation and learning, attention, performance, and knowledge could contribute to motor performance and physical education learning. According to the theory, to increase motivation, it is essential to maintain student autonomy in terms of control over the learning process that can ultimately lead to focusing on the goal. The theory also posited that giving learners control over specific practice areas or using assistive technology can improve motor learning. Combining confidence in their potential to perform effectively with instructions that can raise their external focus can help students achieve successful movement results. These will boost self-efficacy and help solidify the positive impacts of performance, producing a virtuous circle that will have benefits for learning and motivation in the long run.

Learning elements that increase expectations for future completion and support autonomy through perceived control and motivational mediators like self-efficacy, perceived competence, and positive affect accelerate motor learning. Dopamine is released when these motivational variables are met, which aids in brain circuit growth and memory consolidation (Puig et al., 2014). Furthermore, combining OPTIMAL variables increases motor learning by enhancing goal-action coupling efficiency (Wulf & Lewthwaite, 2016). Figure 1 displays the Optimal Theory of Motor Learning. Autonomy and enhanced expectancies are illustrated as motivational, while the external focus is an attention factor that improves learning and performance of motor skills. Autonomy support describes a situation in which a person is given the ability to control or choose certain aspects of practice or performance conditions. Focusing on the movement goal or effect, such as focusing on the dartboard while throwing a dart, is an example of an external focus of attention.

Figure 1
The Optimal Motor Learning Theory (Wulf & Lewthwaite, 2016)



PE has significant effects on the overall growth of SLDs. However, researchers have found several issues the SLDs face in PE (Di Palma et al., 2018; Greguol et al., 2018; Tafuri & Cassese, 2017). According to Kohli et al. (2018), some SLDs have been given inadequate learning materials, are afraid to mingle due to a lack of social skills, are nervous when performing PE, and lack institutional assistance. SLDs' participation in PE classes is also lower than other same-age students in primary and secondary education (Adams, 2016). Thus,

educators must consider the needs of SLDs while providing them with superior PE learning experiences. Educators can work on the necessary modifications to the curriculum and class settings that benefit the students. In a physical education class, better learning guidance makes PE enjoyable and provides positive results. However, there is still a lack of assessment of PE teaching and learning effectiveness in Malaysia and whether the implementation has been catering to the SLD.

Mayer's (2011) Cognitive Theory of Multimedia Learning (CTML) proposes that an elemental overload will occur when cognitive processing exceeds the learner's ability, thereby inhibiting learning. Previous research has shown that when a multimedia course is presented in immersive VR, learners are more likely to experience complete overload than the same course in non-immersive media because the external load increases due to the rise in sensory information (Freeman et al., 2019). This model will be used to distinguish two kinds of cognitive load for the design process of immersive multimedia learning in physical exercise. The first is the inherent cognitive load related to the properties of the learning material, such as its intrinsic difficulties. The other is an unrelated cognitive load associated with the presentation of the material. The CTML is used as a guide alongside the OPTIMAL Motor Learning theory in developing the multimedia design for the app.

Immersive Technologies in Learning

Immersive learning uses enhanced simulated or purely artificial environments so that learners can experience scenarios and simulations to produce valuable and engaging knowledge. This technology is becoming popular as it offers learning outcomes by providing authentic experiences. In the field of instructional technology, the terms "virtual reality" and "augmented reality" have been trending for the past five years (Kimmons, 2020). For physical education, the potential usage of VR is limitless. In their study, Jiao and Qian (2020) used VR to teach PE by displaying various videos using the Flipped Learning approach. Their research shows that combining VR and Flipped Learning significantly increased PE students' satisfaction compared to traditional classroom learning. Another study on the application of VR for PE conducted by Brooke et al. (2020) proved that the technology could be used to teach badminton. Their research concluded that VR-based PE training could: (a) improve understanding, (b) teach repeated practice, (c) increase teamwork and mutual support, and (d) promote motivation. In addition, Mokmin (2020) and Mulders et al. (2020) concluded that VR technology could provide additional stimulation to encourage students to engage in PE whenever teacher supervision is unavailable.

Virtual reality often uses a headset to shut out visual stimuli from the outside world. In this immersive alternative, the user can pick up and move objects, turn on and disassemble gadgets, stroll around a room, and interact with virtual characters. Not only can virtual reality technology be utilised to teach knowledge, but it can also be used to teach actions and skills. As long as there is a suitable model library, students can put on virtual reality glasses and watch the steps of action in person. Because this process is computer-controlled, students can watch it repeatedly, slow it down, study it from different angles, or even engage in the action. Students can freely control the pace of instruction and choose the content that is critical to them based on their circumstances and ability (Wu et al., 2021). Virtual reality (VR) allows physically disabled people to try out-of-reach experiences like climbing a mountain, extreme sports, or swimming in the sea for the first time.

Mokmin and Jamiat (2020) discussed the development of a virtual fitness trainer to motivate undergraduate students to engage in physical exercise. Their study showed that most respondents gave positive reviews of the fitness activities with the trainers, and their motor performance increased when learning with the app. However, their design has not been tested for SLDs. Reducing the cognitive load during learning, especially for SLDs, is vital to engage them in learning (Hardiyanti & Azizah, 2019). Therefore, the CTML is used to guide the development process so that the multimedia presented to the students can improve their learning achievement.

People with special needs may benefit from augmented reality (AR), which can help them build everyday life skills. AR allows users to see the real world while overlaying virtual elements on top of it. According to a meta-analysis by Baragash et al. (2020), AR is an appropriate learning medium to enhance the involvement of SWDs in society, teach varied abilities, educate, diversify physical learning, conduct self-care duties, and retain information for an extended period. Because AR has the function of displaying context-sensitive digital information, which can support individual needs at the time and provide timely learning, it is a potent tool for people with disabilities (Walker et al., 2017). The term "augmented reality" refers to virtual reality in which virtual things are placed in real-world settings. The objects can be visualised in front of the users statically or dynamically. This technology allows developers to add labels, videos, or related information to the displayed objects. It is like having a different environment on your mobile device. In addition, AR could lead the blind with guided audio.

These two immersive learning technologies can be used separately or in combination to produce compelling learning experiences. These technologies should be explored as an alternative to typical classroom settings, particularly in the event of a disruption in schooling or immersive learning. The exciting element of immersive learning is that it creates a highly engaged environment for users, both virtually and physically (Kumar, 2020). This allows an instructor to effectively reproduce a variety of actual locations that are not accessible within the confines of a classroom. The virtual content may be so motivating that it has a lasting effect on the learner's mind (Hennick, 2020). The technology typically uses a headset to block external visual stimulation (VR) or overlay visuals over the real world (AR). Because the technology is available on cell phones, it is being more widely used and thus readily available to students (McCarthy & Uppot, 2019).

Our research focused on designing and developing an app that used virtual and augmented reality technology to help physical education students learn more effectively. This study developed five virtual trainers and one augmented trainer using optimal motor learning theory and CTML. The following are the study's primary objectives: (a) to see how effective virtual physical education coaches are at engaging and motivating pupils to participate in fitness activities and (b) to design and develop an AR book and AR app for PE based on the information collected from objective primary and secondary data. The CTML has been used to create the virtual trainer, exercise movements, choose suitable texts, illustrate images, and choose suitable sounds for the app.

The Design and Development Process

This study is a multiphase design and development study with a qualitative evaluation component. Interviews were used to understand how immersive physical education trainers can facilitate learning and function as good learning material. The paper aims to answer the following questions: (a) how can a virtual physical education trainer help engage and motivate

students to learn physical exercise and (b) what could be the design of a suitable AR trainer for physical exercise for SLDs? This study was divided into two main phases. Table 1 summarizes the research and design procedure that followed the ADDIE Model.

Table 1
The Design and Development Process

Process	Activities
Analysis	Needs analysis from teacher interviews and secondary resources collection
Design	The design of the five virtual trainer characters and storyboard
Development	The development of the trainers and the app using Unity and Adobe Mixamo
Implementation	The implementation of the app with a head-mounted device and testing in the actual setting
Evaluation	The evaluation of the app using student interviews

Phase 1: The Development of The VR Trainers

A preliminary investigation was done in the school to get an overview and additional information about the teaching and learning process. Unstructured interviews were carried out with five teachers. The questions were: (a) what are the most important things that should be considered in class, (b) will the students understand the 3D object and learn the movements, (c) what is the maximum number of students for each lesson, and (d) what type of learning materials are used in teaching and learning? The teachers listed important things to clarify related to teaching SLD. The students must be in a group of less than 10 per session and the instructions must be done step by step. The students also like a trainer that shows actions that are easy to follow. The needs analysis results were used to select the participants and design the virtual trainers.

Design and Development

In the first phase, five virtual trainers were developed to test how students reacted to the training of physical movements using virtual trainers. Five virtual fitness trainers were created to see how effective virtual physical education coaches engage and motivate pupils to participate in fitness activities. These trainers were developed based on the suggestions from the teachers. The teachers suggested that the trainers show the training steps from the preliminary investigation. The activities must also be fun and attract the students' attention. Thus, the five trainers' movements were unique. They were created based on the optimal motor learning theory, which proposes that students learn motor movements by observing the trainers and the signs of motor actions shown explicitly by the trainers. Different trainer types with animations were used to increase student motivation and interest in physical activity. According to motor learning theory, specific motor techniques can be gained from training the body to perform precise motor movements. The CTML is applied to the design process of the VR trainer. Table 2 gives the usage description of the multimedia principles used for the design.

Table 2
Multimedia Learning Principles, Definition, and the Application

Multimedia Principle	Definition	Usage Description
Coherence	Concise, short, and support the instructional goal	In this design, only the virtual trainers show the movements, accompanied by suitable sound.
Redundancy	Avoid displaying the same content of information using audio and text	The trainers only show the movement with music, and the narration is not applied
Contiguity	The text must be close to the visuals that are the subjects of training	The text was placed near the trainer.
Segmenting	The learning content must be broken down into lessons	The steps were presented in segments and phase by phase to make it easier for the students to follow.
Signaling	Learners must be shown exactly what to see on the screen.	Showing exactly what items they need to pay attention to during the movements

The first trainer was Sharky in Figure 2, where the character displayed funky and enjoyable dance movements. Sharky is dressed as a human with a shark costume to attract the learners' attention. This motion is intended to encourage the learners to warm up before engaging in more vigorous exercise activities. This was from a report by Anderson and Rastegari (2016) that for students with a disability, dance, especially a happy dance, can encourage them to exercise. AJ's second character, displayed in Figure 3, demonstrates more intense activities like running and jumping around. The third trainer is Malcolm in Figure 4, who shows fitness through fighting techniques like punching and kicking. The fourth is Granny's character in Figure 5, which focuses more on dancing and easy movement. Although this character is named Granny, she is a sporty granny with Jazz and Zumba dancing. Figure 6 shows Scarlet's character, which demonstrated vigorous activities in video games like running, zombie fighting, and high kicking. The average duration of activities with each of the characters is approximately five minutes. These characters were developed based on the report by Mokmin and Jamiat, 2020. According to these reports, students with disabilities can learn physical activities from adaptive physical exercise suitable to their learning needs.

Figure 2
Sharky with Happy Dance Movements

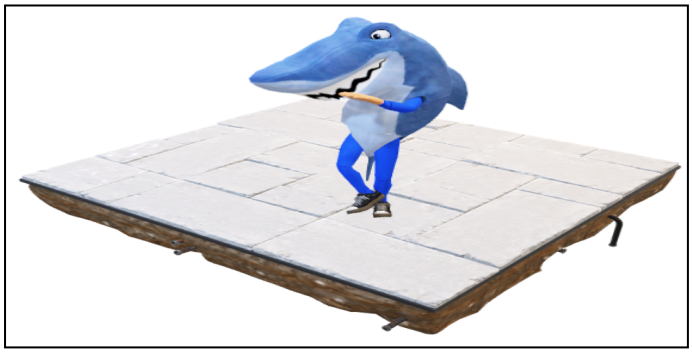


Figure 3
AJ with Exercise Movements

Figure 4
Malcom with Fighting Movements

Figure 5
Granny with Dance Movements

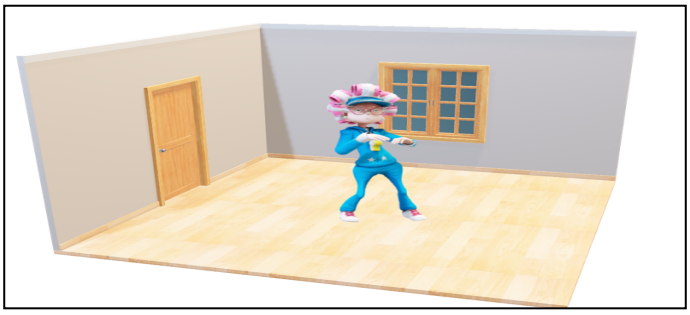


Figure 6
Scarlet with Zombie Fighting

Implementation and Evaluation

The VR Trainers developed were compiled into the app, ready to be used by the students. The developed app was published into a .apk file and linked to a Head Mounted Device (HMD). The facilitators involved in collecting data were trained to use the HMD and run the app. The participants for the evaluation were chosen from a special needs secondary school in Malaysia. The teacher selected the students to join the study who could understand the information and answer all the questions. The ethical committee in the university approved the study. Permission to conduct the sessions was also obtained from the Malaysian Special School Department.

Twelve students were interviewed after they were introduced to the virtual trainers to learn the physical exercise movements. They were aged between 16 to 17 years old and have learning disabilities. Before the exercise started, students' physical fitness was assessed. The students were divided into two groups of six students each. The first group had to follow intense and rigorous exercises with AJ, Malcolm, and Scarlet. The second group required low-intensity movement. Therefore, Granny and Shaky were selected for this group. Both groups were assessed separately inside a gym in one of the educational institutions in Malaysia. They were asked to complete a simple warm-up first and then follow the trainers' movement with a facilitator's help. After the session ended, each participant was interviewed.

Overall, all the participants were able to follow the movements of the trainers. Students who participated in this study also liked the music used in training. They could remember and clearly describe the song used in the activities. However, some students preferred trendier pieces that suited their moods. Some students even expressed enjoyment and excitement in doing a low-intensity salsa and dancing activity. They said the virtual fitness trainers were attractive and willingly followed the movements without coercion. The respondents also suggested adding more trainers to increase their fitness in the long run.

Most said it was 3D and realistically done for all the virtual trainers. A majority said they found Scarlet's movements a bit weird but that it has a value that added to the learning experiences. According to the comments, Scarlet shows specific signs like jumping and running around that provide more student fitness activities. For the combat trainer (Malcolm), students stated that they could learn and hopefully increase their fitness. Most of the students could describe in detail the movements they had learned. They even mentioned "looking around" by one of the trainers to prove that they could remember all the movements. The following are selected quotes from the interviews.

Group 1: Virtual fitness trainers with High-Intensity Movements

Respondent 1:
"The movement is ok. The Scarlet has specific movement and added new fun experience"
"The movement of Malcolm exposed to fitness activities and fitness"
Respondent 2:
"I have done most of the activities previously, but it is ok"
Respondent 3:
"It is too simple for me. The song should be changed to something more trendy"
Respondent 4:
"The movement is not too hard. Easy for me to follow"
Respondent 5:
"The zombie movement is unique. I like it because it is different from the other app I used before because the trainer got movements"
Respondent 6:
"I like it. I sweat a lot"

Group 2: Virtual fitness trainers with Low Intensity Movements

Respondent 1:
"The Sharky training is OK"
Respondent 2:
"Sharky movement is best. It got viral song. But I don't prefer the Salsa movements. It is slower than Sharky"
Respondent 3:
"Should be more movements for Sharky. It is good. "
Respondent 4:
"This make me sweat a lot."
Respondent 5:
"I like the music"
Respondent 6:
"I feel good"

We concluded from the interview that all students prefer Sharky or Scarlet's movements. This is because the actions of the two virtual trainers were easy to understand and follow by the students. The comments and suggestions from the students were used as a guideline to construct the AR book. However, for the first edition of the AR Book, the trainer characters were not included in the AR Book because we had to follow the requirements of the original textbook.

Phase 2: The Development of an AR Book

Needs Analysis

The design at this stage was based on semi-structured interviews done to know how students responded to the lessons with virtual trainers and secondary data concerning the appropriate design of physical exercise movements collected from the textbooks and teaching materials from the Department of Special Education, Malaysia. Additional information was also

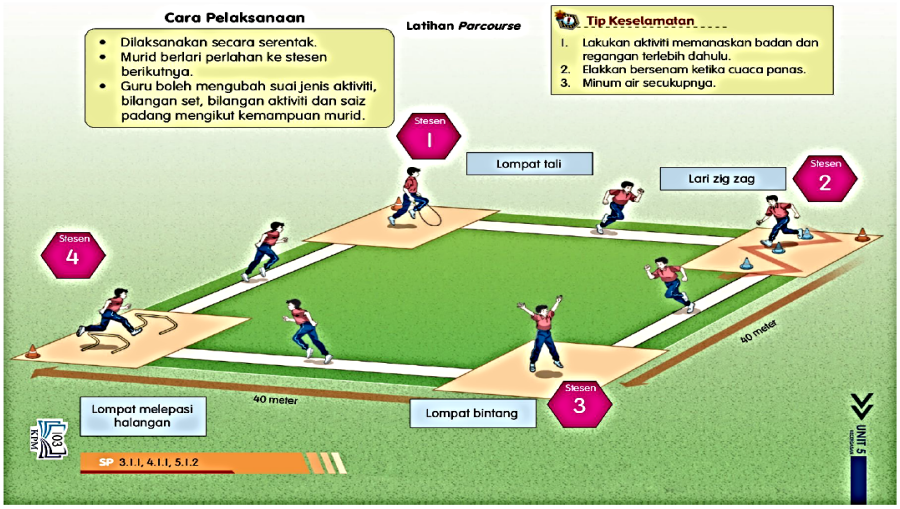
collected from reports and research papers for the second phase. Based on the feedback from Phase 1 and the information collected in Phase 2, AR books and an AR app were developed to facilitate physical education for students with disabilities.

Design and Development

Selecting the best design for an AR trainer suitable for physical exercise involved analyzing the information from official sources such as textbooks as well as using the CTML principles. The content covered was as follows: (a) Stretching, (b) Muscle Strength, (c) Parcourse Training, and (d) Fitness Test. All movements were designed based on the guidelines from the official textbook the Ministry of Education provided.

The parcourse activity was specially designed for students with a learning disability. Parcourse is a set of training that often gives a well-rounded workout based on health-related fitness concepts (MacDonald et al., 2017). This is a fitness activity with checkpoints designed to increase the students' fitness level and be suitable for special needs students (Mustaffa et al., 2019). Thus, the activity was chosen to be included in this study. The training was done by referring to the Physical Education textbook published by the Department of Special education with the title, "Pendidikan Jasmani dan Pendidikan Kesihatan Pendidikan Khas Tingkatan 4," translated as "Health and Physical Education for Form Four Special Needs Students." Figure 7 displays the screenshot of the parcourse training. The textbook covers one year of the syllabus for the secondary form four students in the Malaysian Special Education school system. In the textbook, students are provided instructions on fitness activities to do in class for PE.

Figure 7
The Parcourse Training in Special Education PE textbook (Mustaffa et al., 2019)



Based on the interview data, the authors concluded that the activities must be increased and follow a particular order. According to the students, good fitness trainers must have a specific training routine to engage users and improve fitness. For a virtual trainer to gain the users' attention, it must be designed in 3D and provide a good animation design. They like vigorous activities and a human-like trainer. Therefore, for the AR book design, the training started with stretches, followed by particular fitness activities that target muscle areas. The students also

stated that they could understand and follow the routine with repetitive movements. These items were added to the design for the AR book.

The analysis of secondary data such as reference books and formal guidelines from the Ministry of Education was the basis for creating the AR book and the AR trainer. AR is relayed to the students using AR-printed books and apps downloaded from the app store. The book has eight pages, excluding the cover and end page. There are two methods of learning with this book. The student can just read and follow the steps illustrated or use the AR app to view the animated version of the activities. Table 3 describes the sources and how they were applied in the design of the AR book.

Table 3
The Resources for the Design of the AR Book

Item	Source	The resources applied in the design
Special Need School Textbook	Health and Physical Education for Form Four Special Needs Students (Mustaffa et al., 2019)	The design of the parcourse training in the book was used as a guide for the fitness course training in the AR book
Immersive Multimedia Design Principles	Immersion Principle in Multimedia Learning (Makransky & Mayer, 2022)	The application of CTML for immersive learning
Suggestions from Reports on Physical Exercises for SLD	Activities suitable to engage SLD in PE (McMahon et al., 2020) How SLD learn (Hardiyanti & Azizah, 2019)	At-home activities for SLD

With the AR book, the students will have to learn the physical exercises, starting with stretching. The first activity stretches the Stemocleidomstoid, Pectoralis Major, Deltoid, External Oblique, and Latissimus Dorsi muscles. The students have to perform neck, shoulder side, and hamstring stretching. The next part is focused specifically on muscle endurance with more intense activities. The students must perform push-ups, sit-ups, bench-ups and down, squat, and jump. The targeted muscles are Pectoralis Major, Biceps, Triceps, Abdominal Muscle, Quadriceps, Hamstring, Gluteus Maximus, and Gastrocnemius. The last activity is the fitness test compulsory for most sports activities. In this test, the students will have to do shoulder rotation, body curling, side bend, giant steps, and back legs stretching. Table 4 describes the students' activities and the target output. The book used the Malay language as it is the native language of the students and the original textbook also used Malay. Figure 8 displays a page from the book that functions as a marker where the students can use their smartphones to view the AR overlay of activities. Figure 9 shows the animation overlay when the camera from the student's smartphone hits the marker.

Figure 8
The Page from the AR Book

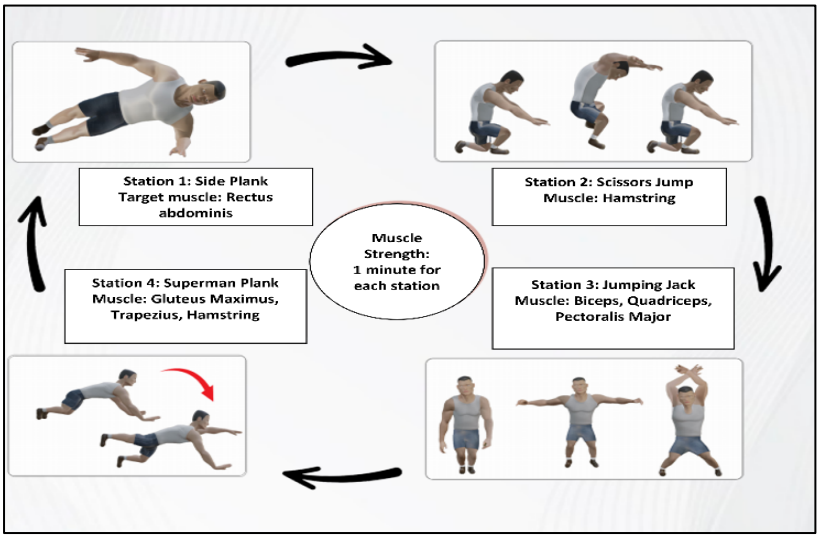


Figure 9
The AR Overlay

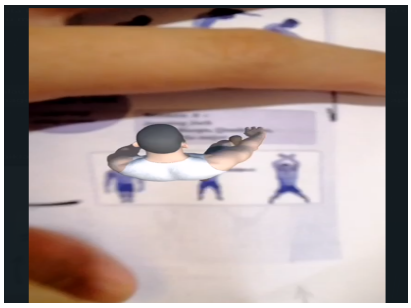


Table 4
The Activities, Motions Illustrated, and Target Outcome

Activities	Motions Illustrated	Target outcome
Stretching	Neck Stretching	Stemocleidomstoid
	Shoulder	Pectoralis Major, Deltoid
	Side Stretching	External Oblique, Latissimus Dorsi
	Hamstring	Hamstring, Gluteus maximus
Muscle Endurance	Non-stop Push up,	Pectoralis Major, Biceps, Triceps
	Sit-up	Abdominal Muscle
	Bench up and Down	Quadriceps, Hamstring
	Squat and Jump	Gluteus Maximus, Gastrocnemius
Fitness Test	Shoulder Rotation, Body Curling, Side Bend, Big Steps, Back Legs Stretching	To measure fitness by measuring the frequency, intensity, and time for each activity

Discussion

Optimal Motor Learning Theory states that motivation and attention are essential to improve motor performance and achieve targeted motor learning. When educators and learning material

developers consider an appropriate design for physical exercise education, the student's motivation is essential. Motivation is the contributing factor that makes the students keep doing the exercise until specific targets are achieved. The students will be engaged and active in physical activities when the learning materials can motivate them to do the activities (Mokmin & Jamiat, 2021). According to this theory, for motivation, students must be given autonomy in learning control, and eventually they can focus on their goals. We found that motor learning can be enhanced by allowing learners to control specific aspects of exercises or assistive devices. During the movement restriction times, such as the pandemic, when the students must stay mostly at home, they must be motivated to follow through with the training to maintain a certain level of activity and physical fitness.

This study demonstrated how observational learning, even in a virtual context, is beneficial for physical education. One of the most prevalent instructional approaches for motor learning acquisition is demonstration or observation (D'Innocenzo et al., 2016). Thus, in the first phase of this study, five types of virtual trainers were introduced to allow the students choice of the trainer(s) they wanted to learn the exercise from and facilitate their learning. They could also freely rewind and pause whenever needed throughout the lessons. Through the interviews, students indicated they were satisfied with the activities they had completed and could easily navigate among the trainers and explore which activities they wanted to do. The trainers' catchy sounds and different appearances also motivated and attracted the learners to move along. In this study, the virtual trainers were set in various settings with different levels of exercise to keep the students engaged and motivated when doing the movements. According to Andrieux and Proteau (2016), when several skill levels are imposed, the students' learning through observation also improves. Here, technology helped the trainer to teach remotely with a virtual trainer. Although an in-person trainer may be the best choice, these virtual trainers are practical when remote learning with technology is needed. Nevertheless, for an efficient PE app, more activities should be added in the future.

AR is the next emerging technology after VR for instructional content designers due to its effectiveness in providing immersive learning (Ariffin et al., 2022) and ease of access. In the era of disrupted education, where face-to-face learning in classroom settings is sometimes impossible to implement, some schools have to opt for immersive technologies. Various studies have shown that learning becomes more exciting by implementing AR technology for physical education, leading to more positive learning outcomes. Chen et al. (2020) have used AR technology to demonstrate Tai-Chi movements to older adults. They have developed an app that applied augmented reality-assisted training with selected Tai-Chi movements tailored to the practitioner's ability. The results showed that the users successfully learned the fitness exercise and got positive outcomes in their activities.

In this study, the AR has been designed according to the specific guidelines from the physical education textbook. The activities started with stretching that targeted specific muscle points, which the AR technology illustrated immersively. The other activities in the book are muscle strength and fitness training, which are also immersively taught to the students. For students with disabilities, AR is an excellent potential tool, as suggested by learning material developers as it can facilitate the unique needs of special needs students.

The best strategy for PE in current distance home learning is to supplement the traditional teaching with creatively designed and personalized resources based on the students' needs (Roe et al., 2021). Both VR and AR technologies used in this study can help developers and educators facilitate the teaching and learning process of PE.

Conclusion

This study examined how students can learn physical education via virtual trainers and the most effective design of a virtual trainer from the students' perspective. However, the virtual trainer and the AR book have not been tested for different types of disabilities, and more virtual trainers should be added to improve the app. The results, alongside secondary data information, were used to design and develop an AR book with an AR app as a learning material for students with learning disabilities. Since the book is developed for the usage of the students with special needs, the five virtual trainers are not included in the book's first publication. It is possible to be included for the subsequent publication of the book for public use. The results show that immersive technology designed using the Optimal Motor Learning Theory and carefully implementing the Cognitive Theory of Multimedia Learning can be a suitable learning material for PE and should be considered for inclusion in the learning material design for students with disabilities. For future study, we suggest the book and the trainer be tested with different groups of disabilities and more movements added for the virtual trainers.

Acknowledgements

This work was supported by the Ministry of Higher Education Malaysia for the Fundamental Research Grant Scheme with Project Code: FRGS/1/2021/SSI0/USM/02/10

References

Adams, D. (2016). the effectiveness of the buddy support system in special education in Malaysia. International Conference on Teacher Learning and Development (ICTLD), November 2016, 1–23. https://www.researchgate.net/profile/Donnie_Adams2/publication/320442550_THE_EFFECTIVENESS_OF_THE_BUDDY_SUPPORT_SYSTEM_IN_SPECIAL_EDUCATION_IN_MALAYSIA/links/59e572d8a6fdcc1b1d8d3542/THE-EFFECTIVENESS-OF-THE-BUDDY-SUPPORT-SYSTEM-IN-SPECIAL-EDUCATION-IN-MA

Anderson, J., & Rastegari, I. (2016). Dance that adapts to disabilities. *Harvard Gazette 7*(1). https://www.researchgate.net/publication/269107473_What_is_governance/link/548173090cf22525dcb61443/download%0Ahttp://www.econ.upf.edu/~reynal/Civil wars_12December2010.pdf%0Ahttps://think-asia.org/handle/11540/8282%0Ahttps://www.jstor.org/stable/41857625

Andrieux, M., & Proteau, L. (2016). Observational learning: Tell beginners what they are about to watch and they will learn better. *Frontiers in Psychology, 7*(51), 1–9. https://doi.org/10.3389/fpsyg.2016.00051

Ariffin, U. H., Mokmin, N. A. M., & Akmal, M. A. (2022). Augmented reality technology in physical education: A systematic review in instructional design, and AR implementation option over the last 5 years. *Advanced Journal of Technical and Vocational Education, 6*(1), 13–20. https://doi.org/10.26666/rmp.ajtve.2022.1.3

Baragash, R. S., Al-Samarraie, H., Alzahrani, A. I., & Alfarraj, O. (2020). Augmented reality in special education: a meta-analysis of single-subject design studies. *European Journal of Special Needs Education*, *35*(3), 382–397. https://doi.org/10.1080/08856257.2019.1703548

Brooke, B., Zhang, T., Lee, J., Gu, X., & West, A. (2020). Virtual reality and its effectiveness on motor development and rehabilitation in children with disorders. *American Journal of Biomedical Science & Research*, 269–273. https://doi.org/10.34297/AJBSR.2020.07.001156.Received

D'Innocenzo, G., Gonzalez, C. C., Williams, A. M., & Bishop, D. T. (2016). Looking to learn: The effects of visual guidance on observational learning of the golf swing. *PLoS ONE*, 11(5), 1–19. https://doi.org/10.1371/journal.pone.0155442

Di Palma, D., Varriale, L., Briganti, P., & Tafuri, D. (2018). The importance of sport activities to stimulate an educational management of students with SLD. *Autumn Conferences of Sports Science, 14*(November), 2–3. https://doi.org/10.14198/jhse.2019.14.proc1.02

Filiz, B., & Konukman, F. (2020). Teaching strategies for physical education during the COVID-19 pandemic. *Journal of Physical Education, Recreation and Dance, 91*(9), 48–50. https://doi.org/10.1080/07303084.2020.1816099

Freeman, A., Becker, S., A., S., & Cummins, M. (2019). Investigating the effect of pre-training when learning through immersive virtual reality and video: A media and methods experiment. *Computers and Education, 140*(June), 103603. https://doi.org/10.1016/j.compedu.2019.103603

Greguol, M., Malagodi, B. marso, & Carraro, A. (2018). Inclusion of students with disabilities in physical education classes: Teachers' attitudes in regular Sshools. *Revista Brasileira de Educação Especial, 24*(1), 33–44

Hamizi, M. A. A. B. M., Mokmin, N. A. M., & Ariffin, U. H. (2022). Virtual reality technology in physical education: A systematic review in instructional design & implementation. *Advanced Journal of Technical and Vocational Education, 6(*1), 6–12. https://doi.org/10.26666/rmp.ajtve.2022.1.2

Hardiyanti, F. P., & Azizah, N. (2019). Multimedia of educational game for disability intellectual learning process: A systematic Review. 296(Icsie 2018), 360–368. https://doi.org/10.2991/icsie-18.2019.66

Hennick, C. (2020). VR Gives Students New Ways to Learn. Ed Tech Focus on K-12. https://edtechmagazine.com/k12/article/2020/03/vr-gives-students-new-ways-learn#:~:text=VR Gives Students New Ways to Learn Virtual,for new physical environments and master academic content.

Jiao, C., & Qian, K. (2020). Application of flipped classroom teaching method based on VR technology in physical education and health care teaching. *IEEE Access, XX*, 1–9. https://doi.org/10.1109/ACCESS.2020.3019317

Kimmons, R. (2020). Current Trends (and Missing Links) in Educational Technology Research and Practice. TechTrends, 64(6), 803–809. https://doi.org/10.1007/s11528-020-00549-6

Kohli, A., Sharma, S., & Padhy, S. (2018). Specific learning disabilities: Issues that remain unanswered. *Indian Journal of Psychological Medicine, 40*(5), 399–405. https://doi.org/10.4103/IJPSYM.IJPSYM_86_18

Kumar, J. (2020). Everything you need to know about immersive learning. *Elearning Industry*. https://doi.org/10.1016/j.jpeds.2014.07.019

Lim, C. K., Yusof, M. M., Fauzee, M. S. O., Othman, A. T., Aman, M. S., Elumalai, G., & Ali, H. M. (2016). Examining sport and physical activity participation, motivations and barriers among young Malaysians. Asian Social Science, 12(1), 159–171. https://doi.org/10.5539/ass.v12n1p159

MacDonald, L. C., Doan, R. J., & Chepko, S. (2017). Books write review lesson planning for high school physical education: Meeting the national standards & grade-level outcomes. Human Kinetics. https://doi.org/10.5040/9781718209329

Makransky, G., & Mayer, R. E. (2022). Benefits of taking a virtual field trip in immersive virtual reality: Evidence for the immersion principle in multimedia learning. *Educational Psychology Review*, 0123456789. https://doi.org/10.1007/s10648-022-09675-4

Mayer, R. (2020). Multimedia Learning (3rd ed.). Cambridge University Press. https://doi.org/https://doi.org/10.1017/9781316941355

Mayer, R. E. (2011). Instructions based on visualizations. In R. E. Mayer & P. A. Alexander (Eds.), *Handbook of Research on Learning* (pp. 427–445). Routledge.

McCarthy, C. J., & Uppot, R. N. (2019). Advances in virtual and augmented reality—Exploring the role in health-care education. *Journal of Radiology Nursing, 38(*2), 104–105. https://doi.org/10.1016/j.jradnu.2019.01.008

McMahon, D. D., Barrio, B., McMahon, A. K., Tutt, K., & Firestone, J. (2020). Virtual reality exercise games for high school students with intellectual and developmental disabilities. *Journal of Special Education Technology*, 35(2), 87–96. https://doi.org/10.1177/0162643419836416

Mokmin, N. A. M. (2020). The effectiveness of a personalized virtual fitness trainer in teaching physical education by applying the artificial intelligent algorithm. *International Journal of Human Movement and Sports Sciences, 8*(5), 258–264. https://doi.org/10.13189/saj.2020.080514

Mokmin, N. A. M., & Jamiat, N. (2020). The effectiveness of a virtual fitness trainer app in motivating and engaging students for fitness activity by applying motor learning theory. *Education and Information Technologies*, September, 1–19. https://doi.org/10.1007/s10639-020-10337-7

Mulders, M., Buchner, J., & Kerres, M. (2020). A framework for the use of immersive virtual reality in learning environments. *International Journal of Emerging Technologies in Learning, 15*(24), 208–224. https://doi.org/10.3991/ijet.v15i24.16615

Mustaffa, F., Ismail, K. A., & Ahmad, A. (2019). Pendidikan jasmani dan Pendidikan Kesihatan Pendidikan Khas TIngkatan 4 (S. F. Yahya (ed.)).

Nordin, N. A. M., Yusoff, N. A. H., & Singh, D. K. A. (2019). Facilitating exercise engagement among community dwelling stroke survivors: Is a once per week group session sufficient? *International Journal of Environmental Research and Public Health, 16*(23). https://doi.org/10.3390/ijerph16234746

Puig, M. V., Rose, J., Schmidt, R., & Freund, N. (2014). Dopamine modulation of learning and memory in the prefrontal cortex: Insights from studies in primates, rodents, and birds. *Frontiers in Neural Circuits, 8*(AUG), 1–15. https://doi.org/10.3389/fncir.2014.00093

Radzi, C. W. J. M., Jenatabadi, H. S., Alanzi, A. R. A., Mokhtar, M. I., Mamat, M. Z., & Abdullah, N. A. (2019). Analysis of obesity among malaysian university students: A combination study with the application of Bayesian structural equation modelling and pearson correlation. *International Journal of Environmental Research and Public Health, 16*(3). https://doi.org/10.3390/ijerph16030492

Roe, A., Blikstad-Balas, M., Dalland, C. P., Alshehri, M., Stewart, C. D., Cristea, A. I., Baker, R. S., Behera, A., Matthew, P., Keidel, A., Vangorp, P., Fang, H., Canning, S., Education, P., Reality, A., Azlina, N., Mokmin, M., Secondary, C. A., Author, C., … Kobesova, A. (2021). Teachers and school health leaders' perspectives on distance learning physical education during the COVID-19 pandemic. *Journal of School Health, 91*(7), 541–549. https://doi.org/10.1111/josh.13030

Tafuri, D., & Cassese, F. P. (2017). The importance of Physical and Sport Activity for SLD People at School L ' importanza dell 'attività Fisica e Sportiva per le Persone con DSA nella Scuola. Sports and Inclusive Didactics, 1(3), 2532–3296.

Tan, V. (2021). In Focus: Prolonged School Closure in Malaysia due to COVID-19 Shakes Up Learning Experience. https://www.channelnewsasia.com/news/asia/in-focus-malaysia-covid-19-school-closure-2020-parents-students-13740364

Varea, V., & González-Calvo, G. (2020). Touchless classes and absent bodies: teaching physical education in times of Covid-19. Sport, Education and Society, 0(0), 1–15. https://doi.org/10.1080/13573322.2020.1791814

Walker, Z., McMahon, D. D., Rosenblatt, K., & Arner, T. (2017). Beyond Pokémon: Augmented reality is a universal design for learning tool. *SAGE Open, 7(*4). https://doi.org/10.1177/2158244017737815

WHO. (2020). Health education. *The Zambia Nurse Journal*. https://www.who.int/topics/health_education/en/

Wu, P. F., Chang, Y. W., Chen, T. B., & Chang, L. C. (2021). The effects of integrated step training into the physical education curriculum of children with intellectual disabilities. *International Journal of Environmental Research and Public Health, 18*(21). https://doi.org/10.3390/ijerph182111340

Wulf, G., & Lewthwaite, R. (2016). Optimizing performance through intrinsic motivation and attention for learning: The OPTIMAL theory of motor learning. *Psychonomic Bulletin and Review, 23*(5), 1382–1414. https://doi.org/10.3758/s13423-015-0999-9

Corresponding author: Nur Azlina Mohamed Mokmin
Email: nurazlina@usm.my

Using Educational Digital Storytelling to Enhance Multilingual Students' Writing Skills in Higher Education

Eleni Meletiadou
London Metropolitan University, UK

Abstract

Educational Digital Storytelling (EDS) is a powerful technology-enhanced learning approach that enables learners to develop 21st century skills. Students often complain about their digital illiteracy, academic writing challenges, and lack of interaction in classes. In the current case study, 50 multilingual and multicultural ESL student-teachers were involved in the creation of digital stories in an undergraduate module. Students used Canva to create their own digital stories which included text, images, videos, podcasts, and infographics. The overall aim was to improve their academic performance and motivation towards learning, and explore their attitudes towards this new dynamic learning-oriented instructional strategy. The current semi-experimental study tried to challenge monolingual bias and promote a more integrated and inclusive approach to learning as both efficient and desirable in preparing university students for constructive involvement with various cultural perspectives promoting the creation of global networks. Findings from both quantitative (paired and independent samples t-tests of test scores) and qualitative (anonymous feedback, lecturer observations and focus group discussions) data analyses indicated that learners improved their writing performance, critical thinking skills, self-confidence, and intercultural awareness. Students stated that they felt proud of their final products (digital stories) and that the EDS intervention was rewarding. However, some non-traditional students reported facing challenges with the use of technology. Learners expressed their wish to experiment more with digital stories and use them in other modules. Implications for teaching and learning practices in the Higher Education academic environment and suggestions for the successful implementation of EDS at the tertiary level are provided.

Keywords: educational digital storytelling, digital skills, writing performance, motivation, multilingualism, undergraduate students

Educational Digital Storytelling (EDS) is a pioneering learning-oriented technology-enhanced approach which allows students to develop a wide range of academic and professional skills (Dewi et al., 2019; Hava, 2021; Robin, 2008). Lambert (2012) describes a digital story (DS) as a narrative blending visual and aural features for telling a personal story. Various studies have indicated that EDS provides numerous benefits to learners. Selective examples include: (a) affective—enhancing motivation (Hung et al., 2012), (b) cognitive—developing critical thinking skills (Yang & Wu, 2012), (c) academic—developing writing skills (Yildiz Durak, 2018), (d) technological—enhancing IT skills (Chan et al., 2017), and (e) social—promoting interaction (Lin et al., 2013). Additionally, Sukovic (2014) indicated that EDS provided an increased sense of achievement to learners while Hung et al. (2012) underlined the development of student confidence. EDS also supported a conducive context for the enhancement of language skills (e.g., listening and speaking) and mastery of story structure and multimodal expression (Liu et al., 2018). Finally, EDS was reported to increase other awareness as creating, crafting, and exchanging stories are part of people's everyday life and a basic element of social group interaction (Carmona & Luschen, 2014).

This article examines the use of EDS in a Higher Education Institution (HEI) in Cyprus. The overall aim was to improve multilingual and multicultural undergraduate students' writing skills and motivation towards learning. International ESL student-teachers were asked to tell their own stories using Canva and a variety of resources, exchange ideas, and provide feedback and suggestions for improvement to each other using the target language (English) and their first language (L1). This was the first time these undergraduate students were asked to engage in this creative activity.

This intervention enabled undergraduate student-teachers to craft and share digital stories (DS) with the aim of stimulating creative and thoughtful philosophies of teaching to develop specific skills. The research considered that students might enjoy using media to describe their teaching aspirations in a narrative format. Robin (2008) proposed that EDS could be used to synthesize learners' knowledge and findings in a more imaginative, meaningful, and interesting way. While reflecting on their current teaching principles and practices, these learners were encouraged to refine their teaching philosophy so as to better detect and manage unpredicted challenges. IT use was necessary during the development of their DS. This reflected the current need for educators to use technology in their sessions due to crises such as the COVID-19 pandemic (Ahmed & Opoku, 2022). As soon as the pandemic started, educational institutions had to resort to blended and online learning worldwide (Choi et al., 2021). Consequently, the experience and the findings of the current study should encourage student-teachers to use EDS in their classrooms in the future. Scant research has investigated learner perceptions of EDS use in a Higher Education (HE) instructional context including the use of EDS to develop undergraduate student writing skills (Eissa, 2019). In the current research study, learner perceptions about EDS were explored as they participated in an EDS intervention. The aim was to examine and understand student reflections regarding EDS use for educational purposes. The research questions for the study were:

- What was the impact of EDS on undergraduate multilingual student-teacher writing performance?
- What were undergraduate multilingual student-teacher perceptions of the impact of EDS on their motivation and academic achievement?

Literature Review

EDS allows multilingual and multicultural learners to explore the possibility of using multimodality to create and share their stories with their peers and even with a wider audience (Lambert, 2012; Liontas & Mannion, 2021). Students can combine their written texts with pictures and music or video to participate in new forms of online literacy, become more creative, and understand how these forms may relate to print literacy they use in their everyday lives as students. However, many lecturers avoid using EDS in their classrooms due to the amount of time students need to complete relevant tasks, the demand on IT equipment and expertise, and doubts regarding value as EDS does not conform to the rules of traditional writing assignments (Belcher, 2017).

Nevertheless, such new approaches to writing allow learners to explore basic academic writing concepts from a different perspective (Bloch, 2018). EDS encourages the use of a mixture of different modes of print, visual, and aural expressions which allow students to be more creative and engage more deeply in their own learning process. Students can therefore make choices and transform staid assignments into meaningful exploration for alternative expressions. A DS allows learners to present their own ideas by telling their own story, for example, relating it to a significant period in their lives. They can also record parts of their stories using their own voice or add voices or videos of other people. They can include images, photos, infographics, or even music. These multimodal forms have become very prominent as students can tell their own story in a unique way. DS also became more important when used outside the teaching sessions for professional reasons, e.g., to showcase their creative talents to potential employers (Yancey, 2004).

Engaging learners in comprehending genre (stories) across both print and digital modalities potentially allows learners to become more active members of their academic and professional groups as well as the wider digital world. Additionally, the implementation of EDS may facilitate discussions on language and content in the writing classroom as students may find the creation of DS preferable to writing an assignment. Students can also use their own native language, what Wei (2018) refers to as “translanguaging” – a practice used to create intercultural narratives and improve multi-cultural awareness promoting a “circle of digital storytelling” (Pahl & Rowsell, 2019, p. 12). Unfortunately, opportunities for learners to engage in activities which involve the utilization of more than one language are infrequent in HEIs in Cyprus and other European countries.

Silvers and Shorey (2012) discussed learner identities and the significance of new literacies allowing students to become socially responsible, critically literate, as well as genuinely involved in the learning process. Barrett (2019) claimed that EDS combines four student-centered learning techniques: learner engagement, reflection for enhanced learning, project-based learning, and the successful blending of technology with instruction. McLellan (2008) claimed that EDS facilitates training in creativity, complex problem solving, cooperation, and autonomy. EDS may also promote reflection and collaboration (Jamissen et al., 2017). Other benefits include flexible pacing, increased concentration, imagination, extended reach, motivation, and cooperation (Robin, 2016). Some researchers also claimed that users’ creation of a personal and academic identity, the development of skills such as digital searching and writing literacy, and its interdisciplinary and participatory nature, were advantages for engaging students in this innovative approach (Chiang, 2020; Özüdoğru & Çakir, 2020).

Taking into consideration increased digitization of education due to COVID-19 (Díez Gutiérrez & Gajardo Espinoza, 2020; Wang et al., 2020), there is an increasing need to promote social justice and support all students, irrespective of their background, especially in providing training and technical support (Choi et al., 2020; Portillo et al., 2020). Heidari et al. (2021) highlighted the significance of digital informal learning for students' academic development. The current pandemic forced HEIs to prioritize digital technologies (Murphy, 2020) although these presented a number of challenges to both students and academics (Toquero, 2020). To ensure students' academic engagement, HEIs needed to develop students' competencies (Villela et al., 2020) through involvement in innovative learning methods such as EDS (Wu & Chen, 2020).

Although some studies have explored EDS in primary (Fokides, 2016; Liu et al., 2018) and secondary education (Damavandi et al., 2018), few studies have investigated EDS in foreign/second language education (Eissa, 2019). Moreover, limited studies have examined the impact of EDS on learner writing skills (Balaman, 2018) or motivation (Hava, 2019) in Higher Education (HE). For example, Balaman (2018) explored the impact of EDS on 43 English as a Foreign Language (EFL) English-major student writing skills at the School of Foreign Languages, Cumhuriyet University for 14 weeks. Hava (2019), who examined the effects of EDS on student motivation in teacher education, reported that learners' self-reliance and personal use improved after their engagement in EDS activities. The research highlighted that EDS is an emerging approach for the enhancement of writing skills in the narrative genre, but more research needs to be conducted to explore its effectiveness when used with other literary genres in different contexts.

In this article, the challenges of using EDS to assist students developing writing skills and increasing motivation was explored. EDS was introduced in an undergraduate course at a University in Cyprus. The aim was to help learners improve essay writing skills. As some of these students seemed to struggle with academic genres, a goal of the research was to use EDS to introduce students to key concepts from a different perspective (Bloch, 2018). The following section lays out the research methods and describes the implementation in detail.

Methodology

This research employed a mixed-methods approach (Almeida, 2018), collecting both quantitative (essay scores) and qualitative (anonymous student feedback, focus group discussions, lecturer's observations) data to answer the research questions (Table 1). Paired t-tests compared students' scores in the pre- and post-tests for two modules (control and experimental). Student performance in the control versus the experimental module were also compared to examine the impact EDS had on academic achievement. Finally, thematic analysis was used to analyse data from student feedback, triangulating data with lecturer observations and comparing main themes for increased reliability and validity (Flick, 2018).

Table 1
Methodology

Mixed-methods approach	
Quantitative data	**Qualitative data**
Sample: 50 students **Sources of Data:** 1. In-class pre- (week 1) and post-tests (week 13) 2. Two essays about students' personal teaching philosophy **Method of analysis**: Paired and independent sample t-tests **Raters:** Researcher and an assistant	**Sample**: 50 students and 1 lecturer **Sources of Data:** 1. Anonymous peer feedback via Mentimeter every 3 weeks 2. Focus group discussions every 2 weeks 3. Lecturer observations about the procedure and student responses to the implementation, every week **Method of analysis**: Thematic analysis of recorded and transcribed material. Triangulation with data from observations. **Coders**: Researcher and an assistant

Fifty EFL/ESL student-teachers (Table 2) attended two mandatory parallel modules on Lesson Planning and Classroom Management which explored basic principles and approaches of teaching and learning as part of their regular undergraduate curriculum. One module focused on productive skills (writing and speaking) and the other on receptive skills (listening and reading).

The researcher received research ethics approval for the study and students provided informed consent. The researcher maintained confidentiality of learner responses. The DS and Mentimeter feedback were not compulsory and did not count for student grades.

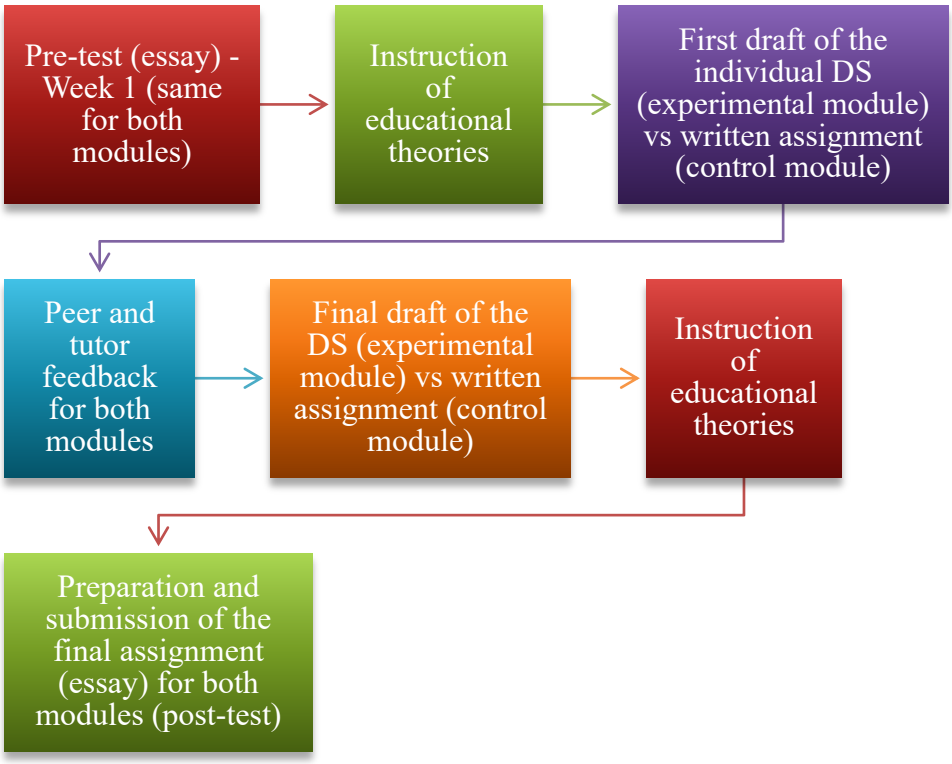
Table 2
Student Demographic Characteristics

	Students	Frequency
Gender	Male	19
	Female	31
Age	22-30	29
	30-40	21
Class rank	High-performing learners	4
	Average-performing learners	10
	Low-performing learners	36

The Implementation Process

In previous years, many students who completed the same two modules complained about their low writing performance and the repetition of monotonous essay assignments used to assess their academic performance. Therefore, DS was implemented instead of written assignments in one of the two modules and its impact explored. All students took a pre-test (Figure 1), which was an essay to assess their writing performance at the beginning of the academic semester. The essay asked them to discuss their current philosophy in teaching productive and receptive skills. The researcher implemented EDS in the module focusing on productive skills (experimental module) and used the module focusing on receptive skills as the control module (no use of EDS). The aim was to explore the impact of EDS on student writing skills and motivation. The post-tests for the experimental and control modules were the final assignments students had to submit at the end of the semester.

Figure 1
EDS Implementation Scheme



Participants in the experimental module were asked to prepare a DS by the end of the module. Students did not receive a grade for their DS, but they had to use the texts they produced in their DS for their final assignment. They were expected to work individually, then share their stories with peers and receive feedback from their lecturer and peers.

During the implementation, student communication in their L1 was promoted in class to facilitate the flow of ideas and allow a fruitful collaboration as students were asked to help and learn from each other. Learners were encouraged to create and share their multilingual DS to cross boundaries of language, culture, and the syllabus using the extended possibilities for cooperation and communication which were made possible by the digital media. They were supported to represent their multilingual repertoire positively through their work. Therefore,

multilingualism was used with the aim of developing multiliteracies and involving the many voices of the students. A significant part of this multilingual process took into consideration learner opinions and examined multiple perspectives as a predominant aspect of diversity and social inclusion. Learners were also free to share their DS on YouTube to reach a wider audience. At the beginning, students were asked to create a first draft. They received feedback from their peers and lecturer and then completed their final draft. The students in the control group went through the same procedure (including the peer and tutor feedback stage with a focus on translanguaging) but produced written essays instead of a DS.

All learners had to participate in weekly webinars (3 hours each) and a forum every week for both modules. In terms of written assignment, the lecturer requested learners to discuss their personal philosophy in teaching (to develop students' writing skills in the experimental module and their reading skills in the control module). They were also asked to prepare a DS to present their philosophy using Canva in the experimental module. They used covered theories in the module and developed digital learning skills at the same time. This allowed them to include not just text but also images, infographics, podcasts, and videos to present their stories. Their goal was to illustrate ways in which they would teach specific skills successfully and manage their classrooms effectively. Students also spent time discussing the theories in depth and writing drafts of their essay in the control module but did not prepare a DS. The lecturer and the assistant used the same assessment criteria to assess all student essays.

Students were divided into groups and participated in discussions regarding their DS (experimental module). The researcher used various questions to prompt discussion in the focus groups every 2 weeks. For example, did you find this experience (using DS) worthwhile? Why or why not? Every 3 weeks, learners also provided anonymous feedback using Mentimeter (https://www.mentimeter.com/), an interactive digital platform used by educators to elicit anonymous responses from students, to explore their attitudes towards the learning strategy.

The researcher kept a research diary during the implementation of this technology-enhanced approach, adding field notes every week. Students also had access to a Google document where they shared thoughts about participating in the implementation. This allowed the lecturer to intervene and provide support when needed and to learn which teaching aspects were helpful during the EDS implementation. The lecturer/researcher took an insider role and devoted time lecturing, observing, and collecting data. Finally, peer assistance and feedback was sought during the study (Morse, 2016).

Findings

Impact of EDS on Student Writing Performance

The researcher compared learner writing performance on a pre- and a post-test (Table 3). A second assessor marked 20% of the tests. Both received inter-rater training in which they marked 3 scripts (a high quality, an average, and a low quality one) utilizing a rubric provided by the University. The second rater was a colleague who taught the same module to another group of students. Inter-rater reliability was estimated by calculating the similarity percentage of 94 %. The high percentage indicated student grading was reliable (Chaturvedi & Shweta, 2015).

Table 3
Student Writing Performance

Measurement	N	M	SD	T value	Df	Sig.	Cohen's d
Pre-test same for both modules	50	25.9	17.4				
Post-test with EDS	50	52.7	14.5	17.4	49	$p < .05$	$d = 1.67$
Post-test without EDS	50	33.4	17.9	13.4			$d = .42$

A paired t-test was used to explore academic progress in the two modules. The test indicated a statistically significant difference between learner pre-tests ($M = 25.9$, $SD = 17.35$, $n = 50$) and post-tests ($M = 52.72$, $SD = 14.53$, $n = 50$) in terms of their writing performance ($t(49) = 17.35$, $p < .05$) for the experimental module, while there was a small difference for the control module ($M=33.4$, $SD=17.9$, $n=50$, $t(29)=13.4$, $p<.05$). Cohen's effect size value ($d= 1.67$) suggested a "large" effect size and high practical significance for the impact of EDS on learner writing achievement for the experimental module and a small effect size ($d=.42$) for the control module. These tests indicated the use of EDS improved writing performance in essay writing compared to the written assignments.

An independent t-test was also used to examine the differences between the post-test scores of the same group in the two modules. On average, student scores in the EDS module ($M= 53.2$, $SD=13$) were higher than those in the module without EDS ($M= 33.4$, $SD=18$). This difference was statistically significant $t(49) = 6.33$, $p = .000$, $d = 1.27$. This finding highlighted that the use of EDS had a statistically significant impact on student writing performance confirming previous research (Yildiz Durak, 2018).

Paired t-tests were also utilized to explore the influence of EDS on learner writing performance taking into consideration each one of the categories in the marking rubric. There were statistically significant differences between learner pre-tests and post-tests on the five categories of the marking rubric which showed the various areas of learner writing achievement in the EDS module. Overall, EDS had a significant impact on all aspects of learner academic achievement. Cohen's effect size values suggested a "large" effect size and high practical importance for its impact on various aspects of student writing achievement (Table 4), but predominantly for vocabulary and language use confirming previous research (Duman & Göcen, 2015).

Table 4
Aspects of Writing Performance

	Measurement	N	M	SD	'T' value	Df	Sig.	Cohen's d
Content/ Analysis	Pre-test	50	5.7	4.3	9.31	49	p < .05	Cohen's d=1.59
	Post-test		12.3	4				
Organisation/ Structure	Pre-test	50	5.5	4.6	8.23	49	p < .05	Cohen's d=1.21
	Post-test		10.9	4.3				
Vocabulary & Language use	Pre-test	50	5.7	4.8	10.93	49	p < .05	Cohen's d=1.28
	Post-test		11.9	4.8				
Purpose/ Audience	Pre-test	50	5.4	4.4	6.21	49	p < .05	Cohen's d=.9
	Post-test		9.6	4.7				
Mechanics & Presentation	Pre-test	50	3.8	3.1	7.2	49	p < .05	Cohen's d=1.2
			7.9	3.4				

Impact of EDS on Student Motivation and Academic Achievement

The research used thematic analysis to explore the perceived impact of EDS on learner academic achievement and motivation. Analysis of qualitative data relied on an inductive approach, intended to identify the main themes and patterns emerging in the data (Lester et al., 2020). Finally, interpretive content and thematic analysis were also performed (Creswell & Poth, 2016).

The researcher collected qualitative data from learners (i.e., anonymous feedback and focus group discussions). The data were first read in their entirety and then coded using an exploratory and holistic approach (Saldaña, 2021). Saldaña's (2021) method of "in-vivo" coding (referring to direct learner quotes from student anonymous feedback and the focus group discussions) was applied to the data. Analysis of the data showed different themes, e.g., *development of critical thinking skills* and *self-confidence* (Table 5). Data were then triangulated with lecturer field notes. An additional lecturer reviewed 20% of the data collected and analysed it to minimize researcher bias (Cumming et al., 2006).

Table 5
Impact of EDS on Student Motivation

Themes (with frequency)	Sample Student Comments
Positive Impact	
1. Digital skills enhancement (48)	*I must confess I was a bit terrified when I heard that we had to prepare a digital story as I am not that good with computers. Our lecturer was very supportive. Incorporating images and videos was very exciting and I feel so confident now… (Focus group discussion 2)*
2. Development of critical thinking, reflective and writing skills (31)	*I was able to develop my writing skills as creating an EDS was so interesting…I got plenty of support, too…I was also able to develop my critical thinking skills, reflect on my work and provide arguments to support my ideas and suggestions…all these theories suddenly made sense… (Anonymous feedback – session 3)*
3. Professional skills enhancement (37)	*EDS allows me to prepare a portfolio of tasks I can use to showcase my work to prospective employers. It also allows me to use interactive elements which make my work even more engaging for my audience. (Focus group discussion 3)*
4. Impact on students' enjoyment of learning (46)	*I love using EDS. I can tell my own stories and be creative. I want to use it in other modules, too. I will certainly use it with my students as well. Writing seems so much fun now… (Anonymous feedback – session 4)*
5. Influence on students' self-confidence (45)	*I felt so proud of myself as peers congratulated me on the strategies, I have used to cope with various challenges I faced while creating EDS… (Focus group discussion 4)*
6. Impact on development of intercultural awareness (41) & collaborative skills (35)	*Interacting with peers from around the world through our DS and sharing problems and experiences helped us realise we are not alone and that peers face similar problems in other countries…We would not reach other people by just writing an essay as part of our assessment for the module… (Anonymous feedback – session 4)*
7. Improvement of learning attitude (47)	*Working on real-life stories and personal experiences made us more conscious of potential challenges we might encounter as teachers and some of the pitfalls of our profession. We became aware of different scenarios, and stories were more engaging as we could listen to podcasts or short videos and read our peers' texts…I do not think I would have paid so much attention if I just had to read a plain assignment… (Focus group discussion 5)*

Challenges	
8. Non-traditional students' challenges with technology (17)	*I cannot complete my assignment… I do not know how to use podcasts. Thank God, one of my peers helped me. We need additional support. For example, an assistant who could devote some time to each one of us individually to help us…We are old…We did not use these techniques 10 years ago… (Focus group discussion 1)*
9. Lack of stable Wi-Fi and access to the internet (10)	*Wi-Fi is very poor in the block of flats I live… Lots of people log in at the same time and I cannot download the images I need…Otherwise, I have to wait forever…Who will help me and how? (Anonymous feedback - session 2)*
10. Lack of equipment, i.e., personal laptop (4)	*I only have a desktop computer which is rather slow. I need help to make changes so that I can improve my stories… They are so poor. I need training as well. (Anonymous feedback - session 1)*

Data indicated participants valued authentic engagement in highly interactive real-life experiences, such as EDS, which allowed them to express unique points of view using words from their own language. Students indicated that EDS enhanced digital, professional, and critical thinking skills; improved writing skills; increased motivation and self-confidence; and developed intercultural awareness and collaborative skills compared to written assignments (Table 5). These findings, supported by lecturer observations, corroborated previous research in other settings (Hung et al., 2012). As students had to submit similar written assignments for all their modules, which they characterized as demotivating in previous surveys, they were more excited when working on their DS. They collaborated more with their peers, developed digital skills, and resolved various problems encountered while preparing their DS. Although there were twenty-one non-traditional students who faced several challenges while using Canva and other technology, all students successfully submitted their digital stories. Students shared their final products through social media, and some of them reported they intended to include them in blogs and share them with friends and colleagues. Student-teachers felt less isolated and enjoyed sharing DS with peers from around the world when their identities were reflected in the DS.

However, some non-traditional students reported that they faced challenges while using Canva, needed additional training to use certain elements, such as podcasts, and more time to prepare a DS compared to written assignments. These findings were also confirmed by the lecturer who observed that students faced a number of challenges due to lack of internet at their home. The lecturer confirmed most of the benefits and challenges except for the lack of laptops as most students seemed to have one. In sum, the current implementation may help educators reflect on their practices, help students develop digital skills, and inspire HEIs to create more interculturally oriented curricula.

Discussion

Involving and motivating learners is crucial for effective learning and educators should prepare meaningful activities to increase learner interest and engagement and foster active learning (Hyun et al., 2017). Previous studies indicated that the use of technology enhances student writing performance and attitudes towards learning (Barrot, 2021). According to the qualitative findings of the current study, EDS promoted authentic learning as students often used their own personal stories, which they integrated with theory, creating compelling content (Table 5, Comment 7). This was not always possible when students were asked to write a traditional essay. Completing challenging tasks successfully as they developed digital skills due to the EDS increased students' sense of autonomy. Students learned how to create podcasts, were more self-confident and creative, and improved their overall attitude towards learning (Table 5, Comment 7). Consequently, the study indicated that EDS emphasized various motivational constructs such as task significance, self-reliance, and reflective practice, confirming previous research (Jamissen et al., 2017; McLellan, 2008).

The use of technology for EDS created meaningful, interactive, and inclusive multimodal instructional content (Rubino et al., 2018) that facilitated the creation of a community of learning (Table 5, Comment 6). As undergraduate students often have varying life experiences and sociocultural and linguistic backgrounds, the EDS intervention encouraged negotiation of new theories and knowledge allowing learners to present their own perspectives and negotiate language teaching with peers. This ultimately enhanced students' professional and academic skills (Tables 3 and 4), especially their writing skills (Table 3), confirming previous research (Rubino et al., 2018). Moreover, the current study indicated that EDS could improve student academic performance significantly in terms of writing, improving student vocabulary and language use, content, and organization as well as their sense of purpose and audience (Table 4). This outcome was also consistent with previous research (Rong & Noor, 2019; Wu & Chen, 2020; Yamaç & Ulusoy, 2015) which indicated that EDS was a viable approach to help students improve various aspects of writing.

EDS provided an authentic context allowing students to work on real-life tasks (Table 5, Comments 6 and 7). This motivated learners and inspired them to put additional effort to improve their academic performance as they found EDS tasks more enjoyable. Furthermore, as a multimodal writing tool, EDS allowed students to use a variety of elements, such as infographics and videos, in addition to written text. Thus, they could convey their intended message and present the associated theories much more vividly and powerfully. The lecturer observed that students' DS were an interesting marriage of narrative, text, and technology. Rossiter and Garcia (2010) referred to such use of DS as "a potent force in educational practice" (p. 37).

In addition, EDS allowed students to develop their writing skills more effectively due to the audience effect. Having an audience urged learners to pay more attention to detail and try even harder to improve their texts. The findings also supported the idea that involving a real audience created a genuine language context (Table 5, Comment 5). The technological advances in digital media offered innovative ways of exchanging stories and enhancing intercultural awareness and communication. In a fast-paced networked society, there is an even greater demand to enhance intercultural competencies and multilingual skills. These skills can increase the overall set of 21st century competencies frequently linked with professional skills needed in the global workplace, e.g., creativity, imagination, cooperation, problem-solving, and digital

and multimedia literacies. Considering lecturer observations, these were some of the skills the students developed when they were involved in EDS.

EDS also enhanced student motivation and engagement. Literature indicated this often led to increased writing performance (LoBello, 2015). EDS places emphasis on the process and the final product, making learners more persistent and allowing them to engage more fully with the writing process, as they tended to invest considerable time and effort before asking for feedback from their audience (peers and lecturer). To prepare their accompanying videos and podcasts, students had to re-visit their work. This allowed them to detect flaws in their writing compared to if they had to produce written text only as was the case for their traditional final assignments in the control module (Table 3). The lecturer observed that, when students were engaged in EDS, they seemed to devote more time and effort as they tried to improve their work and produce the best end-products because they wanted to share them with their peers, friends, and family. As regards to challenges that students faced, digital literacy was a main issue for some non-traditional students. These learners should be offered systematic training and support before using EDS. This will facilitate the use of this approach which has a statistically significant influence on students' academic performance (Table 3), a finding confirming previous research (Balaman, 2018).

Overall, the EDS intervention managed to increase cooperation and understanding among students from various cultural and linguistic backgrounds and supported them in exchanging ideas about their teaching practices as students shared their DS through the social media and interacted with colleagues from around the world. The literature indicated that digital narratives enhanced effective visualization of reflections and ideas which enabled sharing multicultural views and thoughts (Fokides, 2016). Digital narration created a psychologically safe and supportive foundation for intercultural and multilingual cooperation and learning (Fokides, 2016) as learners in the present research study were also allowed to use short videos in their own native language (with a translation in English). This was not possible with the traditional writing assignments. Consequently, by adopting EDS, the lecturer was able to create a space which promoted intercultural awareness and multilingual interaction in the context of an undergraduate module. The internationalization of HE can also be seen as an exchange among various cultures. Given this stance, more initiatives that promote intercultural learning, plurilingualism and interaction among learners are vital.

EDS can engage university students through involvement in the creative process it necessitates (see Kocaman-Karoglu, 2016) and promote professional skills such as negotiation. Moreover, EDS may involve learners in genuine learning and enhance their understanding of theories and module content (Table 5, Comment 2). Research showed that the use of EDS in HE is still developing but does provide new techniques for learners to organise and present their work in alternative ways as well as think critically (Chan et al., 2017). As an important new area of study in HE, EDS may capture learner interest and develop valuable capabilities such as digital skills, which are considered essential in the 21st century (Germaine et al., 2016). Gregori-Signs (2014) claimed that EDS enabled learners to "evaluate the reality that surrounds them and produce their own interpretation of it" (p. 241). The current study, confirming previous research (Smeda et al., 2014), reported that the ability of EDS to personalize student learning experiences helped support students' diverse cultural and linguistic backgrounds, increased learner confidence, and developed writing, social and psychological skills (Tables 3, 4 and 5).

Conclusion

Various studies have revealed that adopting EDS connects the high-tech world outside the university and the ordinary typically lower-tech within the university setting, but also engages learners in developing their skills through the creation of personal stories (Smeda et al., 2014). This study advances the understanding of student writing, digital literacy, and motivational enhancement through EDS tasks in multicultural and multilingual HE classrooms. Findings will assist education faculty to use technologically suffused pedagogies to meet module aims successfully as EDS can improve student writing performance and attitudes towards learning. Additionally, having a real audience to view the stories increases learner motivation and helps them improve their work by editing it more carefully. Lastly, the collected data revealed that the previous concerns of some of the students, which were linked to the use of technology and the lack of time, gradually turned into positive feelings, including pride and enthusiasm about their final stories (Table 5, Comment 5).

However, educators must still be cautious when implementing this exciting yet relatively new technique as students face considerable challenges when they have limited access to the Internet or technology. Moreover, some especially non-traditional students lack the relevant knowledge and experience in using technological tools in education. Consequently, practitioners should provide training and continuous support to their students when using EDS to avoid inequity. In addition, educators must have a detailed plan, which can guide their students. This should help students understand the reasons why they are asked to engage in EDS and the benefits to academic and professional development. Lecturers should also emphasize the product as well as the process of learning as learners develop their academic skills while preparing their DS. They also need to focus on assessing student writing skills rather than the elements that learners use to make their stories more attractive. There should also be clear assessment criteria that match curricular goals. Otherwise, the implementation may not be successful and may be unfair for some students. Moreover, HEIs should provide professional development courses to academic staff regarding these new technological tools and encourage lecturers to use them in various modules. Although the current research was a small-scale study limited in time and involved only 50 students at one university, this implementation may be valuable as a genuine learning experience for undergraduate learners.

Therefore, additional research on the use of EDS in multicultural and multilingual HEI settings is necessary. Future research should explore the use of EDS in other academic programs, for example, at the doctoral level, or take into consideration other types of course delivery such as blended learning that have become increasingly popular during the COVID-19 crisis. Conducting interview based qualitative research to explore learners' retention of various learning theories and content would also be helpful to reveal the impact of EDS on academic performance. In addition, quantitative longitudinal analysis on techniques to measure retention and development of other skills, such as oral presentation skills, would be valuable. Further research should examine the influence of this learning method on practicing teachers' school-based activity regarding technology integration and the extent to which teachers use EDS in their own classrooms after being exposed to it as students.

Being a reflective educator requires higher order thinking skills. Problem-solving and decision-making are seen as an integral part of being reflective with respect to student knowledge, social and cultural circumstances, psychological processes, attitudes towards learning and teaching, and self-awareness about oneself as an educator (Schunk, 2012). Taking this into consideration, this study aspired to introduce student-teachers to the significance of reflective practice through

EDS with the goal of enhancing writing skills and motivation. Based on the findings of the study, EDS is a reliable method to develop undergraduate student digital literacy and enhance their motivation to learn. Finally, the present study provides useful guidelines for educators in HE to integrate EDS activities into their modules and courses.

References

Ahmed, V., & Opoku, A. (2022). Technology supported learning and pedagogy in times of crisis: the case of COVID-19 pandemic. *Education and Information Technologies*, *27*(1), 365–405. https://doi.org/10.1007/s10639-021-10706-w

Almeida, F. (2018). Strategies to perform a mixed methods study. *European Journal of Education Studies, 5*(10), 137–151.

Balaman, S. (2018). Digital storytelling: A multimodal narrative writing genre. *Dil ve Dilbilimi Çalışmaları Dergisi, 14*(3), 202–212.

Barrett, A. K. (2019). Digital storytelling: Using new technology affordances to organize during high uncertainty. *Narrative Inquiry, 29*(1), 21–243. https://doi.org/10.1075/ni.18017.bar

Barrot, J. S. (2021). Effects of Facebook-based e-portfolio on ESL learners' writing performance. *Language, Culture and Curriculum, 34*(1), 95–111. https://doi.org/10.1080/07908318.2020.1745822

Belcher, D. D. (2017). On becoming facilitators of multimodal composing and digital design. *Journal of Second Language Writing, 38*, 80–85. https://doi.org/10.1016/j.jslw.2017.10.004

Bloch, J. (2018). Digital Storytelling in the multilingual academic writing classroom: Expanding the possibilities. *Dialogues: An Interdisciplinary Journal of English Language Teaching and Research, 2*(1), 96–110. https://doi.org/10.30617/dialogues.2.1.6

Carmona, J. F., & Luschen, K. V. (2014). Introduction: Weaving together pedagogies and methodologies of collaboration, inclusion, and voice. *Counterpoints*, 1-8.

Chan, B. S., Churchill, D., & Chiu, T. K. (2017). Digital literacy learning in higher education through digital storytelling approach. *Journal of International Education Research (JIER)*, *13*(1), 1–16. https://doi.org/10.19030/jier.v13i1.9907

Chaturvedi, S. R. B. H., & Shweta, R. C. (2015). Evaluation of inter-rater agreement and inter-rater reliability for observational data: An overview of concepts and methods. *Journal of the Indian Academy of Applied Psychology, 41*(3), 20–27.

Chiang, M. H. (2020). Exploring the effects of digital storytelling: A case study of adult L2 writers in Taiwan. *IAFOR Journal of Education, 8*(1), 65–82. https://doi.org/10.22492/ije.8.1.04

Choi, B., Jegatheeswaran, L., Minocha, A., Alhilani, M., Nakhoul, M., & Mutengesa, E. (2020). The impact of the COVID-19 pandemic on final year medical students in the United Kingdom: a national survey. *BMC Medical Education*, *20*(1), 1–11. https://doi.org/10.21203/rs.3.rs-24792/v1

Choi, J. J., Robb, C. A., Mifli, M., & Zainuddin, Z. (2021). University students' perception to online class delivery methods during the COVID-19 pandemic: A focus on hospitality education in Korea and Malaysia. *Journal of Hospitality, Leisure, Sport & Tourism Education*, *29*, 100336. https://doi.org/10.1016/j.jhlste.2021.100336

Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. Sage Publications.

Cumming, A., Kantor, R., Baba, K., Eaouanzoui, K., Erdosy, U., & James, M. (2006). *Analysis of discourse features and verification of scoring levels for independent and integrated prototype written tasks for the new TOEFL*. ETS.

Damavandi, Z. M., Hassaskhah, J., & Zafarghandi, A. M. (2018). The effects of computer assisted mediating prompts on EFL learners' writing ability. *International Journal of Education and Literacy Studies, 6*(1), 64–71. https://doi.org/10.7575/aiac.ijels.v.6n.1p.64

Díez Gutiérrez, E. J., & Gajardo Espinoza, K. (2020). Educating and evaluating in times of coronavirus: The situation in Spain. *Multidisciplinary Journal of Educational Research*, *10*(2). https://doi.org/10.17583/remie.2020.5604

Dewi, N. R., Maghfiroh, L., Nurkhalisa, S., & Dwijayanti, I. (2019). The development of contextual-based science digital storytelling teaching materials to improve students' critical thinking on classification theme. *Journal of Turkish Science Education, 16*(3), 364–378.

Duman, B. & Göcen, G. (2015). The effect of the digital storytelling method on pre-service teachers' creative writing skills. *Anthropologist, 20*(1–2), 215–222.

Eissa, H. M. S. (2019). Pedagogic effectiveness of digital storytelling in improving speaking skills of Saudi EFL learners. *Arab World English Journal (AWEJ), 10*(1), 127-138.

Flick, U. (2018). *Doing triangulation and mixed methods*. Sage.

Germaine, R., Richards, J., Koeller, M., & Schubert-Irastorza, C. (2016). Purposeful use of 21st century skills in higher education. *Journal of Research in Innovative Teaching, 9*(1), 19–29.

Gregori-Signes, C. (2014). Digital storytelling and multimodal literacy in education. *Porta Linguarum, 22*, 237–250. https://doi.org/10.30827/Digibug.53745

Hava, K. (2021). Exploring the role of digital storytelling in student motivation and satisfaction in EFL education. *Computer Assisted Language Learning, 34*(7), 958–978. https://doi.org/10.1080/09588221.2019.1650071

Hava, K. (2019). Exploring the role of digital storytelling in student motivation and satisfaction in EFL education. *Computer Assisted Language Learning*, 1–21. https://doi.org/10.1080/09588221.2019.1650071

Hung, C. M., Hwang, G. J., & Huang, I. (2012). A project-based digital storytelling approach for improving students' learning motivation, problem-solving competence and learning achievement. *Journal of Educational Technology & Society, 15*(4), 368–379.

Hyun, J., Ediger, R., & Lee, D. (2017). Students' satisfaction on their learning process in active learning and traditional classrooms. *International Journal of Teaching and Learning in Higher Education, 29*(1), 108–118.

Jamissen, G., Hardy, P., Nordkvelle, Y., & Pleasants, H. (2017). *Digital storytelling in higher education*. Palgrave Macmillan.

Kocaman-Karoglu, A. (2016). Personal voices in higher education: A digital storytelling experience for pre-service teachers. *Education and Information Technologies, 21*(5), 1153–1168. https://doi.org/10.1007/s10639-014-9373-1

Lambert, J. (2012). *Digital storytelling: Capturing lives, creating community*. Routledge.

Lester, J. N., Cho, Y., & Lochmiller, C. R. (2020). Learning to do qualitative data analysis: A starting point. *Human Resource Development Review, 19*(1), 94–106. https://doi.org/10.1177/1534484320903890

Lin, L. K., Thang, S. M., Jaafar, N. M., & Zabidi, N. A. (2013). Digital storytelling as a project in an EAP course: Insights from Malaysian undergraduates. *Journal of Institutional Research South East Asia, 11*(2), 48–67.

Liontas, J. I., & Mannion, P. (2021). Voices heard, voices seen: From classroom praxis to digital stories worth sharing. *Iranian Journal of Language Teaching Research, 9*(2), 73–84.

Liu, C. C., Lu, K. H., Wu, L. Y., & Tsai, C. C. (2016). The impact of peer review on creative self-efficacy and learning performance in Web 2.0 learning activities. *Journal of Educational Technology & Society, 19*(2), 286-297.

Liu, K. P., Tai, S. J. D., & Liu, C. C. (2018). Enhancing language learning through creation: The effect of digital storytelling on student learning motivation and performance in a school English course. *Educational Technology Research and Development, 66*(4), 913–935. https://doi.org/10.1007/s11423-018-9592-z

LoBello, C. (2015). *The impact of digital storytelling on fourth grade students' motivation to write*. Master's Thesis, The College at Brockport, State University of New York.

McLellan, H. (2008). Digital storytelling: Expanding media possibilities for learning. *Educational Technology*, 18–21.

Morse, J. M. (2016). *Mixed method design: Principles and procedures* (Vol. 4). Routledge.

Murphy, M. P. (2020). COVID-19 and emergency eLearning: Consequences of the securitization of higher education for post-pandemic pedagogy. *Contemporary Security Policy*, *41*(3), 492–505. https://doi.org/10.1080/13523260.2020.1761749

Özüdoğru, G., & Çakir, H. (2020). An investigation into the opinions of pre-service teachers toward uses of digital storytelling in literacy education. *Participatory Educational Research, 7*(1), 242–256. https://doi.org/10.17275/per.20.14.7.1

Pahl, K., & Rowsell, J. (2019). *Artifactual literacies: Every object tells a story*. Teachers College Press.

Portillo, J., Garay, U., Tejada, E., & Bilbao, N. (2020). Self-perception of the digital competence of educators during the COVID-19 pandemic: A cross-analysis of different educational stages. *Sustainability*, *12*(23), 10128. https://doi.org/10.3390/su122310128

Robin, B. R. (2008). Digital storytelling: A powerful technology tool for the 21st century classroom. *Theory Into Practice, 47*(3), 220–228. https://doi.org/10.1080/00405840802153916

Robin, B. R. (2016). The power of digital storytelling to support teaching and learning. *Digital Education Review*, *30*, 17–29.

Rong, L. P., & Noor, N. M. (2019). Digital storytelling as a creative teaching method in promoting secondary school students' writing skills. *International Journal of Interactive Mobile Technologies*, *13*(7), 117–128. https://doi.org/10.3991/ijim.v13i07.10798

Rossiter, M., & Garcia, P. A. (2010). Digital storytelling: A new player on the narrative field. *New Directions for Adult and Continuing Education, 126*, 37–48. https://doi.org/10.1002/ace.370

Rubino, I., Barberis, C., & Malnati, G. (2018). Exploring the values of writing collaboratively through a digital storytelling platform: A mixed-methods analysis of users' participation, perspectives and practices. *Interactive Learning Environments, 26*(7), 882–894. https://doi.org/10.1080/10494820.2017.1419499

Saldaña, J. (2021). *The coding manual for qualitative researchers*. Sage Publications.

Schunk D. H. (2012). *Learning theories: An educational perspective* (6th ed). Pearson.

Silvers, P., & Shorey, M. C. (2012). *Many texts, many voices: Teaching literacy and social justice to young learners in the digital age*. Stenhouse Publishers.

Smeda, N., Dakich, E., & Sharda, N. (2014). The effectiveness of digital storytelling in the classrooms: A comprehensive study. *Smart Learning Environments, 1*(1), 1–21. https://doi.org/10.1186/s40561-014-0006-3

Sukovic, S. (2014). iTell: Transliteracy and digital storytelling. *Australian Academic & Research Libraries, 45*(3), 205–229. https://doi.org/10.1080/00048623.2014.951114

Toquero, C. M. (2020). Challenges and opportunities for higher education amid the COVID-19 pandemic: The Philippine context. *Pedagogical Research, 5*(4), 1–5. https://doi.org/10.29333/pr/7947

Wang, G., Zhang, Y., Zhao, J., Zhang, J., & Jiang, F. (2020). Mitigate the effects of home confinement on children during the COVID-19 outbreak. *The Lancet*, *395*(10228), 945–947. https://doi.org/10.1016/S0140-6736(20)30547-X

Wei, L. (2018). Translanguaging as a practical theory of language. *Applied Linguistics, 39*(1), 9–30. https://doi.org/10.1093/applin/amx044

Wu, J., & Chen, D. T. V. (2020). A systematic review of educational digital storytelling. *Computers & Education*, *147*, 103786 https://doi.org/10.1016/j.compedu.2019.103786

Yamaç, A., & Ulusoy, M. (2015). *The effect of digital storytelling on improving the writing skills of third grade students*. Unpublished Doctoral Dissertation. Gazi University, Ankara, Turkey.

Yancey, K.B., Robertson, L. & Tacsak, K. (2014). *Writing across contexts: Transfer, composition, and cultures of writing*. Colorado: University Press of Colorado.

Yang, Y. T. C., & Wu, W. C. I. (2012). Digital storytelling for enhancing student academic achievement, critical thinking, and learning motivation: A year-long experimental study. *Computers & Education, 59*(2), 339–352. https://doi.org/10.1016/j.compedu.2011.12.012

Yildiz Durak, H. (2018). Digital story design activities used for teaching programming effect on learning of programming concepts, programming self-efficacy, and participation and analysis of student experiences. *Journal of Computer Assisted Learning, 34*(6), 740–752. https://doi.org/10.1111/jcal.12281

Villela, E. F. D. M., de Oliveira, F. M., Leite, S. T., & Bollela, V. R. (2020). Student engagement in a public health initiative in response to COVID-19. *Medical Education*, *54*(8), 763–764. https://doi.org/10.1111/medu.14199

Corresponding author: Eleni Meletiadou
Email: elenim@outlook.com

Reviewers – Volume 10 – Issue 2

The editorial team would like to thank the following reviewers for their contributions to the peer review of this issue. Their dedication and assistance are greatly appreciated.

Senior Reviewers

Dr Shiao-wei Chu, National Chin-Yi University of Technology, Taiwan
Dr Melinda Cowart, Texas Woman's University (TWU), USA
Dr Mikel Garant, Beijing Institute of Technology, China
Dr Elena Mishieva, Moscow State University, Russia
Dr Leonardo Munalim, The Philippine Women's University-School of Arts & Sciences and School of Education, The Philippines
Dr Murielle El Hajj Nahas, Lusail University, Qatar
Dr Shwadhin Sharma, California State University Monterey Bay, USA
Dr Michelle Yeo, Coventry University and University of Newcastle, Australia
Dr Serpil Meri-Yilan, Ibrahim Cecen University, Turkey

Reviewers

Dr Philip Ajewole, Federal University Oye-Ekiti, Nigeria
Dr Hee Seon Jang, Pyeongtaek University, Korea
Dr Michelangelo Magasic, Kochi University of Technology, Japan
Dr Debbie Meharg, Edinburgh Napier University, United Kingdom
Dr Nancy Nisbett, California State University, Fresno, USA
Dr Menyani Nourreddine, Tofail University Faculty of Arts and Humanities, Morocco
Dr Queen Ogbomo, Tennessee Technological University, USA
Dr Urarat Parnrod, Songkhla Rajabhat University, Thailand
Dr Metee Pigultong, Department of Educational Technology & Communications, Rajamangala University of Technology Thanyaburi, Thailand
Dr Elena Raevskikh, Department of Culture and Tourism, United Arab Emirates
Dr Stephanie Wendt, Tennessee Tech, USA

the iafor
journal of education

ISSN: 2187-0594