IS PEERSCHOLAR A REFLEXIVE PEDAGOGY PLATFORM?
¿ES PEERSCHOLAR UNA PLATAFORMA DE PEDAGOGÍA REFLEXIVA?

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	ABSTRACT
Keywords: digital competencies, educational technology, edtech, reflexive pedagogy, recursive feedback.	The utilization of information and communication technologies (ICT) has an impact on pedagogy and the learning experience, but their use should go beyond merely replacing the teacher or a specific learning activity. ICT is used in many educational institutions worldwide to enhance student interest and participation. This research focuses on how the use of ICT contributes to a new type of learning called reflexive pedagogy, which is based on seven digital affordances: ubiquitous learning, active knowledge creation, multimodal meaning, recursive feedback, collaborative intelligence, metacognition, and differentiated learning. The objective of this research was to identify which educational technologies truly innovate the pedagogy, rather than simply adding technological elements without any impact. The use of ICT in education is not new, but the COVID-19 pandemic accelerated its adoption, generating political, economic, and legislative debates worldwide. This research demonstrates how the peerScholar software supports the digital affordance, recursive feedback, promoting reflexive pedagogy that enhances communication and collaboration among students in the digital learning space. This research's statistical and descriptive analysis demonstrates that the use of peerScholar contributes to the development of students' digital competencies. The results of this research are relevant in the field of educational technologies worldwide, highlighting their impact on student learning.

	RESUMEN
Palabras clave: competencias digitales, tecnología educativa, edtech, pedagogía reflexiva, retroalimentación recursiva.	La utilización de las tecnologías de la información y la comunicación (TIC) tiene un impacto en la pedagogía y la experiencia de aprendizaje, pero su uso debe ir más allá de simplemente reemplazar al docente o una actividad de aprendizaje específica. Las TIC se utilizan en muchas instituciones educativas a nivel mundial para mejorar el interés y la participación de los estudiantes. Esta investigación se centra en cómo el uso de las TIC contribuye a un nuevo tipo de aprendizaje llamado pedagogía reflexiva, que se basa en siete potencialidades digitales: aprendizaje ubicuo, creación

activa de conocimiento, significado multimodal, retroalimentación recursiva, inteligencia colaborativa, metacognición y aprendizaje diferenciado. El objetivo de esta investigación es identificar qué tecnologías educativas realmente innovan la pedagogía, en lugar de simplemente agregar elementos tecnológicos sin ningún impacto pedagógico. El uso de las TIC en la educación no es nuevo, pero la pandemia de COVID-19 aceleró su adopción, generando debates políticos, económicos y legislativos a nivel mundial. Esta investigación demuestra cómo el software peerScholar soporta la posibilidad digital, la retroalimentación recursiva, promoviendo la pedagogía reflexiva que mejora la comunicación y la colaboración entre los estudiantes en el espacio de aprendizaje digital. El análisis estadístico y descriptivo de esta investigación demuestra que el uso de peerScholar contribuye al desarrollo de las competencias digitales de los estudiantes. Los resultados de esta investigación son relevantes en el campo de las tecnologías educativas a nivel mundial, destacando su impacto en el aprendizaje de los estudiantes.

Introduction

Information and communication technologies (ICT) transform the learning experience and teaching approaches in many ways in education, but they can also be used as a mere substitute for the teacher, which may not guarantee a positive impact on pedagogy or the learning experience of the students. Many primary and secondary educational institutions, both private and public, national and international, use various educational technologies to increase student interest and engagement inside and outside the classroom. This research demonstrates how ICT contributes to a new type of pedagogy enhanced by technology, which researchers Cope and Kalantzis (2015) have identified as reflexive pedagogy. The use and application of this pedagogy leads to new forms of communication, collaboration experiences, and the creation of new concepts and knowledge. This pedagogy creates a new type of learning and assessment through seven digital affordances: ubiquitous learning, active knowledge making, multimodal meaning, recursive feedback, collaborative intelligence, metacognition, and differentiated learning. From its start, the intention was to investigate whether the digital affordance of recursive feedback, used through the peerScholar software, truly activates reflexive pedagogy with a positive impact on students' digital competencies. The pandemic accelerated the use of ICT and educational technology solutions in education at such a rapid pace that there was little time for reflection and verification of its appropriateness for the selected objectives. During the pandemic, ICT and educational technology solutions were used for various purposes such as self-assessment, additional assignments, feedback, group work, video conferences, access to subject content, and formative assessment, among others. This massive use of new technologies from early 2020 to late 2022 also raised concerns about excessive screen time and digital exposure of young students. The scientific interest of this research was to identify the parameters of educational technologies that truly innovate pedagogy rather than simply adding a technological element to the educational experience without any impact on learning. The use of ICT in education is not new. Still, it is necessary to acknowledge that the COVID-19 pandemic accelerated the exponential adoption of educational technologies and sparked political, financial, and legislative debates worldwide.

Analyzing the use of the peerScholar software in a K12 learning environment is the first conducted in international secondary educational institutions in Asia after the COVID-19 pandemic. According to the world economic forum publication on July 12, 2022, it shares that from 2010 to 2020, educational technologies have brought to light two educational myths about their application to learning and teaching. First, the confusion about students' use of educational technologies and their demonstration of entertainment is equivalent to a real increase in their learning. Second, educational technologies should be provided to solve the lack of equity in educational systems. Serrano and Martínez (2003) highlight that the widespread use of ICTs in all spheres of human life, family, professional, political, cultural, economic, and educational, is undeniable today. Digital technologies constitute a tool that is immersed in the context of human development. For this reason, it is a requirement for schools to use them when appropriate and prudent. These generational differences marked by the emergence of ICT and added to the expectations of improvement and development of educational processes highlight the prevailing need to address reflections on the possibilities of using the various devices and applications of the new technologies in the teaching and learning process. Although the educational models of the 21st century have indeed incorporated the use of ICT in the teaching and learning process, it is also undeniable that there are still gaps in the

recognition of the positive impacts of ICT as pedagogical resources. Sometimes ICT are poorly applied to education, such as:

- Distraction in the classroom: students may misuse technology, such as smartphones or tablets, to browse social media, play video games, or engage in unrelated activities instead of concentrating on the lesson.
- Plagiarism: easy access to online resources can lead to plagiarism, where students copy and paste content without properly quoting or understanding it.
- Over-reliance on automated grading: while automated grading systems can save time, they may not accurately assess complex assignments or provide meaningful feedback, limiting student learning opportunities.
- Lack of critical thinking: relying solely on search engines and online resources without developing critical thinking skills can hinder students' ability to evaluate information and discern reliable sources critically.

Therefore, this research took as its starting point the use of ICT as a contributor to the development of students' digital skills, so the definition of the problem is: Does the use of peerScholar activate recursive feedback and improve the digital competencies of students?

Literature Review
The Taxonomy of Education 4.0

The World Economic Forum (2023) published its referential framework called The Taxonomy of Education 4.0. which consists of a group of abilities, skills, attitudes, values, and knowledge organized in a hierarchical tree structure. Aptitudes are abstract, but at the same time, they are aspects of learning that are transferable during the teaching process, so they are not innate characteristics in students but qualities that can be taught and learned.

Figure 1
The Taxonomy of Education 4.0
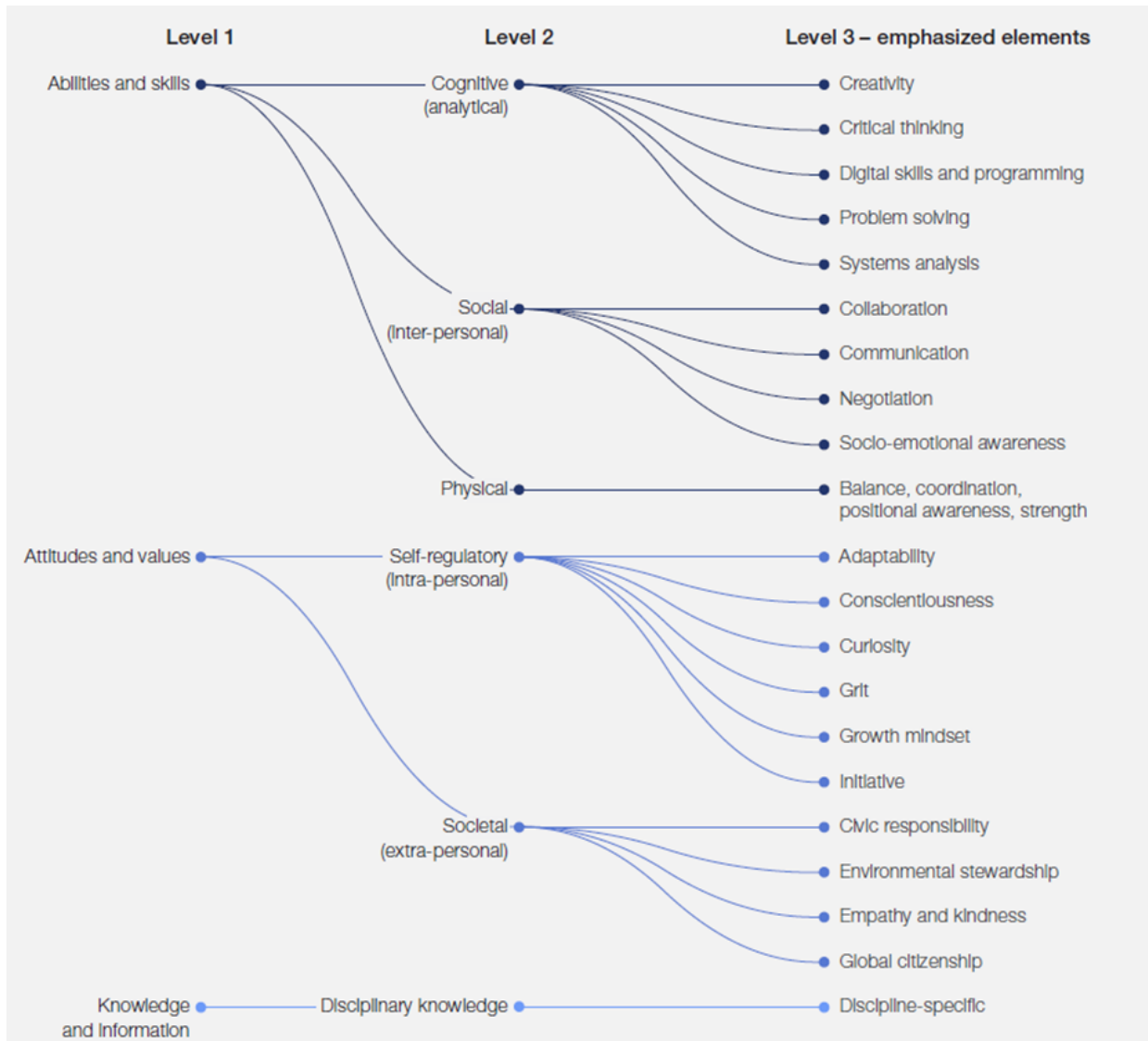
Note. The Taxonomy of Education 4.0 published by the World Economic Forum (2023).

The Taxonomy of Education 4.0, Figure 1, was created as part of a strategy for reimagining the educational system. It includes various learning theories and methodologies used by teachers. This taxonomy identifies 4 domains of innovative pedagogies that will guide learning and teaching and further develop the competencies of elementary and secondary school students.

1. Personalized and self-paced learning.
2. Accessible and inclusive learning.
3. Collaborative and problem-based learning.
4. Lifelong, student-driven learning.

According to Adobe Systems Incorporated (2019), a study of 2 million online job postings, the top five skills employers requested were: communication, creativity, collaboration, creative problem solving, and critical thinking. A similar study carried out by the Foundation for Young Australians (2017) found that between 2012 and 2015, the skills whose demand increased the most were: digital literacy (with a 212% increase in

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requests), critical thinking (increase 158%) and creativity (65% increase). In the digital age we live in, access to information is easier than ever. However, it is important to teach students to discriminate between relevant and irrelevant information, as well as to validate the reliability of sources. Furthermore, knowledge is something dynamic that is constantly updated. Therefore, it is essential to foster curiosity and interest in students to continue learning throughout their lives. At the core of education and learning is also the ability to apply knowledge to solve real-world problems and situations. It's not just about accumulating information but knowing how to use it effectively. Education Taxonomy 4.0 recognizes the need to prepare students to be competent global citizens in a digitalized world, where soft skills and adaptability are as important as technical knowledge. This represents a significant shift in the way we understand and approach education but is critical to preparing future generations to succeed in an ever-changing world.

Figure 1 includes the 3 different levels of the Education 4.0 Taxonomy and their connections. The three most important domains are those included in Level 1.

- Abilities and Skills: are the set of process-oriented capabilities that enable an individual to achieve a specific goal. At the highest level of abstraction, skills and abilities are divided into:
  - Cognitive and analytical skills, including creativity, critical thinking and problem solving
  - Interpersonal (non-cognitive) skills, including communication, collaboration, and social-emotional skill set.
- Attitudes and values: are the set of beliefs that inform self-regulated behavior, such as personal motivation, commitment to society, and moral or ethical considerations. Attitudes and values are less concerned with how something should be done, but rather with "why" it should be done. These aptitudes have a strong motivational component, which is essential to foster the resilience needed to overcome difficult challenges, including the challenges of learning itself.
- Knowledge and Information: knowledge and information will always be at the heart of education and learning. The economies of the future will require advanced skills and capabilities to interpret the future proliferation of knowledge and information, and the appropriate attitudes and values to guide those interpretations. For this reason, the Education Taxonomy 4.0 places less direct emphasis on knowledge and information, and rather addresses them indirectly through the other skills in the taxonomy.

It is critical that students and educators are willing to try new ideas, methods, and technologies to improve learning. This involves being willing to make mistakes, learn from them, and seek creative solutions. The innovative mindset also involves the ability to quickly adapt to changes and challenges, as well as the willingness to question the status quo and constantly look for ways to improve.

IEEE 3527.1 ™ (2020) - digital intelligence standard (DQ)

Beyond IQ and EQ, the DQ (digital intelligence) standard represents the critical skills needed to thrive in the digital age. Melissa Sassi, chair of the Digital Literacy & Skills Working Group: IEEE Smart Village explains:

After reviewing hundreds of frameworks, definitions, platforms and modules, the digital intelligence working group was delighted to have identified one that encompasses the skills needed to use the internet. Our mission behind the work has been to align the world with a standard framework to guide the formal and informal sectors worldwide to empower others with the digital skills necessary to

prepare for the future of work while being safe and secure online. (DQ Institute, 2019, page 51)

The DQ Institute (2020) referential framework comprises 24 digital competencies, as in Figure 2. This framework focuses on 8 critical areas of digital life: identity, use, security, emotional intelligence, literacy, communication, and rights. These 8 areas can be developed at three levels: citizenship, creativity, and competitiveness.

- Citizenship focuses on basic skills necessary to use technologies responsibly, safely, and ethically.
- Creativity enables problem-solving by creating new knowledge, technologies, and content.
- Competitiveness focuses on innovations to change communities and the economy for the general benefit.

Figure 2
The 24 digital competencies of the digital intelligence standard (DQ)

	Digital Identity	Digital Use	Digital Safety	Digital Security
Digital Citizenship	1 Digital Citizen Identity	2 Balanced Use of Technology	3 Behavioural Cyber-Risk Management	4 Personal Cyber Security Management
Digital Creativity	9 Digital Co-Creator Identity	10 Healthy Use of Technology	11 Content Cyber-Risk Management	12 Network Security Management
Digital Competitiveness	17 Digital Changemaker Identity	18 Civic Use of Technology	19 Commercial and Community Cyber-Risk Management	20 Organisational Cyber Security Management

	Digital Emotional Intelligence	Digital Communication	Digital Literacy	Digital Rights
Digital Citizenship	5 Digital Empathy	6 Digital Footprint Management	7 Media and Information Literacy	8 Privacy Management
Digital Creativity	13 Self-Awareness and Management	14 Online Communication and Collaboration	15 Content Creation and Computational Literacy	16 Intellectual Property Rights Management
Digital Competitiveness	21 Relationship Management	22 Public and Mass Communication	23 Data and AI Literacy	24 Participatory Rights Management

Note. This figure shows the 24 digital competencies of the digital intelligence standard published by the DQ Institute (2020).

During this research the focus was DQ6, 14, which is the subject of digital communication, including collaboration and online communication. Figure 3 describes the knowledge, aptitudes, values and abilities necessary for this digital competence, which is the essence of this research work about the use of the peerScholar software and its contribution to the development of these digital competences in students.

Figure 3
DQ6, 14: digital communication – collaboration and online communication

Knowledge	Abilities	Values / Aptitudes
People understand different types of peer-to-peer communication and collaboration strategy tools and formats and decide which methods are most effective for individual or collaborative goals. Additionally, they understand the various social and market pressures that can encourage or discourage communication and collaboration in certain	Individuals can develop social-emotional cognitive and interpersonal skills that support their communication and collaboration efforts. Skills include the ability to interact and collaborate with an online community of peers and experts for the incorporation of knowledge construction. You can also leverage your technical skills to officially exchange ideas and work together even remotely by using a variety of different communication	Individuals can develop social-emotional cognitive and interpersonal skills that support their communication and collaboration efforts. Skills include the ability to interact and collaborate with an online community of peers and experts for the incorporation of knowledge construction. You can also leverage your technical skills to officially exchange ideas and work together even remotely by using a

Note. This figure shows the DQ6, 14 breakdown of the Digital Communication competency published by the DQ Institute (2020).

e-Learning Ecologies

Cope and Kalantzis (2016) explore the concepts of online learning, which can be categorized as new learning environments and traditional learning environments that are transformed by educational technologies. Both categories use a wide range of educational technologies and technology platforms in traditional and new contexts. Cope and Kalantzis (2016) identify the following educational technologies as the most important and those that will continue to transform education:

- Learning management system: this category includes open-source systems such as Moodle or those used by university centers called Blackboard. Commercial online learning management systems such as Coursera and EdX have recently followed the same format.
- Electronic books and texts: beginning to replace print products, which may include multimedia content and often formative assessments.
- Flipped classes: where students outside of class hours consume content.
- Tutors, simulations, and intelligent games: Contribute to the personalized learning of students.
- Discussion forums: support different modes of conversation, one of which is the asynchronous method.

None of these technologies are essentially new, and their use or application in the teaching process cannot necessarily affect students. Cope and Kalantzis (2016) analyze the learning paradigm that distinguishes didactic pedagogy from reflexive pedagogy.

The characteristics of didactic pedagogy include:

- The teacher is the one in control of the learning environment.
- There is a focus on cognition, especially a focus on long-term memory.
- There is a unique focus on the individualized student.
- There is an emphasis on how students can replicate disciplinary knowledge.

Features of reflexive pedagogy include:

- There is a shift in control between teacher and student, where the student has considerable scope and responsibility.
- The knowledge activity is dialogic, with a forward and backward movement between teacher and student, students and students, as can be seen in Figure 4.
- The focus is on the artifacts and knowledge representation constructed by the student and their construction processes.
- The focus is on the social sources that contribute to the construction of knowledge.

Figure 4
Roles in reflexive pedagogy
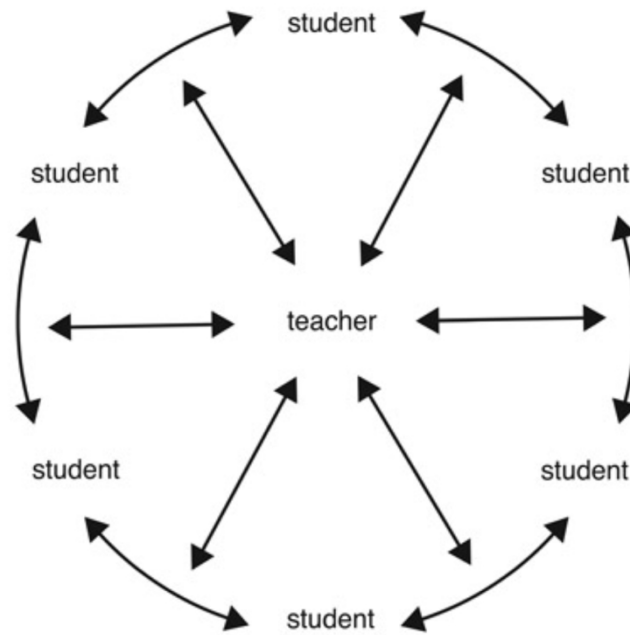
Note. Reflexive pedagogy roles. Adapted from e-Learning Ecologies book, by Cope and Kalantzis (2016, p.10).

What is potentially new and transformative about online learning ecologies? Educational technologies can support the most fundamental changes in the learning process to make the educational experience more engaging for students, effective, resource efficient, and equitable for their own diversity. The seven e-learning affordances of the new learning era created by new digital media are ubiquitous learning, active knowledge creation, multimodal meaning, recursive feedback, collaborative intelligence, metacognition, and differentiated learning.

Figure 5

The 7 E-learning Affordances of reflexive pedagogy
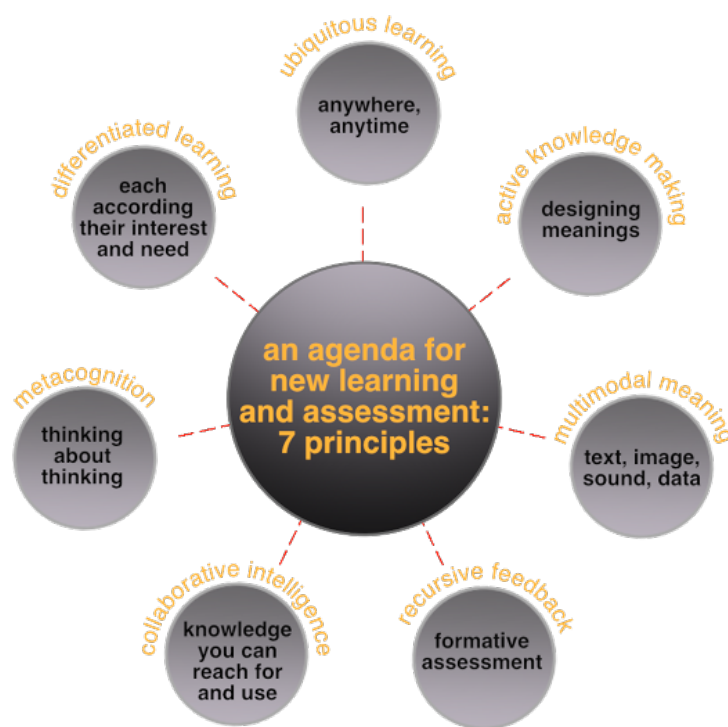
Note. The 7 E-Learning Affordances, by B. Cope and M. Kalantzis (2016).

- E-Learning Affordance 1: ubiquitous learning. This is a form of learning according to demand. ICT allows students to participate in the learning process at the moment, at the time, and at the time in the way they prefer. This type of learning goes over all of the restrictions of the class timetable and the physical limits of the traditional school scenarios and the didactic pedagogies.
- E-Learning Affordance 2: active knowledge making. This corresponds to a method of instruction that involves students in the learning process, requiring them to perform significant learning activities and think reflectively about them.
- E-Learning 3: multimodal meaning. Multimodal refers to multiple modes of communication, such as visual, linguistic, spatial, gestural, and auditory (Silverstone, 2017).
- E-Learning Affordance 4: recursive Feedback. Iterative feedback is where messages return to the author to enable reflection and the creation of new knowledge.
- E-Learning Affordance 5: collaborative Intelligence. Interconnected social networks amplify intelligence, which has a greater impact than individual action.
- E-Learning Affordance 6: metacognition. This is thinking about thinking that generally involves a level of abstraction that will improve learning.
- E-Learning Affordance 7: differentiated Learning. This philosophy values what and who students are before they come into the classroom and works with them to achieve what they need to learn.

In their latest research Kalantzis & Cope (2020) explore the concept of technology as a social construction. They identify that we acknowledge technology as a human invention, and our daily interactions with it often obscure this fact. Technologies transform from inventions to objects that we integrate into our lives, shaping our experiences. This can lead to a sense of technological determinism, where we perceive technology as an independent force driving change. However, their research argues that despite the powerful influence of technology, human agency remains a significant factor in shaping its impact on our lives.

E-Learning Affordance 4: recursive feedback

This research is focused on this affordance and it is important to expand this concept with the reflections of other authors. Jenkins et al. (2009) expose the importance of educating people on how to participate effectively in the participatory culture of media in the 21st century. Jenkins suggests that media education must adapt to changes in technology and society, and must train people to be active and critical producers of media, rather than simply passive consumers. In addition, he highlights the need to promote media literacy and encourage citizen participation in the ever-evolving media culture.

Laurillard (2022) addresses the question of how to use educational technology effectively in university teaching in her book "Digital Technologies and Their Role in Achieving Our Ambitions for Education". The book offers a theoretical and practical framework for educators who wish to integrate technology into their teaching practices. Laurillard explores how technology can be used to enhance teaching and learning, focusing on aspects such as collaboration, feedback and personalization of learning.

The software peerScholar

peerScholar, is a web tool used for peer review created by Steve Joordens, Professor of Psychology at the University of Toronto Scarborough and is the Director of the Advanced Learning Technologies Lab and by Dwayne Pare who is a cognitive psychologist and associate director of the Advanced Learning Technologies Lab at the University of Toronto. Paré, D. & Joordens, S. (2008) first research project on peerScholar was published in the Journal of Computer Assisted learning. This research examined whether peer grading in peerScholar was fair or not. The research acknowledged that undergraduate students might not be as skilled at grading as graduate-level teaching assistants. The grades students received in peerScholar was the averages of six peer grades. In fact, the study found that the average peer grade was just as reliable as a grade from a graduate-level mark. In their work called "peerScholar: Based on evidence, a digital peer assessment tool to promote critical thinking and clear communication: Joordens, Pare & Pruesse (2009), explain that the main objective of universities is to train academics, students who do not only possess information, but also know how to think and communicate their thoughts effectively. While assessing how well knowledge has been acquired is relatively easy, it is much more difficult to promote and assess thinking and communication skills in a pedagogically powerful and logistically manageable way. These challenges are especially evident as class sizes increase, and the all-too-common result is eliminating any form of written homework. Ten years ago, they created peerScholar, a web-based peer assessment tool that enabled them to bring critical thinking and writing skills back to a class that had, by that time, grown to 1,500 students. In 2008, this tool was licensed for distribution by Pearson Education Canada. As part of their research, they showed evidence of how peerScholar is a pedagogically and logistically tool superior to

the traditional practice of having expert-grade essays. They highlighted in their research findings quantitative support that:

(a) peerScholar is effective in promoting enhanced critical thinking skills, even after a single assignment.

(b) grades earned within peerScholar are as fair as those provided by teaching assistants at the graduate level.

(c) when combined with a retest option, the system remains logistically reasonable to implement and gains additional pedagogical and practical merits.

According to this, peerScholar encourages collaboration between students and gives them the opportunity to learn through constructive feedback from their peers. This can help develop critical thinking skills, effective communication, and teamwork. By using peerScholar, educators can foster a learning environment in which students are motivated to actively participate, reflect on their own ideas, and constantly improve through the feedback received.

Method

The methodological design of this investigation was built on what has been found around all the practices of reflexive pedagogy, digital competencies, and peerScholar software. It is important to highlight the specific objectives considered in this research.

Objectives
1. Identify the new digital skills of students after the COVID-19 pandemic.
2. Determine the digital principles of the 21st century is according to reflexive pedagogy.
3. Analyze the direct and indirect relationship between the digital principles of the 21st century and the components of reflexive pedagogy.
4. Analyze the connection between reflexive pedagogy and students' digital competencies.

Authors such as Hernández-Sampieri et al. (2010) point out the differences in research, variables, and effects in research studies. Hence, this work's methodology includes experimental research (quasi-experiment) with a design that includes posttest and intact groups. The variables identified for this quasi-experimental research is:

- Independent variable (controlled and analyzed).
  - peerScholar frequency of use (active).
- Dependent variables (controlled and analyzed).
  - Digital communication competence of students.
  - Digital competence of collaboration of students.
  - Strategies of recursive feedback by teachers.
- Mediators' variables (not controlled, analyzed).
  - Frequency of use of ICT for learning.
- Quantitative variables.
  - Frequency of use of peerScholar.
  - Frequency of use of ICT for learning.
- Qualitative Variables.
  - Recursive feedback strategies.
  - Digital communication competence of students.
  - Digital collaboration competence of the students.

Instruments

Two instruments, a non-participant direct observation and a survey, were used to collect suitable data on the selected population in this scientific and educational investigation. These instruments provide quantitative and qualitative data; although the research is quantitative, this does not invalidate some qualitative data from the different techniques. The indicators in Table 1 were used during the investigator's non-participant observation.

The direct non-participant observation means:

Direct non-participant observation (descriptive, focused, selective), in which the researcher is a passive spectator of the phenomenon studied; His task is to record the information that appears before him. This distancing between the phenomenon and the researcher aims to guarantee a high level of objectivity and veracity of the data. This type of observation is applicable to the periodic activities of social groups, but not to the study of their structure and daily life according to Rodríguez-Gómez et al (1996).

Table 1
Indicators of direct non-participant observation

Indicator	Acceptable	Regular	Deficient	Not Observable
Teacher				
Knowledge of using peerScholar software				
Promoter of recursive feedback strategies				
Student Group				
Knowledge of using peerScholar software				
Communication between peers				
Collaboration in groups / Teamwork				
Application of recursive feedback strategies				
Evidence of the 5 Characteristics of reflexive pedagogy				

The survey

This quasi-experimental research was conducted at an international educational center in the city-state of Singapore on the Asian continent. The focus of this research work was grade 9 students and the digital competencies of its students. The population of this survey was 250 students in grade 9 and the sample used for this research was an intentional selection of 50 grade 9 students whose subjects are history and physics. In the

development of this research, a survey was used that has two sections: an unstructured section with a dichotomous question to collect qualitative data and a structured section for the collection of quantitative data, which will have different types of questions such as:

A. Single answer multiple choice.
B. Likert scale—frequency. The Likert scale is a psychometric research method. It contains a rating range that collects information about the level of agreement or disagreement with a statement.
C. Net Promoter Score (NPS) question. This tool measures end customer satisfaction with a single question that results in a growth indicator for the company, service, or final product.

Table 2
Survey Indicators for Students

Question Type	Indicator	Possible Answers
Dichotomous	Subject	History, Physics
Likert	Frequency of use of ICT for learning	Daily, Weekly, Monthly, Once a semester, Once a year, Never
Likert	Frequency of use of peerScholar software	Daily, Weekly, Monthly, Once a semester, Once a year, Never
Single answer multiple choice	Evidence of the application of recursive feedback strategies	Yes, No, Not Applicable
NPS	Recommendation of using peerScholar	0-10 Scale

Relationship between Reliability and Validity

In this investigation, the following relationship was found to corroborate the reliability indicators and validate the instruments with the following steps.

- Preparation of data collection instruments.
- Instrument content validation process by an expert judgment system.
- Adjustment of data collection instruments, according to the recommendations of experts involved in the validation process.
- Reliability study of the survey for students: Cronbach's alpha coefficient. Cronbach (1951) defines it as a coefficient that serves to measure the reliability of a measurement scale, and whose name is Alpha.
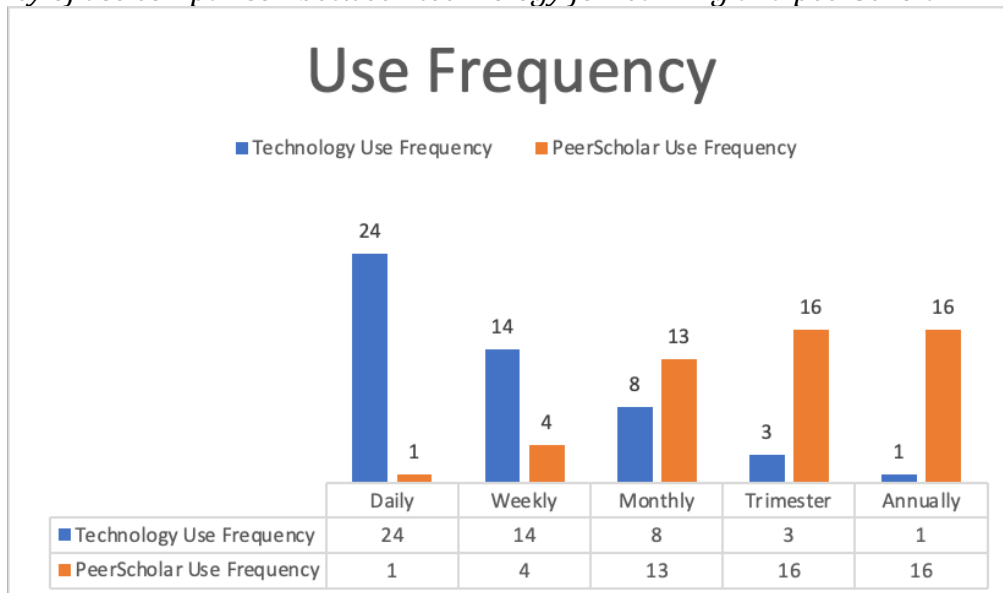
Table 3
Instruments validity and reliability methods

Instruments	Validity	Reliability
Non-participant direct observation sheet	Expert Judgment System	
The Survey	Expert Judgment System	Cronbach's alpha

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Results

The study confirmed that using the software peerScholar impacts the enhancement of digital competencies among students, suggesting that these skills are crucial for contemporary educational settings and future job markets. Questions about the attributes of digital competencies post-pandemic and the evidence of peerScholar's effectiveness in fostering these skills guided the research focus. In Figure 6, the analysis of the results showed a high receptivity to the question about the frequency of using technology for learning, which suggests a strong commitment to using technological resources in the student's educational experience. However, a more discrete reception is observed regarding using peerScholar software to strengthen skills linked to the subjects of history or physics.
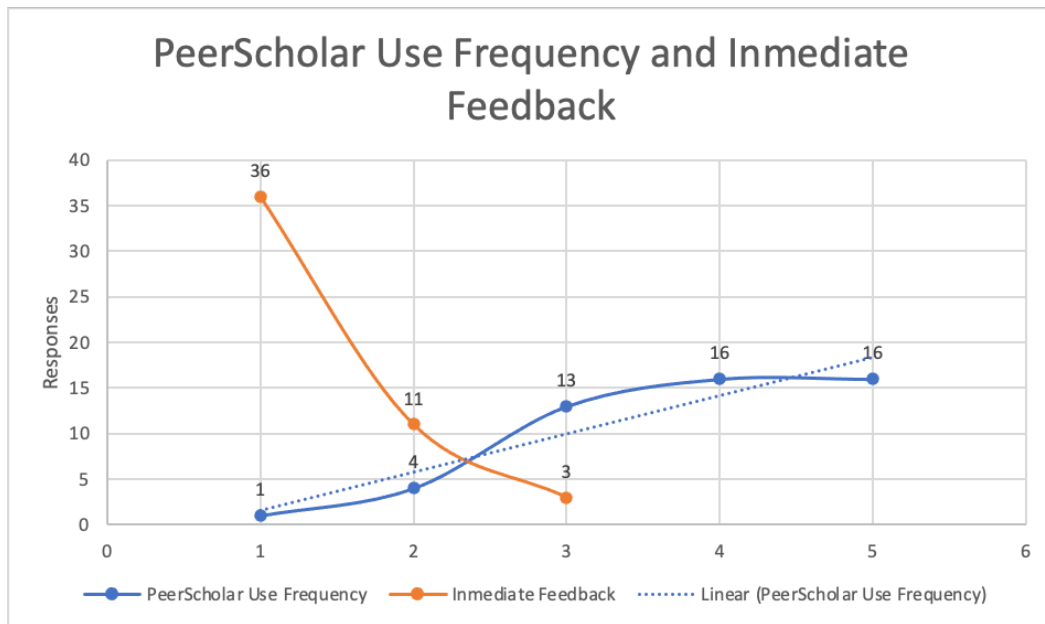
Figure 6
Frequency of use comparison between technology for learning and peerScholar

|	Daily	Weekly	Monthly	Trimester	Annually
Technology Use Frequency	24	14	8	3	1
PeerScholar Use Frequency	1	4	13	16	16

It is important to recognize that various factors could have influenced the use of the software beyond the students' predisposition and class circumstances. For example, changes in teaching methodologies, the availability of alternative educational resources, or even students' perceptions of the usefulness and effectiveness of peerScholar could have influenced this trend. Additionally, individual differences in learning preferences, level of motivation, and familiarity with the technology could also have played a role in the variation in software use.

Figure 7
p*eerScholar frequency of use comparison and Recursive feedback*

In Figure 7, a particular trend can be seen: the blue line, which represents the frequency of use of the peerScholar software, shows an increase as the frequency of use of technology for learning decreases, while the orange line reflects a decrease in relation to the negative perception about the importance of immediate feedback. This pattern suggests that, although using the software peerScholar was infrequent, its usefulness is recognized for receiving timely and relevant feedback to continue building new knowledge. Despite the low frequency of use of peerScholar, students value the software's ability to quickly provide relevant feedback, potentially contributing to improving their digital competencies. This relationship between peerScholar frequency of use and positive perception of immediate feedback highlights the importance of considering not only the number of times a digital tool is used but also the quality of the learning experience it really provides.

Figure 8
Qualitative variable: Recursive Feedback Strategies

|	1	2	3
■ Inmediate Feedback	36	11	3
■ Peer Review	45	4	1
■ Relevant Feedback	35	8	7
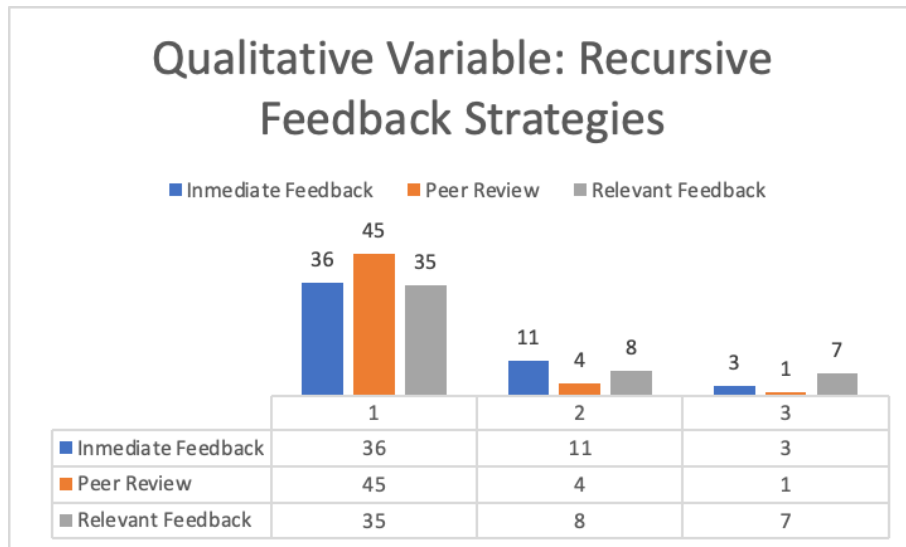
The results of this research are somewhat similar to those obtained by González, Rivadulla & Golías 2022 who carried out an analysis of the emotions triggered by peer evaluation in a group of students. Their work suggests that reflexive pedagogy, combined with concepts such as authentic assessment, benefits from these practices. In the case of this research, it is recognized that peer evaluation is part of a broader process and is not limited to simply being a specific result.

What seems to stand out on both researches, is that these activities generate considerable satisfaction in the participants, provoking positive emotions that contribute to the quality of learning. In addition, they allow for the natural integration of actions, such as the diagnosis of strong aspects and areas for improvement, which otherwise could go unnoticed. This revelation suggests that the implementation of peer assessment not only improves the quality of learning but fosters a culture of reflection and continuous growth in the educational field.

Figure 9

Qualitative variable: Digital Communication and Collaboration competencies
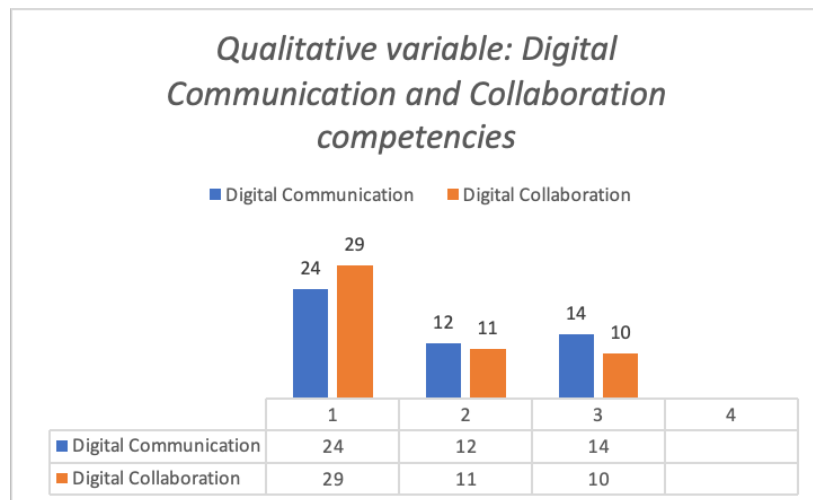
The results seen in Figure 9 corroborate the idea expressed in the conceptual part of this research study, which maintains that the digital skills of communication and collaboration are essential to prepare students for the future, given that more and more jobs will require skills related to technology and innovation. This is evident in the Taxonomy of Education 4.0, which seeks not only to impart theoretical knowledge but also to encourage the development of relevant practical skills and competencies in a constantly changing world.

In addition to the aspects mentioned above, another key element that emerges from the analysis of the collected data is the evaluation of the possible impact of the peerScholar software on acquiring new knowledge. This study also examines how implementing additional teaching and learning strategies, such as rubrics and applying metacognitive strategies, can influence the achievement of the proposed learning objectives. The objective is not only to determine whether the use of peerScholar software promotes learning in general terms, but also to identify the specific mechanisms and conditions that enhance its effectiveness. This deeper understanding will inform more effective, evidence-backed pedagogical practices, as well as provide practical recommendations for the design and implementation of technology-based educational interventions.

Figure 10
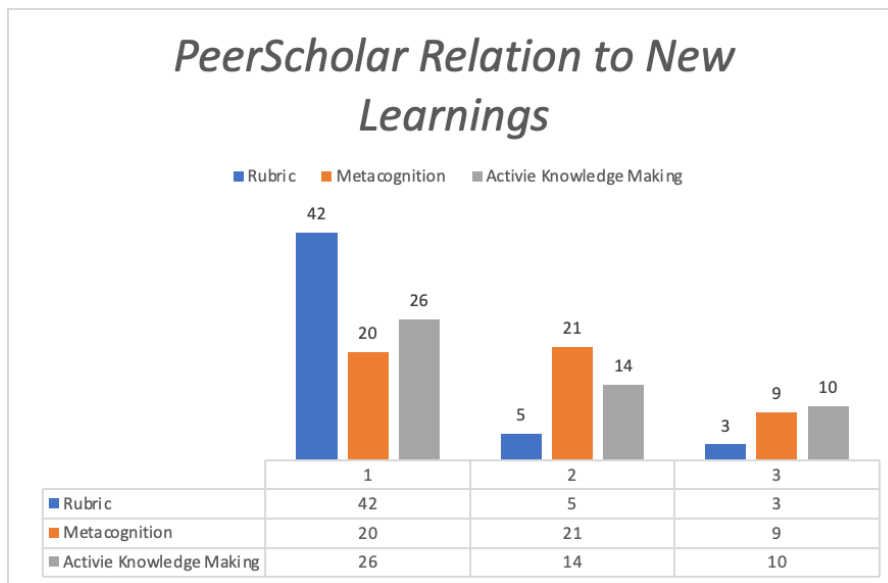*peerScholar Relation to New Learnings*

Figure 10 shows that the software not only promotes the development of new learning experiences among students but also promotes the capacity for self-regulation and metacognition, making it a valuable resource to move towards a more solid reflexive pedagogy. In this educational approach, students assume an active and leading role in their learning experience, ceasing to be passive recipients of information to become committed and autonomous participants. This transformation implies that students memorize concepts and data and deeply understand their usefulness and applicability in different contexts, allowing them to develop critical and creative skills fundamental to their personal and professional development.

Table 5
peerScholar NPS Results

NPS Scale	Detractors	0	1	2	3	4	4	6	Passives	7	8	Promoters	9	10
		1	0	0	2	4	3	7		16	6		10	1

The data provided clearly show that, from a total of 50 students surveyed, different levels of perception towards the use of the peerScholar software were identified. There are more passives than promoters or detractors, indicating a general sense of satisfaction but not a strong loyalty. Most of the scores are between 6 and 9, suggesting that while many respondents are somewhat satisfied, there's room for improvement to shift passives to promoters. The extremes of the scale (0 and 10) are the least populated, with only one respondent each, which suggests a less polarized opinion about the software peerScholar.

The NPS survey results were unsurprising yet good to analyze to identify the following actions. Based on what can be done with the introduction of new software for teaching and learning in a short amount of time, these strategies can be used to continue the analysis of this research:

- Understand the Passives: since this is the largest group, understanding why they are not promoters could provide actionable insights.
- Improve Features for Detractors: identify common issues or reasons for dissatisfaction among detractors.
- Enhance User Experience: based on feedback, see if there are any features or user experience improvements that could be made to shift the NPS score upwards.
- Improve Communication and Support: sometimes, users are unaware of all the features or how to use them.
- Follow-up with Users: periodically re-assess satisfaction levels to see if changes have the intended positive effect.

To synthesize the above, the research reveals several key findings:

- High Receptivity to ICT for Learning: students demonstrated a strong commitment to using technological resources for educational purposes, reflecting a shift towards increased comfort with digital tools post-pandemic.
- Frequency of Use: while the overall usage of peerScholar was lower than expected, the software's value in providing timely and relevant feedback was highly appreciated. This indicates that the quality of the learning experience, rather than the frequency of use, is crucial in enhancing digital competencies.
- Recursive Feedback Strategies: the implementation of recursive feedback through peerScholar was shown to improve students' ability to provide and receive constructive criticism, thereby enhancing their communication and collaboration skills.
- Digital Communication and Collaboration Competencies: the study underscores the importance of these competencies in preparing students for future job markets, aligning with the Taxonomy of Education 4.0, which emphasizes practical skills and adaptability.
- Positive Impact on New Learnings: peerScholar was found to promote self-regulation and metacognition, essential components of reflexive pedagogy, by enabling students to take an active role in their learning process.

Discussion and conclusions

By reflecting on the findings, this research contributes to the broader understanding of how digital tools can be integrated into educational practices to foster an environment conducive to developing necessary digital competencies. The study situates its findings globally, suggesting that such educational innovations can profoundly impact teaching and learning practices worldwide. It also calls for continued exploration of how digital tools and reflexive pedagogy can be aligned to prepare students for the challenges of the digital age.

The study yielded valuable insights into peerScholar's role in cultivating digital competencies among students in a post-pandemic world. While the data suggests a positive correlation between the software's use and the perception of its value in providing immediate feedback, the overall usage rates were lower than anticipated. This highlights the need for further investigation into the factors influencing software adoption. The research findings also emphasize the importance of considering the quality of the user experience alongside the frequency of use.

The Digital Intelligence Standard DQ6.14: "Digital Communication" emphasizes the effectiveness of communicating and collaborating using digital tools and platforms. It

is important to outline the correlation of the findings in this research with DQ6.14. The first correlation evolves around peer review and collaborative learning. Students engaged in providing and receiving feedback on each other's work, fostering communication skills and the ability to articulate ideas constructively in a digital environment. This aligns with DQ6.14 by encouraging students to:

- Communicate effectively online: peer review necessitates clear and concise written communication, ensuring the recipient understands the feedback.
- Collaborate using digital tools: peerScholar serves as a platform for digital collaboration, facilitating the exchange of ideas and feedback within a structured online environment.
- Provide and receive constructive criticism: effective peer review involves offering constructive feedback that is specific, actionable and delivered respectfully. This hones students' communication skills in delivering critical analysis while maintaining a professional tone.

The second correlation talks about understanding the audience and context. Digital communication necessitates personalized messages to the intended audience and considering the context in which they are delivered. Peer review within peerScholar reflects this concept in several ways:

- Adapting communication style: students need to adjust their communication style depending on whether they are providing feedback (informative and instructive) or receiving feedback (open-minded and receptive).
- Considering context: feedback becomes more meaningful when students consider the purpose of the assignment, the learning objectives, and the specific strengths and weaknesses of the work being reviewed. This fosters critical thinking and the ability to tailor communication for maximum impact within a digital learning environment.

The study also provides meaningful understandings and findings that directly speak to the specific objectives of the research. When looking at the specific objective #1 "identify the new digital skills of students after the COVID-19 pandemic" the research doesn't explicitly list entirely new digital competencies. Still, it highlights a shift in emphasis towards an increased comfort with technology for learning as students show a high receptivity to using technology for educational purposes in general, adaptability to online learning environments as the pandemic likely accelerated students' ability to navigate and learn within online platforms an intentional focus on communication and collaboration skills which are essential for functioning effectively in online environments. For the specific objective #2 "determine the digital principles of the 21st century are according to reflexive pedagogy" the study highlights aspects of the reflexive pedagogy that align with 21st-century digital skills like an emphasis on critical thinking and communication as peer review activities encouraged by reflexive pedagogy can foster critical analysis, evaluation, and clear communication, a focus on student reflection and self-assessment as reflexive pedagogy encourages students to reflect on their learning process, which can translate to a more metacognitive approach to using digital tools for learning.

For the specific objective #3 "analyze the direct and indirect relationship between the digital principles of the 21st century and the components of reflexive pedagogy" the direct relation is that peer review, a core component of reflexive pedagogy, directly strengthens digital communication and collaboration skills through online feedback exchange and the indirect relationship is that by reflecting on their own learning and that of their peers, students can develop critical thinking skills applicable to evaluating online information which contributes to information literacy and responsible digital citizenship.

Lastly, the specific objective #4 of this research is to "analyze the connection between reflexive pedagogy and students' digital competencies" where many of the findings in this section have already been outlined. As additional thoughts we can know now that reflexive pedagogy connects to students' digital competencies in several ways:

- Active Learning: reflexive pedagogy encourages students to become active participants in the development of their digital skills by placing them at the center of their learning journey through peer review and reflection.
- Metacognition: the emphasis on reflection fosters a metacognitive approach, where students become aware of their own learning process and how they can leverage technology for optimal learning outcomes.
- Transferable Skills: the critical thinking, communication, and self-evaluation skills honed through reflexive pedagogy are directly transferable to various digital environments and applications.

Limitations

One of the most notable limiting factors in the research process was the lack of commitment of some of the teachers who supported the experience. It was evident that some of them did not commit to asking students to use the software, nor did they include it in the curricular design or in the planning of their class sessions. This lack of interest was reflected in a lack of exploration of the potential and benefits of the software, negatively affecting the implementation and use of the educational tool. This situation is not isolated, since the lack of motivation of teachers to innovate, learn new tools and incorporate useful digital resources for learning is a common problem in many school systems. The studies consulted confirm that this resistance to change and the adoption of new technologies is a recurring obstacle. In this particular case, the apathy of some teachers reinforced this tendency, thus limiting the positive impact that the software could have had on the educational process. However, what could be considered the greatest obstacle to this research was the lack of adequate digital skills of the students. A notable lack of motivation, curiosity and sense of opportunity to take advantage of the benefits of the software was observed. This deficit negatively affected the students' ability to interact effectively with the tool, thus limiting its potential to enhance learning.

Implications for Future Research and Practice

This study confirmed many different wonderings and not-proofed claims about using technologies for teaching and learning. The below reflection points can maximize peerScholar's (or any educational technology software, including AI) impact on digital communication skills for future studies:

- Training and Scaffolding: provide students with training on effective online communication and peer review techniques. Offer initial scaffolding to help students adjust to the platform and classroom expectations.
- Integration with Learning Objectives: ensure peerScholar activities are linked to specific learning objectives and assignments requiring communication and collaboration skills.
- Faculty Involvement: faculty members should actively participate by providing feedback on peer reviews and guiding students toward constructive communication practices.
- Continuous Assessment: periodic re-assessment of students' satisfaction and feedback can help in refining the use of peerScholar and other digital tools to meet educational goals more effectively.

This research student provides compelling evidence that peerScholar positively impacts the development of students' digital competencies. By fostering a reflexive pedagogy environment, the software not only enhances critical thinking and communication skills but also prepares students for the challenges of the digital age. This research underscores the need for continued exploration of digital tools and their alignment with innovative pedagogical practices to create an engaging and effective learning experience for students worldwide.

References

Adobe Systems Incorporated. (2019). Get Hired: The Importance of Creativity and Soft Skills.

Cope, B. & Kalantzis, M. (2015). *The things you do need to know: An Introduction to the Pedagogy of Multiliteracies.*

Cope, B. & Kalantzis, M. (2016). *E-learning ecologies: Principles for New Learning and Assessment.* Routledge.

Cronbach, L. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16(*3), 297-334. https://doi.org/10.1007/bf02310555

DQ Institute (2019). DQ Global Standards Report 2019, Common Framework for Digital Literacy, Skills, Readiness. https://www.dqinstitute.org/wp-content/uploads/2019/03/DQGlobalStandardsReport2019.pdf

DQ Institute (2020). Digital Intelligence (DQ) Competencies. https://live.dqinstitute.org/dq-framework/

Foundation for Young Australians (2017). The New Basics: Big data reveals the skills young people need for the New Work Order.

González, Ó., Rivadulla, J. & Golías , Y. (2022). La coevaluación como metodología complementaria de la evaluación en el Grado de Educación Primaria. In García, J.A. (ed.) (2022). *Contextos universitarios transformadores: a innovación como eixo vertebrador da docencia*. Universidade da Coruña

Hernández-Sampieri, R., Fernández, C. & Baptista, P. (2010). *Metodología de la investigación* (5ª. Ed.). McGraw-Hill Interamericana.

IEEE 3527.1. (2020). IEEE Standard for Digital Intelligence (DQ) – Framework for Digital Literacy, Skills, and Readiness. In *IEEE Standards Association*. https://standards.ieee.org/ieee/3527.1/7589/

Laurillard, D. (2022). *Digital Technologies and their role in achieving our ambitions for education. Leading education and social research.* Institute of Education University of London.

Jenkins, H. et al (2009). *Confronting the Challenges of a Participatory Culture: Media Education for the 21st Century*. MIT Press.

Joordens, S., Paré, D. E. & Pruesse, K. (2009). peerScholar: An Evidence-based online peer assessment tool supporting critical thinking and clear communication. In *Proceedings of the 2009 International Conference on e-Learning* (pp.236–240). Academic Conferences Limited.

Kalantzis, M. & Cope, B. (2020). *The Digital Learner - Towards a Reflexive Pedagogy.*

Paré, D. & Joordens, S. (2008). Peering into large lectures: examining peer and expert mark agreement using peerScholar, an online peer assessment tool. *Journal of Computer Assisted Learning*, *24*(6), 526–540. https://doi.org/10.1111/j.1365-2729.2008.00290.x

Rodríguez-Gómez, G., Gil-Flores, J., & Garcia-Jimenez, E. (1996). *Metodología de la investigación cualitativa.* Editorial Aljibe.

Serrano, A. & Martínez E. (2003). *La Brecha Digital: Mitos y Realidades.* UABC

Silverstone, R. (2007). *Media and morality: On the rise of the mediapolis.* Polity.

World Economic Forum (2022)*. EdTech promised a learning revolution — but didn't deliver.* https://www.weforum.org/agenda/2022/07/edtech-has-not-lived-up-to-its-promises-heres-how-to-turn-that-around/

World Economic Forum. (2023). *Education 4.0. A Taxonomy for the future of Learning.* World Economic Forum. https://www.weforum.org/whitepapers/defining-education-4-0-a-taxonomy-for-the-future-of-learning/