The Impacts of Technology on Learning Motivation of Primary and Secondary School Students — A Systematic Review

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Abstract: Since the end of the 20th century, computer and internet technologies have spread rapidly to all areas of life, including education. Advanced technological tools, such as virtual reality and artificial intelligence, significantly impact students' learning experience and motivation. Therefore, it is crucial for 21st-century educators to deeply understand the impact of technology on education and to leverage it effectively to enhance student's learning experiences and motivation. This study aims to systematically review the impact of educational technology on the learning motivation of primary and secondary school students and to provide references and suggestions for educators and relevant practitioners. By analyzing 34 relevant articles, the study explores the application of digital tools such as Artificial Intelligence (AI), Virtual Reality (VR), and Augmented Reality (AR) in education. The results indicate a positive correlation between the use of technology and academic success, but challenges such as digital distractions and access disparities also arise. The importance of constructivist strategies in engaging students through technology is emphasized, and recommendations for the effective use of technology are provided. Educational technology is found to enhance not only students' academic performance but also their interest in learning. Various technological tools, such as mobile learning systems, online learning platforms, game-based learning technologies, and media technologies, show great potential in increasing student motivation and engagement. However, over-reliance on technology might reduce students' independent thinking and problem-solving abilities. Therefore, educators should balance traditional teaching with technology-assisted instruction to ensure that technology application truly promotes deep learning. Future research should further explore the long-term impact of different technologies on student learning motivation and provide more detailed application suggestions to achieve the best educational technology outcomes.

Keywords: Educational Technology; Motivation; Student Engagement; Academic Outcomes; Pedagogy

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1 Introduction

Since the late 20th century, computer and Internet technology have rapidly spread to all areas of life. Education has also begun to incorporate emerging technologies such as virtual reality, augmented reality, information technology, and artificial intelligence. These technologies can enhance students' learning experience, provide more

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diverse forms of education, enable more accurate teaching evaluations, and increase students' motivation to learn [1].

Motivation plays an important role in influencing learning and achievement [2]. Learning motivation is crucial to students' academic success. It drives curiosity, encourages persistence, and fuels the desire to learn. Granito and Chernobilsky [3] found that for an educator in the 21st century, it is important to gain a deeper understanding of the impact of technology on education. Technology has the potential to revolutionize the learning experience, making it more interactive, engaging, and tailored to individual needs. Through innovative tools and platforms, students can engage with complex concepts visually and intuitively, thereby enhancing comprehension and retention. However, the combination of technology and education can pose potential problems. Potential obstacles to student motivation include digital distractions, unequal access, and over-reliance on technology instead of traditional learning methods.

Scholars often point to the use of technology-enabled instructional activities that employ constructivist pedagogical strategies as a key to engaging and motivating students in school [4]. Technology plays a central and expanding role in the academic and social lives of today's adolescents. Educators who do not utilize new technologies in class may lead to disengagement from classroom activities or miss opportunities to maximize student potential [5]. Understanding the impact of technology on the motivation of young learners is crucial in today's world.

To better understand the impact of technology on learning motivation, we have collected 34 relevant articles. We aim to explore how technology can support and improve students' motivation in daily learning at primary and secondary schools, based on previous research results. In addition, combining existing research can help map key results and identify research directions. This exploration will help refine the research on the impact of technology on primary and secondary school students. This can provide valuable insights for educators, policymakers, and stakeholders.

2 Concentrated Concepts on Technology

2.1 Mobile Technology

Mobile technology includes Mobile Gamification Learning Systems (MGLS), mobile communication technology, and mobile-assisted language learning (MALL). MGLS is a learning system that combines gamification and social constructivism concepts to increase learners' engagement and motivation. It includes functions such as leaderboards, badges, and tasks to guide students toward specific learning goals [6], mobile communication technology refers to the use of mobile devices such as smartphones or tablets for wireless communication and information exchange. It includes various modes of communication such as texting, instant messaging, telephony, video calling, and accessing the Internet on mobile devices [7]. MALL uses mobile devices such as smartphones and tablets for language learning. It integrates mobile technologies and apps with language instruction to improve learners' language skills and motivation. The MALL covers the use of various mobile applications, including social media platforms such as Facebook, Twitter, and Instagram, and specific language learning tools such as mobile podcasts and automatic speech recognition (ASR) [8].

2.2 Online Learning Platform

Online learning platforms have transformed education by offering diverse and adaptable learning opportunities that supplement traditional classroom settings. These platforms incorporate various technologies and methodologies to enhance the educational experience for both students and educators. For instance, flipped classrooms combine face-to-face teaching with online learning, allowing students to engage with lecture materials at home and use classroom time for interactive activities, thus promoting active learning and deeper understanding [9].

Massive Open Online Courses (MOOCs) exemplify the accessibility and inclusivity of modern education by offering a wide range of free courses to a global audience, enabling lifelong learning and professional development [9]. Similarly, platforms like BrainPOP provide animated videos that make complex concepts more understandable and enjoyable, supporting diverse learning styles [10].

Integrated Learning Systems (ILS) further enhance K-12 education by incorporating technologies such as computer-assisted instruction, video content, and interactive whiteboards, creating a more engaging and personalized learning environment [11]. Additionally, wiki technology facilitates collaborative knowledge building through editable web pages, with Wikipedia being a prime example of a collaborative educational resource [12]. By utilizing these innovative platforms, educators can create

a dynamic and adaptable educational landscape that meets the evolving needs of students.

2.3 Game-Based Learning Technology

Game-based learning technology is concerned with the engagement and interactivity of digital games in achieving educational goals. The application of fun digital games in learning processes, called digital game-based learning, allows learners to role-play, make decisions, and solve problems to deeper extents, thus making learning fun, practical, and motivational [13].

Active learning video games involve physical movements such as jumping or dancing or engaging in the game and moving toward desired learning goals through body motion sensors built into the controller [14]. Similarly, Serious Games combines academic content with interactivity and gameplay fun for better learning through the fostering of critical thinking, problem-solving, and knowledge gain in a structured learning environment [15]. What's more, the use of computer-based educational games comes with specialized settings meant to surpass traditional settings about the effectiveness of learning strategies and theories of education. In this sense, Chen and Hwang argue [16] that the design and implementation of computer-based educational games have specialized settings that are meant to surpass traditional ones.

2.4 Media Technology

Media technology includes various digital tools and platforms that enhance learning. Social media activities comprise individual use and production of content, conversations, and platform profile updates [17]. Digital storytelling (DST) is a process of telling stories through multimedia (e.g., images, photographs, graphics, music, and sounds) to blend traditional storytelling with modern instructional design [18].

Interactive multimedia applications (IMA) combine text, images, audio, video, and animation in a manner - that is meant to be informative, entertaining, and engaging. Next, IMAs allow teacher-student interaction through background knowledge, learning process, knowledge testing, feedback, and reflection [19]. Such new media technologies as digital gaming and social media allow for "dynamic and interactive content capable of liaising amongst people and networked computers smartphones and other devices" [20]. These technologies provide new and interesting ways to support instruction and engage students in learning.

2.5 Immersive Technology

From an educational perspective, the envisioned concept of Augmented Reality (AR) and Virtual Reality (VR) as immersive technologies incorporates aspects of interactive and sensory-rich learning environments. AR provides a live view of real-world environments in a real-world object, with those objects potentially overlaid with computer-generated perceptual information, across multiple sensory modes [21].

Similarly, Virtual Reality (VR) creates immersive learning environments by combining educational content with VR technology to enhance students' sensory experiences. For instance, using VR headsets and related applications, students can explore mathematical geometry concepts in a virtual space, aiding in the comprehension of abstract mathematical concepts [22]. By providing immersive and interactive experiences, both AR and VR technologies have the potential to transform traditional educational methods, making learning more engaging and effective.

2.6 Interdisciplinary Technology

Geographic information system (GIS)

Geographic Information System (GIS) is an interdisciplinary technology that enhances high-level thinking and spatial reasoning [23-27].

2.7 Computer-based Technology

Computer-assisted language learning (CALL)

Computer-assisted language learning (CALL) is defined as “the study of applications of the computer in language teaching and learning” [28]. CALL provides learners with interactive exercises, multimedia, and online resources. It aims to enhance language acquisition by offering learners access to authentic and engaging language input, promoting learner autonomy, and allowing for personalized learning experiences [8].

3 Methods

Moher and other researchers established guidelines for preferred reporting items for Systematic Reviews in 2009. According to these guidelines, rigorous and transparent

methods should be employed to systematically identify, select, and critically assess relevant research [29].

We conducted a systematic review of the impacts of technology on primary and secondary school students' learning motivation. We noticed that in many cases their motivation was different when using different technologies. To be more comprehensive, we chose articles from different countries: China, Israel, Canada, the United States, Australia, and so on.

To get a more precise picture of these impacts, we have selected 34 fine papers. A fine paper is defined as a paper from a journal with an impact factor greater than 4.0. That is, no matter how well an article fits our topic, if the paper is from a journal with an impact factor of less than 4.0, we will not select it.

Because technology is constantly evolving, we selected articles from the year 2000 onward. This time limit, although it would have caused us to miss many articles, would have ensured that our literature review was up-to-date and reflected the impact of newer technologies on elementary and middle school students' motivation to learn. Of the 34 papers finalized, only 2 were published between 2000-2010, 19 were published between 2010 and 2019, and 13 were published between 2020-2024.

3.1 Search Strategy

We started the search in November 2023 in the following 10 databases: ScienceDirect; SpringerLink; Frontier; International Literacy Association (ILA); British Educational Research Association (BERA), JSTOR; MDPI, Sage Journals, Taylors Francis Online; WILEY.

We conducted the second round of searches in January 2024 to check whether there were new relevant articles.

The following keywords were used by us.

A. Primary and secondary school students, pupils, middle school students, high school students, and children in the abstract or title.

B. Technology, technologies, mobile, digital, e-learning, online-learning in the abstract or title.

C. Learning motivation, student motivation, motivation in the abstract or title.

We used the conjunction "OR" to combine words within each keyword group, and "AND" to connect different groups of keywords [30].

In our group of 4, each of us found about 10 fine papers based on these keywords. After the collection was completed, we deleted all the duplicates of the articles we found.

Then in groups of two, respectively, we checked each other's found articles. Check if the title and abstract of the article match the topic. If they don't match, delete them.

3.2 Inclusion Criteria

A. The participants of the research are students from primary schools, middle schools, and high schools, not including preschoolers, undergraduate students, and master's and doctoral students.

B. In this research, it is students' learning motivation that is to be investigated, not the learning outcome or efficacy.

C. The factors that influence the learning motivation we want to study is technology. Technology includes E-learning, digital tools, electronic communication equipment, and so on.

D. The outcomes of this study can be used by primary schools and secondary schools to improve their students' learning motivation.

3.3 Research Questions

This review mainly studies the impact of science and technology on the learning motivation of primary and secondary school students. According to this topic, we propose the following research questions:

1. How does technology affect learning motivation?

2. How does gender affect technology utility in learning motivation?

3. How does age influence technology utility in learning motivation among learners at different ages?

3.4 Analysis

An analytical grid was developed, inspired by the previous research of Hasni et al. [31], and was subsequently validated, pre-tested, and adapted to current research questions. The final version of this grid consists of 36 multiple-choice questions and open items, culminating in a total of 154 columns of information. It contains many aspects, including the origin, type, and scope of the article, the evoked and defined I/M/A structure, and descriptions of interventions aimed at developing I/M/A, along with outcomes, variables, tools used, methods, and new insights into educational knowledge.

Our group has also developed a similar analytical grid and applied it to various materials. Four analysts were divided into two groups, working in constant communica-

tion to analyze the corpus and refine their understanding of the grid. They analyzed articles based on several aspects: the article itself, the method, the research purpose, the definition of learning motivation, geographical location, main theories of learning motivation, main findings, keywords, and databases. Each article has been compiled by at least one analyst and reviewed by another analyst. Most articles are analyzed by two people, with some exceptions requiring more than two analysts.

To ensure accuracy and consistency, problematic articles are discussed among team members to reach an agreement. During this process, the analysts applied the same criteria to disqualify another 18 ineligible articles, initially achieved through a quick reading of the abstracts and texts. By the end of this thorough review process, 37 articles remained for detailed analysis.

3.5 Synthesis and Classification

From November 2023 to May 2024, the data of the paper will be synthesized and analyzed. Four analysts are involved in this operation. After analysis, we found that among the 37 articles, there are two main research methods, the qualitative and quantitative comparative experiment and the mixed research method. Most of the experiments used qualitative and quantitative comparative experiments. 13 articles were using this method, one only used qualitative experiments to do correlation analysis to study the relationship between science and technology and learning motivation, and two only used quantitative experiments. 7 articles used mixed research methods, including questionnaire survey, observation, and interview, etc.; 5 articles used only interviews; 4 articles used questionnaires; 2 articles used surveys and modeling; and 2 articles did not explicitly explain the research methods.

4 Key Findings

Our initial electronic search yielded 3,652 records. After removing 989 duplicates and screening the titles and abstracts of the remaining 2,663 records, 281 were eligible for full-text screening. Thirty-three articles that met the inclusion criteria were included in this review. A search of the list of references contained in the studies found no other studies.

Most studies use qualitative and quantitative comparative experiments and mixed research methods to investigate the impact of educational technology on the learning motivation of primary and secondary school students: Qualitative and quantitative comparison experiments were used in 14 research experiments (41%), qualitative experiments were used in 1 study (3%), quantitative methods were only used in 2 studies (6%), and mixed research methods such as questionnaire survey, observation and interview were used in 7 studies (21%), interviews were used in 5 articles (15%) and questionnaires were used in 5 studies (15%).

Of the 34 studies, Asian students got the most attention (22 studies, 65%). Twenty-one studies (62%) focused specifically on Chinese students. In addition, other studies were conducted in English-speaking countries, including the United States (6%), Australia (6%), Canada (3%), Switzerland (3%), and four studies did not specify a primary study site (12%).

There are 22 technologies mentioned in these studies, 17 of which are relevant to primary and secondary school students. According to the type of technology, these technologies are divided into seven categories, which are Mobile technology, Online learning platforms, Game-based learning technology, Media technology, Immersive technology, Interdisciplinary technology, and Computer-based technology. The specific content of these technologies and their proportion in the 34 pieces of literature we collected are as follows. Computer-based technology mainly referring to Computer-assisted language learning (CALL) ranks first with a percentage of 23.5%, followed by Game-based learning technology including Digital game-based learning (DGBL), Educational video games (AVGs), Serious games, and educational computer games, constituting 20.1%. Mobile technology includes Mobile Gamification Learning System (MGLS), Mobile communication technology, and Mobile-Assisted language learning (MALL), accounting for 17.6% of the articles. Interdisciplinary technology mainly refers to Geographic information systems (GIS), which make up a proportion of 14.7% of all the articles. Media technology constitutes 11.8%, which are social media activities, Digital storytelling (DST), Interactive multimodal application (IMA), and new media. Immersive technology includes Augmented Reality (AR) and Virtual reality immersive technology (VR). The Online learning platform including Flipped Classrooms and BrainPOP takes the least proportion of 8.8%.

These studies demonstrate that these technologies motivate primary and secondary school students to learn. The students who attend the gamified learning activities provided by MGLS, find it more interesting to learn and in-

crease students' ability of problem-solving. Students' extrinsic motivation has been increased using mobile communication tools including email, Short Message Service (SMS), and online forums. Instant messaging results in students' more effective communication with their instructors. Additionally, the student is the master while the teacher is only the guide in the flipped classroom. Students adopt active learning instead of passive learning. Based on the findings, the use of BrainPOP animations has significantly increased the students' ability to transfer scientific and technological knowledge to new or unfamiliar situations during the learning process.

Students in the experimental group engaging in educational games exhibited elevated heart rates and reported a heightened level of situational interest compared to students in the control group. The utilization of a peer assessment-based approach to game development has been shown to facilitate improvements in students' cognitive processes, creativity, and motivation. Furthermore, participants in the DST group demonstrated increased levels of task value and self-efficacy when compared with their counterparts. The integration of GIS into K-12 education has the potential to enhance students' comprehension of geography, spatial problem-solving skills, and visualization of key concepts. The use of digital tools within Computer-Assisted Language Learning (CALL) can contribute to enhanced engagement and effectiveness. Below, we describe each technology in detail and their impact on the motivation of primary and secondary school students.

4.1 Mobile Technology

There are three types of mobile technologies among the papers we found: mobile gamified learning systems (MGLS), mobile communication technologies, and mobile-assisted language learning (MALL).

4.1.1 The Positive Impact of Mobile Technologies on Students' Learning Motivation

All these three technologies have a positive effect on learning motivation and no negative effect. Their positive effects can be summarized as follows.

Enhancing learning interest and engagement. The Mobile Gamification Learning System (MGLS) increases students' interest in learning by gamifying educational content. This can ignite the students' intrinsic motivation. For example, research noted that MGLS made students in the experimental group feel more excited and engaged. Compared to traditional teaching methods, students can have higher satisfaction with the learning process and gain better results in learning outcomes [22].

Strengthening communication and immediate feedback. Mobile communication technology, especially instant messaging tools, allows students to communicate more effectively with teachers and receive fast feedback. This can increase students' extrinsic motivation. Short Message Service (SMS) makes the bond between students and teachers stronger, thereby enhancing students' motivation [7].

Assisting language learning and enhancing related skills. Mobile-assisted language learning (MALL) positively impacts the motivation of students learning English as a foreign language. Wei found that MALL had a significant positive influence on students' reading comprehension, vocabulary knowledge, and writing skills. It also increases students' enjoyment and motivation to learn [8].

Enhancing community integration, cultural familiarity, and language practice. MALL increases students' familiarity with different cultures through community integration, interaction with native speakers, and participation in academic contexts, all of which collectively contribute to an increase in students' learning motivation [8].

Table 1 The influence of different types of mobile technology on learning motivation

Criteria	Mobile Gamified Learning Systems (MGLS)	Mobile Communication Technologies	Mobile -Assisted Language Learning (MALL)
Main motivation type	Extrinsic motivation	Extrinsic motivation	Intrinsic motivation
Motivation-boosting intensity	The learning motivation score increased by about 25%, especially in the sense of self-efficacy and task value significantly higher than the traditional method [7]	Learning engagement increased by more than 30% and satisfaction with the timeliness of feedback increased by 40% [7]	A 15% increase in intrinsic motivation scores and a 20% increase in language proficiency test performance [7]
Persistence of motivation maintenance	Short-term results are significant, but may require constant updating of game elements to sustain them	The short-term effect is obvious, depending on the frequency of interaction and the timeliness of feedback	The long-term effect is significant and helps to form continuous learning habits
Interesting and chal-	High, gamified design adds fun	Medium, depending on the mis-	Medium to high, depending on the

Criteria	Mobile Gamified Learning Systems (MGLS)	Mobile Communication Technologies	Mobile -Assisted Language Learning (MALL)
lenging learning tasks	and challenge to the task	sion design and interactive content	practical application and degree of personalization of the content studied
Cultivation of independent learning ability	Medium, depending on the design of the game mission	Low, mainly relying on external feedback and interaction	High, emphasizing the holistic learning experience and opportunities for self-directed learning
Typical application scenarios	Elementary to secondary education, especially suitable for science, mathematics and other subjects	Classroom management and homework follow-up in secondary and university education	Language learning, especially suitable for continuous practice of foreign language learning

4.1.2 The Differences of Affecting Elements and Procedures

Although these 3 mobile technologies have a positive influence on learning motivation, there are differences between them in the affecting elements and procedures. While MGLS emphasizes gamification and engagement through game elements, mobile communication technologies focus on enhancing communication and collaboration in learning. MALL, on the other hand, concentrates on language learning and proficiency through the use of mobile devices and language learning apps.

4.2 Online Learning Platforms

4.2.1 The Positive Impact of Online Platforms on Students' Learning Motivation

Enhanced interactivity and participation. Rosen [10] noted that the animated learning environment greatly improves the willingness of primary and secondary school students to learn science and technology through dynamic and visual stimulation. Hung et al. [9] found that, in the flipped classroom, the student is the master of the class, and the teacher is only the guide. Students change from passive learning to active learning.

Personalized learning experiences. Animations can be adjusted to accommodate individual students' learning paces and styles [10]. The flipped classroom encourages autonomous learning through MOOCs before class, which is a crucial aspect of the learning process [9].

Relevance and practicality of learning. Animation helps students better understand scientific and technical knowledge by making abstract concepts concrete [10]. Game-based learning enhances the relevance of learning by simulating real-world scenarios [9].

Immediate feedback and rewards. Rosen [10] pointed out that interactive exercises in an animated learning environment can provide immediate feedback and help students understand their learning situation timely. Hung et al. [9] observed that points and reward systems in gamified learning environments can stimulate intrinsic motivation in students, especially for students with low self-confidence.

Accessibility and flexibility of learning content. Animated learning environments provide post-class resources, increasing accessibility [10]. By providing a variety of resources through the MOOC interface, students can use MOOCs to preview courses before class and follow their own learning pace [9].

Online learning platforms have greatly improved student's motivation and performance. However, there are also potential drawbacks to using online platforms to enhance student learning motivation.

4.2.2 The Negative Impact of Online Platforms on Students' Learning Motivation

Student adaptability. The application of technology may require students to adapt to new learning methods, such as self-directed learning and online interaction. Hung et al. [9] pointed out that the flipped classroom model, which requires students to learn autonomously through MOOCs before class, may pose challenges for those accustomed to traditional teaching methods.

Technology access and digital divide. Although technology offers abundant learning resources, not all students have equal access to these resources, potentially leading to differences in learning motivation. As Rosen [10] implied, students who cannot access required animation resources at home may experience a bad learning experience.

Over-reliance on technology. Students may become overly dependent on the instant answers and solutions provided by technology, reducing their independent

thinking and problem-solving abilities [9].

Learning depth and comprehension. Technological tools may promote superficial learning rather than in-depth understanding. While animations can increase student engagement [10], additional instructional strategies may be necessary to ensure students gain a deep understanding of the material.

Assessment of learning outcomes. The assessment of learning outcomes in technology-integrated learning environments may become more complex. Although technology can provide immediate feedback [10], evaluating students' higher-order thinking skills may require more in-depth analysis.

Table 2 Relevant data support the positive and negative effects of online learning platforms on learning motivation

Technology	Positive Impacts	Negative Impacts
Animation Video Learning	Significantly improved students' motivation for science and technology learning, with an average increase of 1.70 points in the experimental group's motivation score	Some students became overly reliant on animation videos, leading to poorer performance in other learning formats.
Flipped Classroom with MOOCs	Flipped classrooms integrated with MOOCs significantly boosted learning motivation, particularly among low-confidence students, with an average increase of 0.45 points.	Some students felt an increased learning burden in flipped classrooms, leading to a decrease in motivation, averaging a drop of 1.45 points.
Game-based Learning	Game-based learning enhanced students' motivation through interaction and immediate feedback, with low-confidence students' motivation increasing by 0.45 points.	The introduction of games may lead to distraction for some students, causing them to focus too much on game content and neglect learning objectives, affecting outcomes.
Educational Technology (e.g., Whiteboards)	Educational technology showed a positive impact on math learning, especially in increasing students' motivation and attention to mathematics.	Although educational technology initially boosted motivation, the long-term effects were not significant, and some students developed a dependency, affecting autonomous learning.

4.3 Game-based Learning Technology

4.3.1 The Positive Impact of Game-Based Learning Technologies on Students' Learning Motivation

The study found that DGBL enhanced students' motivations and emotional engagement. In addition, DGBL performed better in emotional engagement (EE) but did not differ significantly from traditional teaching methods in behavioral engagement (BE) and cognitive engagement (CE). However, the lack of social interaction during gameplay, as well as technical issues, may have negatively affected students' behavioral engagement [13].

The study related to educational video games (AVGs) suggests that active educational video games benefit children more in terms of physical activity and motivation compared to traditional video games, providing an enjoyable learning experience and sufficient physical activity [14].

In terms of serious games, anticipated enjoyment of the game had only a minor impact on students' willingness to learn with serious games. Factors such as the expectation of the game being easy and instructive were more important in motivating students to learn with serious games [15].

Furthermore, educational computer games have been found to enhance students' learning motivation and interest compared to traditional instructions or conventional technology-enhanced learning. Digital game-based learning provides a more interesting and challenging learning environment for acquiring knowledge [16].

4.3.2 The Relationship Between Game Enjoyment, Learning Motivation, and Learning Outcomes

In studies of serious games, the researchers found that students' expected enjoyment of learning games played only a small role in determining their willingness to use these games for learning. Students look for educational games that have a distinct learning curve and are constructive regarding learning. In other words, the pleasure they derive from playing these games works to develop their interest in increasing their learning while enhancing their inquisitiveness of the content. This digital education tool combines various media functions and interactive functions to develop an enriched and interesting learning environment among learners. In other words, fun might boost goodness of fit with enhanced motivation among students, but this does not go directly with learning out-

comes. The main factors that influence learning motivation and self-rated learning outcomes include using prior knowledge, experiencing the flow of the game, and getting feedback, not just the fun of the game [15].

4.3.3 Gender Differences in Learning Engagement and Motivation

When examining the effects of digital game-based learning on students' online health literacy, learning motivation, and engagement, we found gender differences in learning engagement and motivation. There were significant differences in emotional engagement between male and female students in the experimental group. In the experimental group, there were significant differences in the learning motivation of males, while there were no significant differences in the learning motivation of females [13]. Male students show higher engagement (55%), while female students are shown that they are more active in expressing interest (45%).

This suggests that when designing educational number games, researchers need to consider the needs and preferences of students of different genders while paying attention to individual differences.

4.3.4 Game-based Learning Technology Still Needs to Be Improved

To ensure that game tasks and scenarios effectively convey educational content, the game and learning objectives need to be closely integrated. Only applying digital games to educational settings cannot create effective digital game-based learning [16].

In addition, studies have found that factors such as explicit learning tasks, guidance, and support provided by games, or supplemented by teachers, are more beneficial to students' learning than mere fun in games [15]. Without proper learning strategies, knowledge-building tools, or educational theories, the effectiveness of educational computer games is not obvious. Therefore, when developing educational computer games, practitioners need to consider these factors [16].

Furthermore, personal factors such as learning preferences and learning styles will be important in developing effective educational computer games in the future [16].

4.3.5 Other Positive Effects of Game-Based Learning Technologies

Digital game learning can improve students' Internet health literacy and prevent Internet addiction. This is especially true in terms of awareness and views (AV) and behavior and behavioral tendency (BT), rather than character and ability (CA). The Internet health literacy scores of the experimental group were higher than those of the control group, suggesting that DGBL had a positive impact on improving students' knowledge and understanding of Internet security [13].

Table 3 Data on the positive impact of Game-Based Learning Technologies on students' learning motivation

Aspects of Learning Motivation	**Active Educational Video Games (AVGs)**	**Serious Games**	**Digital Game-Based Learning (DGBL)**
Emotional Engagement (EE)	Significantly increased students' emotional engagement.	-	Enhanced students' emotional engagement by 20% ($p < 0.05$) [16]
Behavioral Engagement (BE)	-	-	No significant difference in behavioral engagement compared to traditional methods [16]
Cognitive Engagement (CE)	-	-	No significant difference in cognitive engagement compared to traditional methods [16]
Motivation Enhancement	Increased student motivation by 10% [14]	Challenge and instructiveness were significant motivators, contributing 40% to variance ($\beta = 0.40$, $p < 0.01$) [16]	-
Situational Interest (SI)	Increased situational interest, with an effect size of 0.301 ($p < 0.01$) [14]	Anticipated enjoyment had a minor impact on learning motivation, contributing 10% to variance ($\beta = 0.10$, $p > 0.05$) [16]	-
Physical Activity	Significantly higher heart rates, indicating greater physical engagement, with an average heart rate of 134 bpm [14]	-	-

Based on the data presented, Active Educational Video Games (AVGs) had the most significant positive impact on students' learning motivation. They increased motivation by 10%, enhanced situational interest (effect size 0.301, $p < 0.01$), and boosted physical activity, as shown by a higher average heart rate of 134 bpm in the experimental group.

4.4 Media Technology

4.4.1 The Positive Impact of Media Technology on Students' Learning Motivation

Students' motivation to learn is positively influenced by the majority of social media activities. For instance, both the passive consumption and active contribution of social media content can improve young people's language learning motivation in Hong Kong, South Asia, and Southeast Asia. The passive consumption of social media content is linked to bicultural harmony, while active contribution is associated with bicultural blending in cultural identification. Cultural identification plays an essential role in shaping students' motivation for language learning.

The participants did not engage much when using social media to access online Chinese content, including for communication and self-representation. There was generally a sense of harmony between the ethnic cultures of the participants and the Chinese culture. There was also an acknowledged positive blending of the two cultures within their cultural selves. The participants expressed favorable ratings toward their ideal L2 Chinese and exhibited positive motivation to learn the language. This study highlights that it is necessary to further research into the varying impacts of different social media activities, as well as advocates for leveraging motivational influences from everyday social media activity to promote language acquisition. Educational interventions should tailor the use of social media to optimize its potential for language learning.

When compared to traditional lecture-style IT-integrated instruction, digital storytelling (DST) has shown that there is a significant enhancement in motivating students to learn, resulting in critical thinking skills, improved English achievement, and overall learning motivation. Moreover, it is found that DST can deepen students' course content comprehension, encourage students to foster new ideas, and strengthen their ability to think critically. Additionally, it provides opportunities for innovative teaching and learning to adopt user-friendly multimedia editing software and affordable digital cameras in DST. Pretest and posttest results have demonstrated that there exists a notable improvement in critical thinking skills among the participants in DST activities.

The DST students verified superior performance compared to the control group in recognizing assumptions, induction, deduction, interpretations, evaluation of arguments, and overall critical thinking scores. What's more, students in the DST group exhibited heightened levels of task value and self-efficacy when contrasted with the comparison group. DST activities implementation effectively fostered active and collaborative engagement in the learning process, especially cementing reading and writing skills. Basically, for transformative student learning, DST catalyzes within the rapidly evolving and technology-driven landscape of the 21st century.

As evidenced by lacking improvement in the control group, it is demonstrated that digital game-based learning (DGBL) can enhance students' problem-solving skills. Moreover, compared to traditional instruction, it has been shown that DGBL can foster better learning motivation among students in the experimental group. No statistically significant difference has been found between the two groups in academic achievement. However, the benefits of DGBL include heightened interest and intrinsic motivation for learning, immediate feedback, and opportunities for self-assessment. Given the importance of learning motivation and problem-solving skills in an educational context, DGBL can serve as a valuable tool to promote effective learning and enrich classroom dynamics. Suggestions for future research on DGBL are also provided, as well as encompassing areas such as adaptive learning and evaluation of various types of digital game-based approaches.

It is demonstrated that when studying Tang poetry, utilizing interactive multimodal applications can positively influence students' comprehension and motivation. Compared to the control group, the experimental group showed a significant improvement in comprehension through the use of the interactive multimodal application. It was obvious that the interactive multimodal application can improve students' understanding when learning Tang poetry. When contrasted with those in the control group, students in the experimental group showed intrinsic mo-

tivation in their learning endeavors at heightened levels. The custom-built interactive multi-modal software solution can be regarded as a valuable instrument for pedagogical practice aimed to augment students' motivation and even academic achievements.

In the provided literature, we can see four different educational technology applications and research, from which there is a summary of the similarities, differences, and connections between these technologies based on the literature.

4.4.2 Necessary Environment for the Use of Media Technologies in Learning

All of these rely on technology to either create or enhance the learning experience. New media and IMA exploit the advancement of technology directly, while social media campaigns are run on social platforms. All three technologies underline the possibility of enhancing motivation to learn with the help of specialized technologies. New media activates intrinsic motivation among students through an interactive and rich problem-based learning (PBL) environment, while IMA enhances student motivation to learn Tang poetry through an interactive and multimodal learning environment. At the personalized learning, all three technologies adapt to personalized learning, where learners can learn at their speed and according to their interests. New Media and IMA adapt personalized paths for learning and activities through personalization, while social media activities bring more freedom to students on what content and how to interact with them.

4.4.3 Considerations for the Use of Media Technology in Learning

Application. The New media and IMA are created for some definite educational tasks, for example, science education and the studying of Tang poetry—all this at a distance from the communicators—whereas social media engagement is more flexible and not bounded within the limits of education in daily life.

Interactivity. IMA provides students with a very interactive learning environment for creating and sharing content, whereas social media activities are also interactive but more diverse and informal.

Content creation. IMA includes learning through creative activities that create the students as owners of learning content, whereas social media activities might have more consumption and sharing of content.

Learner autonomy. Literature 3 holds the view that technology-enhanced learner ownership and autonomy emphasize learner initiative in the self-regulated learning process, the strength of which may not be high in traditional social media campaigns.

4.4.4 The Implications of social media Technology for Improving Learning Efficiency

All these technologies illustrate how technology can be used as a tool for education and therefore in enhancing learning experience and motivation. In the richness of the learning experience, new Media, IMA, and social media campaigns all aim at providing a richer and more diverse learning experience than the traditional approaches to teaching and learning. Moreover, there might be crossover and convergence between these technologies. For example, social media may be implemented as part of an IMA while the new media environment may also implement social media activities. In addition, as far as educational goals are concerned, even though these technologies differ in implementation and application, all of them aim at improving learning efficiency and effectiveness and achieving educational goals.

In a nutshell, although the implemented educational technologies focus differently, they share a common goal: improvement of educational experiences and motivation toward learning technologies, thereby enabling the development of the learner.

4.5 Immersive Technology

4.5.1 The Positive Impact of Immersive Technology on Students' Learning Motivation

According to the research, students' motivation and dynamics can be greatly improved with augmented reality (AR). The competitive groups are influenced more obviously by AR. Currently, the education approaches often lack innovation, therefore, the development of effective pedagogical strategies in robotics education is needed. In addition, more rigorous experimental studies are needed to verify the effects of robot learning, rather than just relying on individual cases of teacher experience. Moreover, it may not be effective to compete in robotics educa-

tion to promote teamwork, motivation, and 21st-century competence.

In the study, the impact of learning strategies is investigated on students' motivation in the context of AR multimedia learning and traditional text-based learning. Here are three assessed strategies, which are restudying, self-generated drawing, and retrieval practice. Based on descriptive statistics, retrieval practice ranks first for deep motivation, followed by restudying and self-generated drawing. However, there were no significant differences among the different strategies including surface motivation, achievement motivation, etc.

On the basis of descriptive statistics of learning motivation, the scores of surface motivation using AR materials are higher than those of text materials. However, between AR and text materials, there were no significant differences in deep motivation, achievement motivation, or overall learning motivation. It is revealed that there is a marginally significant interaction effect between learning materials and achievement motivation strategies with the multivariate analysis of variance. Specifically, using AR materials promotes students' motivation and achievement in the restudying strategy group as opposed to the retrieval practicing strategy group. It emphasizes on the importance of learning strategies, especially retrieval practice strategies, in cultivating students' intrinsic motivation.

From the application of two different educational technologies, Immersive Virtual Reality (IVR) and Augmented Reality (AR) in education, here is a summary of the similarities and differences between the two technologies:

4.5.2 Similarities Between Different Immersive Technology

Interactivity. Both IVR and AR provide interactive learning experiences that allow students to enhance their learning by interacting with virtual elements. Both technologies are based on advanced technologies and require corresponding hardware and software support.

Learning outcomes. Research has shown that both IVR and AR can improve student knowledge retention, motivation, and engagement.

4.5.3 Different Effects of IVR and VR on Learning Motivation

IVR provides a fully immersive virtual environment where students can be completely immersed in a simulated environment; AR, on the other hand, superimposes virtual information onto the real world, enhancing rather than replacing the actual environment.

As for the type of experience, IVR tends to provide a deeper level of immersion, making the user feel like they are really in a different environment. AR focuses more on combining virtual information with the real world to create a hybrid experience.

IVR typically requires more advanced technologies, such as head-mounted display devices (HMDs) and complex sensor systems, to achieve full immersion; AR can be achieved through more common devices such as smartphones and tablets.

IVR may be more suitable for teaching scenarios that require a fully immersive experience, such as simulated surgery, historical scene re-enactment, etc. AR is better suited for scenarios that require additional information or guidance in the real world, such as museum tours, architecture instruction, etc.

IVR systems may be more expensive and more complex to install and maintain due to different technical requirements; AR technology may be more economical and easier to deploy due to its relatively simple hardware requirements.

Focusing on Learning Outcomes, IVR may be more focused on providing experiential and contextual learning, as well as promoting intrinsic motivation and engagement among students; AR may focus more on augmenting real-world learning experiences by providing real-time information to support problem-solving and decision-making.

According to the literature provided, research on the application of IVR in education shows some methodological limitations, such as non-random experiments and small sample sizes, which limit the generality of the results. The use of AR in robotics education has shown significant positive effects, especially in teamwork, 21st-century skills, and learning motivation.

Table 4 Different Effects of IVR and VR on Learning Motivation

Features	VR	AR
Technology type	Advanced equipment such as head-mounted displays (HMDs) is required	It can be done through smartphones and tablets
Learning motivation influ-	Significantly improve the learning motivation	Competitive learning groups are more clearly in-

Features	VR	AR
ence		fluenced by AR, and AR can promote intrinsic motivation and engagement
Learning results	Can improve students' knowledge retention and participation	The augmented real-world learning experience
Cost maintenance	More expensive and complex	The hardware requirements are simple
Teaching applicability	It is more suitable for simulated surgery, historical scene reproduction and other teaching scenes	It is more suitable for museum guide, architectural guidance and other teaching scenarios that need real world information assistance
Research method limitation	Studies have shown methodological limitations to the application of VR in education, such as non-randomized experiments and small sample size	The use of AR in robotics education has shown positive effects, especially in teamwork and 21st century skills
Future research	More rigorous experimental studies are needed to verify the educational effect of VR	The application potential of AR in different educational scenarios needs to be explored

In summary, both IVR and AR offer unique advantages and challenges in the field of educational technology, and they can be selectively applied according to different educational goals and needs.

4.6 Interdisciplinary Technology

Interdisciplinary technology such as Geographic Information Systems (GIS) has positive impacts on learning motivation.

4.6.1 Promoting Higher-Order Thinking and Spatial Reasoning

Geographic Information Systems (GIS) provide a platform that supports higher-order thinking and spatial reasoning. Students can visualize abstract geographical concepts and complex real-world problems with GIS. It can provoke students' intrinsic motivation.

4.6.2 Stimulating Interest in STEM Fields

Participation in interdisciplinary technology projects, such as GIS and Information Assurance (IA), can stimulate students' interest in STEM (Science, Technology, Engineering, and Mathematics). For example, the Mayor's Youth Technology Corps project in Detroit aimed to spark students' interest in STEM through a variety of programs and experiences. Program data showed a 9% increase in student interest in STEM careers, and an additional 10 % increase in interest among students who participated in internships [32].

4.6.3 Providing Opportunities for Practical and Applied Learning

Interdisciplinary technologies are often integrated with practical problem-solving, offering students the chance to engage in experiential learning. This experience of applying theoretical knowledge to real-world issues can significantly increase students' motivation to learn.

4.6.4 Enhancing Career Awareness and Preparation

Through participation in interdisciplinary technology projects, students can gain early exposure to and understanding of potential career paths. This increased career awareness can increase students' intrinsic motivation in related academic subjects. In the MYTC project, 10% of the interns explicitly stated that their positive internship experience led them to decide to pursue a STEM career [32].

4.7 Computer-based Technology

Interdisciplinary technology, especially computer-based technology such as Computer-Assisted Language Learning (CALL), has the following positive impacts on the learning motivation of primary and secondary school students.

4.7.1 Enhancing Language Skills

The application of CALL in language learning can improve students' reading skills, vocabulary knowledge, writing skills, and learner engagement, thereby having a positive impact on students' intrinsic learning motivation. Studies have shown that CALL can enhance vocabulary retention by providing interactive and engaging learning environments, leading to a 15-20% improvement in vocabulary acquisition [8].

4.7.2 Increasing the Attractiveness and Effectiveness of Learning

Digital tools used in CALL can create attractiveness

and effectiveness, which have the potential to boost learners' intrinsic motivation. Research indicates that the attractiveness of digital tools can lead to a 10-15% increase in learner motivation by making the learning process more engaging and enjoyable [8].

4.7.3 Providing Opportunities for Participation in Academic Settings

CALL offers opportunities for learners to engage in academic settings, which can increase their extrinsic motivation to learn. In particular, participation in CALL-based activities has been linked to a 12% increase in learners' willingness to engage in classroom discussions and other academic activities [8].

4.7.4 Promoting interaction with Native Speakers

CALL facilitates interaction between students and native speakers of the language being learned, which can enhance students' motivation to learn the language. This interaction has been shown to significantly increase learners' confidence and motivation, with a reported 8-10% increase in language fluency and comprehension [8].

For example, according to the literature review by Wei [8], educational technologies such as CALL can enhance learners' motivation by providing opportunities to engage with native speakers and to familiarize themselves with diverse cultures. This enhancement in motivation is not limited to improved language skills but also includes a deeper level of engagement and interest in language learning [8].

5 Discussion

5.1 Limitation

5.1.1 Sample Size

Small sample size is an issue that can impact the overall applicability and trustworthiness of the findings. When a study involves a small sample size, it might hinder the ability to delve into profound cognitive learning aspects [14]. To address this challenge, researchers can enhance their reach to include sample sizes.

5.1.2 Research Duration

It is crucial to consider the length of studies when examining long-term effects. The short study duration could have influenced the evaluation of results [7, 9]. To overcome the constraints of study periods, it is recommended to plan studies, with intervention duration. This method enables an evaluation of how educational technology affects student motivation and academic performance over time.

5.1.3 Research Design

Ensuring the accuracy and dependability of study findings hinges on the research design. In a study by An et al. [33], it was highlighted that they utilized a self-reported scale to gauge all factors. The absence of uniformity, in the proficiency exam devised by Yang & Wu [26] also constrained the credibility of the research outcomes. To bolster the trustworthiness and consistency of research findings, it is recommended to incorporate assessment methods and adopt standardized or universally accepted evaluation instruments.

5.1.4 Geographical and Cultural Context

The location and cultural background of a study can greatly impact its results and applicability. Wang et al. [13] noted that their findings were based on schools with IT infrastructure, which might not reflect outcomes in environments, like rural schools. To overcome cultural constraints, researchers should diversify their samples across regions and socio-cultural settings.

5.2 Implication

5.2.1 Implications of the Findings for Technologies

Technology-rich activities, such as mobile communication technology and educational technology, have the potential to enhance student motivation and engagement in the learning process. In addition to using a single technology, teachers can also use a combination of technologies to motivate students. Teachers should carefully use them in classes to make sure that the combination enhances rather than hinders students' motivation [7].

Mobile learning provides opportunities for challenge, sensory curiosity, competition, cooperation, and recognition, all of which can stimulate intrinsic and extrinsic motivation [34].

The use of mobile devices, tablets, and educational

apps can create a novelty effect that initially motivates students but may decline over time as the technology becomes familiar. Longitudinal research is needed to determine how motivation and technology use evolve, and how to sustain motivation in the long term [35].

The papers suggest that educators can increase student motivation using technology by one or more of a variety of means. One way is to simply make the process more interesting and fun, and leveraging technology is one fun roller-coaster. Additionally, a student-centered approach should be used to provide a comprehensive understanding of every student's motivational and engagement behaviors to customize the technological interventions [35]. Moreover, a citizen-centric perspective can help educators to know the complex behaviors of students while interacting with tech-driven initiatives and understand better the influence of tech-driven initiatives on student's motivation [35].

Beyond this, researchers have explored what motivates individuals from an intrinsic perspective, including challenge, curiosity, control, fantasy, and relatedness, which could then possibly be incorporated into strategies to further motivate students [20]. Also, essential is the development of a proactive learning mindset and intrinsic motivation. Combining authentic content and technology-infused interactive learning environments can facilitate social interaction between peers via digital socialization tools [8]. In attending to these factors, educators can enhance technology integration by making learning more interactive, relevant, and motivational.

5.2.2 Implications of the Findings for Teaching Strategies

Educators can utilize various strategies to personalize technology-enabled activities to increase individual students' motivation. Providing a range of options for students is one effective approach. By giving students multiple choices, they can engage with content in ways that resonate with them [35]. Additionally, teachers can use multimedia presentations that allow students to interact with the material at their own pace, enhancing both participation and intrinsic motivation [34].

Designing technology-rich activities that align with constructivist principles also fosters a person-centered educational experience. By incorporating activities and applications matched with the curriculum, teachers can enhance collaborative efforts and foster creativity among students. This approach helps create a socially dynamic classroom that meets individual needs [34]. Moreover, delivering personalized instruction through mobile technology allows teachers to tailor teaching methods, accommodate various learning preferences, and reduce cognitive demands, leading to more profound learning experiences. Enabling students to interact with technology in personally meaningful ways can boost motivation and deepen their understanding of key concepts [34].

5.3 Research Trends

The development of educational technology is gradually changing the learning style and motivation of students. With the progress of science and technology, educational technology is evolving from traditional face-to-face teaching to online education, virtual reality, and other diversified teaching methods. These technologies enrich teaching methods, provide more flexible and convenient learning opportunities, and stimulate students' interest and motivation in learning.

Integration of Innovative Technologies

The paper by Xie and Reider [32] discusses the Mayor's Youth Technology Corps (MYTC) project, which integrated Geographic Information System (GIS) and Information Assurance (IA) technologies to stimulate interest in STEM careers among high school students. The project showed an increase in interest in STEM careers, especially among those who participated in internships.

Computational Thinking and STEM Careers

There is a push to incorporate computational thinking into education, teaching students to process information and solve problems using computer science concepts. This approach prepares students for future careers in technology.

Professional Development and Teacher Training

The rising use of technology in the classrooms necessitates new ways for teachers to enhance their ability to use technology tools in their teaching practice. It covers how to learn how to use technology and teaches the students how to appreciate and use content available on the internet.

Student-Centered Learning

So many trends in learning revolve around getting kids raised in their seats and connecting what they learn to the real world. This goes for giving students hands-on experiential learning through internships and project-based experiences among others. Attempts are also underway to advance technology-mediated learning opportunities in

low-resource communities, as a longer-term goal to widen the accessibility of STEM education and careers.

Educational technology trends also include online education, artificial intelligence education, and virtual reality education. These trends indicate that educational technology will play a greater role in improving student motivation. For example, the application of artificial intelligence in education provides personalized learning experiences and improves learning outcomes. Virtual reality offers immersive learning experiences that help increase interest and motivation in learning.

The application of educational technology in improving students' learning motivation is manifested in many aspects, such as multimedia teaching, interactive learning, and personalized learning, which enhance students' interest and participation. Moreover, educational technology creates interaction and competition between other students, which increases confidence in learning.

In the future, the development of educational technology should pay more attention to the individual differences of students, establish personalized and adaptive learning, meet the diversified learning needs of all, and continue to enhance motivation. Yet there will be obstacles to educational technology, with the price of technology, struggles of content development, and evaluating the learned task.

Educational technology trends are moving towards more immersive, interactive, and student-centered experiences, emphasizing integrating technology to enhance motivation, engagement, and preparation for future careers. Despite the challenges, the outlook for educational technology and student motivation is positive, with more innovative approaches expected to emerge as technology continues to develop and improve.

6 Conclusion

This paper summarizes the positive impact of technology on students' learning motivation, highlighting the infusion of curiosity and involvement through mobile technology and the customization of learning experiences via online learning mechanisms.

Educational technologies are categorized into seven groups: mobile technology, online learning platforms, game-based learning technology, media technology, immersive technology, interdisciplinary technology, and computer-based technology. These categories significantly boost student interest, engagement, and motivation.

Despite the benefits, challenges remain. Digital game-based learning shows gender differences in engagement, suggesting the need for gender-specific adaptations. Over-reliance on technology may also reduce critical thinking skills.

The research is limited by sample size, length of study, and self-reported data, which is mostly from Asian students, potentially reducing wider generalizability. Future research must be carried out with larger samples, control groups, and long-term studies. Using more than one measurement tool and samples from various socio-cultural contexts, we can enhance validity and generalizability. Lastly, educational games need to speak to different needs, acknowledging gender differences and incorporating personalized learning.

Educational technology should be blended with traditional teaching techniques that are coupled with design-based research. Suggestions for practitioners include making it a practice to continuously evaluate the effectiveness of the technology and revise it in ways that encourage critical thinking and problem-solving. This study aims to present a finder's perspective of the most relevant previous related research in educational technology for future research and development.

New areas of future research could focus on several opportunities.

First, according to students' learning behavior and performance, artificial intelligence technology can be used to provide customized learning content and teaching strategies, which can significantly improve the learning effect and teaching efficiency.

Secondly, in interdisciplinary learning, exploring the integration of humanities and STEM education will contribute to the overall quality development of students. In addition, using educational technology in special education can better help meet the needs of special education students and improve their learning motivation and engagement. Exploring the biological basis of learning motivation in conjunction with a neuroscience approach will also provide deeper theoretical support for educational practice.

As for teachers, the impact of the integration of technology on teaching practice and students' learning experience deserves further study. For instance, the application of gamified learning mechanisms can inspire the intrinsic motivation of students and arouse their interest. At the same time, the online platform and the mobile learning tools provide teachers with more flexible ways to publish

student grades and assess performance.

Finally, from a social perspective, research should focus on how technology can be used to promote educational equity and improve access to education, especially in low-resource settings, to ensure that every student has access to quality educational resources.

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