

TRANSFORMATIVE STANDARDS FOR STUDENTS IN THE DIGITAL AGE: A ROADMAP FOR LEARNING WITH TECHNOLOGY

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Abstract

Standards outline the skills and competencies that students should develop to become proficient and responsible users of technology. These standards address competencies in educational technology, just as they do in all areas of education. Standards provide a roadmap for instruction and define the ultimate goal in terms of student performance. This study reviewed the Educational Technology standards as provided by the ISTE (International Society for Technology in Education) for the students in the digital age. The ISTE Standards for Students have evolved to address the changing needs and advancements in technology and education. The initial version of the ISTE standards for students, called the National Educational Technology Standards (NETS) for Students, was introduced in 1998. These standards focused on foundational technology skills and concepts, emphasizing the use of technology as a tool for learning and education. In 2007, the ISTE standards underwent a significant update. The revised version expanded its focus beyond basic technology skills to emphasize higher-order thinking, creativity, problem-solving, and digital citizenship. The ISTE Standards for Students were introduced in 2016, replacing the previous NETS for Students. These standards provided a framework for empowering students to become active learners, collaborators, creators, and responsible digital citizens. They emphasized the development of critical thinking, communication, and collaboration skills in a technology-rich environment.

Keywords

Educational Technology, Standards, Digital Citizen, Knowledge Constructor, Computational Thinker.

Introduction

The ISTE (International Society for Technology in Education) standards for students guide effective integration of educational technology into teaching and learning. These standards outline the skills and competencies that students should develop to become proficient and responsible users of technology (Chang, 2022). The ISTE standards provide a roadmap for

educators to effectively integrate educational technology into the classroom. They emphasize using technology as a tool to support student-centred learning, foster critical thinking, promote creativity, and develop digital citizenship. By aligning their practices with the ISTE standards, educators can ensure that students develop the skills necessary to thrive in a technology-rich world (International Society for Technology in Education, 2023).

According to Brooks-Young (2017), the ISTE Standards are a framework for students, educators, administrators, coaches, and computer science educators to rethink education and create innovative and engaging learning environments. The standards are helping educators and education leaders worldwide re-engineer schools and classrooms for digital age learning, no matter where they are on the journey to effective technology integration in education (Liu, 2021).

The ISTE Standards for Students have evolved to address the changing needs and advancements in technology and education. The initial version of the ISTE standards for students, called the National Educational Technology Standards (NETS) for Students, was introduced in 1998. According to Moore (2016), these standards focused on foundational technology skills and concepts, emphasizing the use of technology as a tool for learning and education. In 2007, the ISTE standards underwent a significant update. The revised version expanded the focus beyond basic technology skills and emphasized higher-order thinking, creativity, problem-solving, and digital citizenship (International Society for Technology in Education, 2007). The ISTE Standards for Students were introduced in 2016, replacing the previous NETS for Students. These standards provided a framework for empowering students to become active learners, collaborators, creators, and responsible digital citizens. They emphasized the development of critical thinking, communication, and collaboration skills in a technology-rich environment (International Society for Technology in Education, 2017).

The ISTE Standards for Students outline the digital age skills and knowledge students need to succeed in an increasingly technology-driven world. They emphasize creativity, critical thinking, collaboration, communication, and responsible digital citizenship (Dondlinger, McLeod, & Vasinda, 2016). The ISTE standards for students were first published in 1998 and later revised in 2007 to produce the second version. In 2016, ISTE published the latest version of the standard. The ISTE standards for students evolved from LEARNING TO USE

TECHNOLOGY in 1998 through USING TECHNOLOGY TO LEARN in 2007 to TRANSFORMING LEARNING WITH TECHNOLOGY in 2016 (Fuller, 2020).

ISTE Standards for Students – the first version

The foremost standards of the ISTE for students focus primarily on learning to use technology. The technology foundation standards for students are divided into six broad categories. Standards within each category are to be introduced, reinforced, and mastered by students. These categories provide a framework for linking performance indicators, standards, and profiles as guidelines for planning technology-based activities in which students achieve success in learning, communication, and life skills.

Technology Foundation Standards for Students

1. Basic operations and concepts

- Students demonstrate a sound understanding of the nature and operation of technology systems.
- Students are proficient in the use of technology.

2. Social, ethical, and human issues

- Students understand the ethical, cultural, and societal issues related to technology.
- Students practice responsible use of technology systems, information, and software.
- Students develop positive attitudes toward technology use that support lifelong learning, collaboration, personal pursuits, and productivity.

3. Technology productivity tools

- Students use technology tools to enhance learning, increase productivity, and promote creativity.
- Students use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.

4. Technology communications tools

- Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.

- Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.

5. Technology research tools

- Students use technology to locate, evaluate, and collect information from a variety of sources.
- Students use technology tools to process data and report results.
- Students evaluate and select new information resources and technological innovations based on their appropriateness for specific tasks.

6. Technology problem-solving and decision-making tools

- Students use technology resources for solving problems and making informed decisions.
- Students employ technology in the development of strategies for solving concerns in the real world.

ISTE Standards for Students - the second version

The second version of the ISTE standards for students was published in 2007 to emphasize learning with technology. The full description of the standard is as follows:

1. Creativity and innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.

- a. Apply existing knowledge to generate new ideas, products, or processes
- b. Create original works as a means of personal or group expression
- c. Use models and simulations to explore complex systems and issues
- d. Identify trends and forecast possibilities

2. Communication and collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.

- a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media
- b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats
- c. Develop cultural understanding and global awareness by engaging with learners of other cultures
- d. Contribute to project teams

3. Research and information fluency

Students apply digital tools to gather, evaluate, and use information.

- a. Plan strategies to guide inquiry
- b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media
- c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks
- d. Process data and report results

4. Critical thinking, problem solving, and decision making

Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.

- a. Identify and define authentic problems and significant questions for investigation
- b. Plan and manage activities to develop a solution or complete a project
- c. Collect and analyze data to identify solutions and/or make informed decisions
- d. Use multiple processes and diverse perspectives to explore alternative solutions

5. Digital citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behaviour.

- a. Advocate and practice safe, legal, and responsible use of information and technology

- b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity
- c. Demonstrate personal responsibility for lifelong learning
- d. Exhibit leadership for digital citizenship

6. Technology operations and concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations.

- a. Understand and use technology systems
- b. Select and use applications effectively and productively
- c. Troubleshoot systems and applications
- d. Transfer current knowledge to learning new technologies

ISTE Standards for Students - the third version

The 2016 ISTE Standards for Students emphasize the skills and qualities we want for students, enabling them to engage and thrive in a connected, digital world. The standards are designed for use by educators across the curriculum, with every age student, with a goal of cultivating these skills throughout a student's academic career. Both students and teachers will be responsible for achieving foundational technology skills to fully apply the standards. The reward, however, will be educators who skillfully mentor and inspire students to amplify learning with technology and challenge them to be agents of their learning.

1. Empowered Learner

Students leverage technology to take an active role in choosing, achieving, and demonstrating competency in their learning goals, informed by the learning sciences. Students:

- a. Articulate and set personal learning goals, develop strategies leveraging technology to achieve them, and reflect on the learning process itself to improve learning outcomes.
- b. Build networks and customize their learning environments in ways that support the learning process.
- c. Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.

- d. Understand the fundamental concepts of technology operations, demonstrate the ability to decide, use, and troubleshoot current technologies, and transfer their knowledge to explore emerging technologies.

2. Digital Citizen

Students recognize the rights, responsibilities, and opportunities of living, learning, and working in an interconnected digital world, and they act and model in ways that are safe, legal, and ethical. Students:

- a. Cultivate and manage their digital identity and reputation, and are aware of the permanence of their actions in the digital world.
- b. engage in positive, safe, legal, and ethical behaviour when using technology, including social interactions online or when using networked devices.
- c. demonstrate an understanding of and respect for the rights and obligations of using and sharing intellectual property.
- d. manage their data to maintain digital privacy and security, and are aware of data-collection technology used to track their navigation online.

3. Knowledge Constructor

Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts, and make meaningful learning experiences for themselves and others. Students:

- a. Plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits.
- b. Evaluate the accuracy, perspective, credibility, and relevance of information, media, data, or other resources.
- c. curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions.
- d. Build knowledge by actively exploring real-world issues and problems, developing ideas and theories, and pursuing answers and solutions.

4. Innovative Designer

Students use a variety of technologies within a design process to identify and solve problems by creating new, useful, or imaginative solutions. Students:

- a. know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts, or solving authentic problems.
- b. Select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.
- c. Develop, test, and refine prototypes as part of a cyclical design process.
- d. exhibit a tolerance for ambiguity, perseverance, and the capacity to work with open-ended problems.

5. Computational Thinker

Students develop and employ strategies for understanding and solving issues in ways that leverage the power of technological methods to develop and test solutions. Students:

- a. Formulate issue definitions suited for technology-assisted methods such as data analysis, abstract models, and algorithmic thinking in exploring and finding solutions.
- b. Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
- c. Break issues into parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.
- d. Understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.

6. Creative Communicator

Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats, and digital media appropriate to their goals. Students:

- a. Choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication.
- b. create original works or responsibly repurpose or remix digital resources into new creations.

- c. Communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models, or simulations.
- d. publish or present content that customizes the message and medium for their intended audiences.

7. Global Collaborator

Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally. Students:

- a. Use digital tools to connect with learners from a variety of backgrounds and cultures, engaging with them in ways that broaden mutual understanding and learning.
- b. Use collaborative technologies to work with others, including peers, experts or community members, to examine issues and problems from multiple viewpoints.
- c. Contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal.
- d. Explore local and global issues and use collaborative technologies to work with others to investigate solutions.

Implications of the ISTE standards for the digital age student

The ISTE standards for digital age students have several implications for education and learners. These standards provide a framework for integrating technology effectively into the learning process and preparing students to thrive in a technology-rich world (Ayad, & Ajrami, 2017). Here are some implications of the ISTE standards for digital age students:

1. **Technology Integration:** The ISTE standards emphasize the integration of technology into all areas of education, promoting the use of digital tools and resources to enhance learning experiences. According to Aqel (2021), this implies that students should have access to technology and be encouraged to use it to develop critical thinking, creativity, collaboration, and communication skills.
2. **Digital Citizenship:** The standards highlight the importance of responsible and ethical use of technology. Digital age students need to understand issues like online safety, privacy, copyright, and proper behaviour in digital environments. These standards encourage students to become responsible digital citizens who can navigate and contribute positively to the digital world. The ISTE standards promote ethical and

responsible use of technology. Students are encouraged to understand the rights and responsibilities of digital citizenship, such as respecting privacy, practicing online safety, and engaging in positive online behaviour. They should be aware of the potential risks and challenges associated with technology and develop strategies to address them (Prottzman, 2022).

3. **Information Literacy:** With the abundance of information available online, it is crucial for students to develop skills to find, evaluate, and use information effectively. The ISTE standards emphasize the development of information literacy skills, including the ability to critically analyze information, discern reliable sources, and ethically use and cite digital content.
4. **Research and information fluency:** In the digital age, the ability to find, evaluate, and use information effectively is crucial. The ISTE standards emphasize teaching students research skills, including conducting effective online searches, critically evaluating sources, and citing information appropriately. Students need to develop information fluency to navigate the vast amount of information available online.
5. **Digital literacy and fluency:** The ISTE standards emphasize the development of digital literacy skills, which include understanding how to use technology effectively, evaluating online resources, and practicing responsible digital citizenship. Students need to be fluent in using digital tools and platforms to navigate, create, and communicate in various contexts.
6. **Collaboration and Communication:** The digital age requires students to be adept at collaborating and communicating using technology. The standards emphasize the use of digital tools for effective collaboration, such as online discussion forums, shared documents, video conferencing, and social media. Students should learn to work collaboratively, both in person and virtually, to solve problems, share ideas, and create meaningful work. The ISTE standards highlight the importance of collaboration and effective communication in a digital environment. Students should learn to use technology tools to work collaboratively, share ideas, and communicate with others across different platforms. These skills are crucial for success in today's interconnected world.

7. Creativity and Innovation: The ISTE standards encourage students to think creatively and embrace innovation using technology. Students should be provided with opportunities to explore and experiment with digital tools, allowing them to express their ideas, solve problems, and create original works. The standards highlight the importance of fostering an environment that nurtures imagination and supports students' creative endeavours.
8. Critical Thinking and Problem-Solving: In the digital age, students need to develop critical thinking and problem-solving skills to navigate complex issues and make informed decisions. The ISTE standards emphasize the integration of technology to enhance these skills, enabling students to analyze information, evaluate different perspectives, and apply knowledge to real-world problems. The standards promote critical thinking and problem-solving skills by encouraging students to use technology to analyze information, make informed decisions, and solve complex problems. Digital age students should be able to think critically, evaluate different perspectives, and apply creative solutions using technology.
9. Adaptability and Lifelong Learning: The digital landscape is constantly evolving, and students need to be adaptable and lifelong learners. The ISTE standards encourage students to be flexible and open to new technologies, ensuring they can adapt to changes and continue learning beyond their formal education. Technology is constantly evolving, and the ISTE standards recognize the need for students to be adaptable and lifelong learners. Students should develop a growth mindset, be willing to explore new technologies, and adapt to changes in digital tools and platforms. They need to develop skills that will allow them to continue learning and adapting throughout their lives.
10. Computational thinker and Innovative designer: Computational thinking involves analyzing problems and designing solutions using logic and algorithms. Educational technology offers coding platforms, robotics, and simulations that allow students to practice computational thinking skills. Students develop an understanding of how technology systems work and learn to apply computational thinking in various domains. The ISTE standards encourage students to use technology creatively to design and develop solutions to real-world issues. Through educational technology,

students can engage in project-based learning, coding, and digital storytelling. They learn to think critically, collaborate with peers, and use technology tools to bring their ideas to life.

Implications for the 21st-century curriculum

The ISTE (International Society for Technology in Education) standards for students align with the goals of a 21st-century curriculum, which aims to prepare students for the demands and challenges of the modern world. The ISTE standards provide guidance for integrating technology effectively into teaching and learning, fostering critical thinking, collaboration, creativity, and digital literacy (Smith & Mader, 2017). Here's how the ISTE standards connect with a 21st-century curriculum:

1. Core subjects and 21st-century themes: The ISTE standards complement the traditional core subjects, such as maths, science, language arts, and social studies, by infusing them with 21st-century themes. These themes include global awareness, financial literacy, health literacy, environmental literacy, and civic literacy. Technology integration through the ISTE standards can enhance students' understanding of these themes and help them develop the skills needed to address global challenges (Aslam, Khan & Ahmed, 2020).
2. Learning and innovation skills: A 21st-century curriculum emphasizes the development of critical thinking, communication, collaboration, and creativity. The ISTE standards align with these skills by encouraging students to use technology tools to solve problems, think critically, communicate effectively, and engage in innovative thinking. Technology integration supports active and inquiry-based learning, enabling students to develop these essential skills (Gomez, Trespalacios, Hsu & Yang, 2022).
3. Information, media, and technology skills: In the digital age, students must be proficient in accessing, evaluating, and using information effectively. The ISTE standards emphasize the development of information literacy, media literacy, and technology skills. Students learn to evaluate online sources, ethically use and cite information, and understand the impact of media messages. These skills are essential for responsible digital citizenship and lifelong learning (Bajabaa, 2017).

4. Life and career skills: A 21st-century curriculum seeks to prepare students for future careers and life beyond the classroom. The ISTE standards support the development of essential life and career skills, including adaptability, flexibility, initiative, self-direction, productivity, and digital ethics. Through technology integration, students gain experience in using digital tools, working collaboratively, and practicing effective time management, preparing them for success in the modern workforce (Blocher, Armfield & Harati, 2018).
5. Technology operations and concepts: The ISTE standards provide a foundation for students to develop competency in technology operations and concepts. Students learn how to use a variety of digital tools and platforms, understand fundamental technology concepts, and explore emerging technologies. These skills enable them to navigate the digital landscape, adapt to new technologies, and stay current in a rapidly changing world.
6. Research and information fluency: The ISTE standards emphasize the importance of research and information fluency in a 21st-century curriculum. Students learn to conduct effective online searches, critically evaluate sources, synthesize information, and present findings using technology tools. These skills enable students to navigate and make sense of the vast amount of information available, empowering them to become informed and discerning learners.

Implications for pedagogy

The ISTE (International Society for Technology in Education) standards for students have a significant impact on pedagogy, shaping teaching practices and instructional approaches. According to Nair (2021), the standards guide educators in leveraging technology effectively to enhance student learning experiences. Here's how the ISTE standards connect with pedagogy:

1. Student-centred learning: The ISTE standards promote a shift towards student-centred learning approaches. Educators are encouraged to create learning environments where students take an active role in their education. Technology is used to facilitate student agency, allowing learners to explore, collaborate, and pursue their interests. Pedagogical practices aligned with the ISTE standards prioritize student engagement,

personalized learning, and the development of critical thinking and problem-solving skills (Stearns & Shay, 2014).

2. Differentiated instruction: The ISTE standards support differentiated instruction, tailoring teaching strategies to meet the diverse needs of students. Technology provides opportunities for individualized learning experiences, adaptive assessments, and personalized feedback. Educators can use digital tools and resources to differentiate instruction based on students' abilities, learning styles, and interests (Miller, 2022).
3. Project-based learning: The ISTE standards align well with project-based learning (PBL) approaches. PBL engages students in authentic, real-world projects that require critical thinking, collaboration, and problem-solving. Technology tools and resources enable students to conduct research, design prototypes, collaborate with peers, and present their findings. The ISTE standards promote the integration of technology into PBL, enhancing students' ability to investigate, create, and communicate.
4. Collaborative learning: The ISTE standards emphasize collaboration and communication skills. Pedagogical practices that align with the standards encourage collaborative learning experiences where students work together to solve problems, share ideas, and achieve shared goals. Technology tools support collaborative activities, such as online discussions, virtual group projects, and co-creation of digital content.
5. Inquiry-based learning: The ISTE standards foster inquiry-based learning, encouraging students to ask questions, explore, and investigate. Technology provides access to a wealth of information and resources, empowering students to engage in authentic inquiry. Educators can facilitate inquiry-based learning experiences by guiding students to use technology tools for research, data analysis, and evidence-based reasoning.
6. Assessment for learning: The ISTE standards advocate for formative assessment practices that provide timely feedback to students. Technology supports ongoing assessment and feedback loops, allowing educators to monitor student progress, provide personalized feedback, and adjust instruction accordingly. Digital tools and

platforms facilitate the collection and analysis of data, helping educators make informed instructional decisions.

7. Reflection and metacognition: The ISTE standards promote reflection and metacognition as integral components of the learning process. Technology tools enable students to document and reflect on their learning experiences, capture evidence of their growth, and set goals for improvement. Educators can incorporate digital portfolios, blogs, and online journals to foster metacognitive skills and self-directed learning.

Implications for assessment

When it comes to assessment, ISTE advocates for a shift from traditional assessment methods to more authentic and meaningful approaches that align with the ISTE Standards for Students. These assessment approaches aim to focus on students' abilities to think critically, solve problems, create, collaborate, and communicate effectively using technology, rather than solely on rote memorization or regurgitation of information (Thomas & Knezek, 2008). This includes:

1. Performance-Based Assessment: Assessing students' abilities to apply their knowledge and skills in real-world contexts through projects, presentations, portfolios, and other performance-based tasks.
2. Authentic Assessment: Evaluating students' understanding and proficiency by assessing their ability to solve real problems, create meaningful products, and engage in authentic tasks.
3. Formative Assessment: Providing ongoing feedback and opportunities for reflection to support students' growth and improvement throughout the learning process.
4. Peer Assessment: Involving students in the assessment process by having them provide feedback and evaluate the work of their peers, fostering collaboration and self-reflection.
5. Digital Portfolios: Using digital portfolios to showcase students' work, progress, and growth over time, allowing for a more comprehensive and personalized assessment.

6. Rubrics and Criteria: Using clear rubrics and criteria to assess students' work, providing specific guidelines and expectations for achievement.
7. Assessment strategies should also consider the integration of technology tools and resources to enhance the assessment process. These tools can include online assessment platforms, digital portfolios, multimedia presentations, coding and programming projects, simulations, and more. By using technology in assessments, educators can gather more authentic and timely evidence of student learning and provide valuable feedback for improvement.

Conclusion

The ISTE standards for digital age students emphasize the importance of integrating technology effectively into education, fostering digital citizenship, promoting critical thinking and creativity, and preparing students to thrive in a rapidly changing technological society. By aligning curriculum and instruction with these standards, educators can help students develop the skills and competencies necessary to succeed in the digital age. The ISTE standards for digital age students reflect the skills and competencies needed for success in the 21st century. They emphasize the integration of technology into education and prepare students to navigate the digital world, think critically, collaborate effectively, and be responsible digital citizens. These standards provide a roadmap for educators to foster the development of well-rounded, technologically literate individuals who can thrive in the digital age.

By integrating the ISTE standards into a 21st-century curriculum, educators can ensure that students develop the skills, competencies, and literacies needed to succeed in the digital age. The ISTE standards provide a framework for effective technology integration and support the development of well-rounded, digitally fluent individuals who can thrive in an increasingly interconnected and rapidly evolving world. The ISTE standards provide a roadmap for educators to effectively integrate educational technology into the classroom. They emphasize using technology as a tool to support student-centred learning, foster critical thinking, promote creativity, and develop digital citizenship. By aligning their practices with the ISTE standards, educators can ensure that students develop the skills necessary to thrive in a technology-rich world.

The ISTE standards, When integrated into science education, educators can enhance students' engagement, critical thinking, and problem-solving skills. Technology can serve as a tool to support scientific inquiry, access to information, data analysis, and communication within the scientific community. This integration prepares students to be scientifically literate and empowers them to apply technology effectively in their scientific pursuits. By aligning pedagogy with the ISTE standards, educators can leverage technology effectively to create learner-centred, engaging, and meaningful learning experiences. The standards guide the integration of technology as a tool for inquiry, collaboration, differentiation, assessment, and reflection. Pedagogical practices informed by the ISTE standards empower students to develop critical skills and competencies necessary for success in the digital age.

Regarding assessment, the ISTE Standards for Students emphasize a shift from traditional assessment methods to more authentic and meaningful assessments that align with the skills and competencies outlined in the standards. This can involve performance-based assessments, portfolio assessments, project-based assessments, and other forms that allow students to demonstrate their knowledge, skills, and abilities in real-world contexts. The focus is on assessing students' ability to apply technology effectively, think critically, solve problems, collaborate, and create meaningful products or solutions. Overall, the ISTE Standards for Students encourage educators to design assessments that align with the standards and leverage technology to support and enhance the assessment process, ultimately promoting a more engaging, relevant, and effective learning experience for students.

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