HNUE JOURNAL OF SCIENCE Educational Sciences 2024, Volume 69, Issue 5B. pp. 43-59 This paper is available online at http://hnuejs.edu.vn/es DOI: 10.18173/2354-1075.2024-0134

## HARNESSING SMART E-LEARNING MATERIALS IN MATHEMATICAL EDUCATION IN GENERAL SCHOOLS

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Received June 19, 2024. Revised November 12, 2024. Accepted December 27, 2024.

**Abstract**. Smart Electronic Courseware (SEC) in mathematics education refers to digitized learning materials or content optimized through the integration of modern technologies and AI. This article explores practical research on the application of SEC in mathematics education both globally and in Vietnam. It examines the perspectives and characteristics of SEC in mathematics education, as well as SEC integrated with AI. The novelty of this article lies in its emphasis on the role and impact of SEC on teaching and learning mathematics at the secondary education level, alongside a comparison of different types of SEC.

*Keywords:* smart electronic learning materials, mathematical education, artificial intelligence, multimedia communication.

## 1. Introduction

Smart e-learning materials (SEC) combine e-learning materials with artificial intelligence (AI). Electronic learning materials, or digital learning materials, refer to a collection of electronic tools for teaching and learning, including e-textbooks, electronic reference materials, electronic assessment tests, slideshows, data sheets, audio files, images, videos, e-lectures, teaching software, simulation experiments, and other digitized resources [1]. E-learning materials are digitized learning resources organized according to specific formats and scenario architectures and stored on electronic devices such as CDs, USBs, computers, and computer networks for teaching and learning. Digital formats can include text, data sheets, audio, images, videos, software, or a combination of these elements [2]. Digitalization, in this context, refers to using digital technology to convert traditional documents into digital formats, enabling information to be processed, stored, and transmitted via digital devices and networks [3]. Other studies describe e-learning materials as tools developed and deployed using computer technologies. These materials, also known as digital learning materials, are educational resources created and managed with digital technologies [4]. E-learning materials encompass a wide range of digital resources, including digital videos, digitized audio, multimedia tools, websites, learning management systems, computer simulation programs, online meeting tools, and digital databases [5].

"Intelligence" has two main definitions. The first refers to the ability to quickly understand, learn, and process information. The second pertains to being quick-witted, clever, and skilled in responding and adapting [6]. These definitions suggest that intelligence involves the capacity to understand, learn, and respond flexibly and accurately.

Thus, SEC refers to electronic learning materials capable of absorbing and responding to inputs accurately, quickly, and effectively. In other words, SEC is a type of learning material that integrates modern technology, such as 3D object simulation or artificial intelligence features like machine learning, deep learning, and natural language processing. These technologies enable SEC to process commands and provide voice feedback, creating an interactive experience. Modern information and communication technology (ICT) tools integrated into SEC differ from traditional communication technologies. These tools mimic human-like interaction, allowing for dynamic exchange and communication.

The application of SEC in mathematics education represents a significant trend in modern education [7]-[9]. While SEC is applied not only in mathematics but also in other disciplines such as physics and English, there is limited research on its use in mathematics education. Therefore, further investigation is needed to understand the application of SEC in this field. This article focuses on examining the current state of SEC usage in mathematics education worldwide and in Vietnam, the perspectives, characteristics, and role of SEC in mathematics education, the integration of artificial intelligence technology into teaching, and the influence of SEC on how mathematics is taught and learned at the high school level.

## 2. Content

## **2.1.** Current situation of using smart e-learning materials in mathematical education in the world and Vietnam

In the US, as early as May 2023, the Technology Office of the American Faculty of Education developed smart tutor e-learning materials (SEC tutors). These SEC tutors integrate artificial intelligence to help learners solve mathematical problems more effectively. The SEC tutor monitors how learners approach mathematical problems, gaining insights and experience to improve its assistance.

The SEC tutors found that providing feedback on a learner's problem-solving steps was closely related to academic performance. When a learner asks questions not included in the SEC tutor's script, it immediately provides feedback to guide the learner in the right direction. SEC tutors respond to all of the learner's questions when prompted. AI technology allows SEC tutors to adapt flexibly to learners' needs and to be applied on a large scale. Currently, SEC tutors actively support the learning process, though teachers still play a primary role in interacting with learners and customizing the learning experience. Using SEC tutors, learners can leverage artificial intelligence to create "open learning models," systems that enable AI to provide information, support self-monitoring, and evaluate learners [10].

In 2022, Sweden integrated artificial intelligence into SECs, opening new possibilities for education, particularly in mathematics. Artificial intelligence enables learners to engage with mathematics actively and experience learning in a dynamic way. AI replicates human-like problem-solving abilities, especially in tackling complex mathematical challenges. Consequently, integrating AI into SECs is a vital aspect of teaching in the context of Education 4.0 [9].

In China and Taiwan, SECs have been used in mathematics education, particularly for teaching multiplication and division of fractions. SECs identify errors and mistakes in real-time by analyzing learner conversations and leveraging artificial intelligence to make predictions. Empirical analyses show that SEC-supported teaching outperforms conventional methods.

Learners using SECs exhibit greater enthusiasm and interest in learning mathematics compared to traditional teaching methods [11].

In addition, SECs in distance teaching have enhanced teaching efficiency in China and Taiwan. These systems help manage and assess individual learners' capabilities, enabling self-study while incorporating general and mathematical teaching theories into course design. SECs connect with learners anywhere with an Internet connection, offering features such as smart record management, academic progress tracking, and online exams [8].

Joint research by authors from India, Fiji, and Malaysia has developed SECs that enhance learners' focus compared to traditional methods. These SECs support personalized learning, encourage collaboration among students, and facilitate online learning environments. Internet access is critical for the success of such systems. SECs create ideal conditions for virtual learning by enabling smarter and more informed decisions for teachers and learners, improving performance across platforms, and ensuring academic achievement [12].

Globally, various SECs, such as MozaBook, have been widely adopted. MozaBook is an electronic learning tool that supports lecture preparation and teaching through 3D augmented reality technology, its standout feature. In addition to 3D technology, MozaBook integrates videos, images, and audio into lessons. It also facilitates learner assessment, promotes capacity development, and enables self-study and knowledge exploration [13].

In Vietnam, a private company launched a visually interactive SEC system in 2021, designed to foster capacity development based on the General Education Program 2018. The content is tailored to educational administrators, teachers, and learners in grades 1, 2, and 6. For administrators, the SEC provides tools for managing learning activities, assessing achievement levels, and adjusting teaching strategies. Teachers can use SECs as online teaching platforms to interact with students, assign tasks, and evaluate learning outcomes through automated reports. Learners benefit from engaging in exercises tailored to their abilities, receiving immediate feedback, explanations, and progressively challenging tasks to strengthen knowledge and skills. Parents can monitor their children's progress and collaborate with teachers through the system [14].

In Vietnam, several mathematics-specific SECs integrate AI technologies, such as QANDA, Photomath, Mathway, and Microsoft Math Solver. These applications utilize AI capabilities like handwriting and image recognition to provide detailed, step-by-step problem-solving assistance and enable one-on-one interaction with teachers [15].

Overall, SECs are increasingly researched and applied in education worldwide. These tools leverage advanced technologies such as image recognition, natural language processing, augmented reality, and 3D modeling to enhance mathematical instruction. They support self-study, testing, evaluation, and knowledge acquisition, empowering learners to develop skills effectively.

#### 2.2. Components of smart electronic courseware in mathematical education

As mentioned above, smart e-learning materials combine the two terms "e-learning materials" and "smart." While the term "intelligence" in English is synonymous with "smart" or "intelligent," e-learning is a concept with various interpretations. E-learning materials are also referred to as electronic teaching materials, electronic learning materials, electronic instructional materials, electronic learning resources, digital learning, digital education, and e-resources (electronic resources), among others [16]. Depending on the terminology used, e-learning materials are understood from the perspective of that specific term. Consequently, SECs also have different English names based on how e-learning materials are described.

We classify smart e-learning materials (SECs) in mathematics education into the following categories:

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Figure 1. Types of SEC in mathematical education

### 2.2.1. Smart electronic courseware in mathematical education

Smart electronic courseware (SEC) in mathematics education encompasses teaching materials, lectures, tests, teaching activities, and resources for learning mathematics, all published in electronic formats. SEC in mathematics education functions like a math e-book or an online mathematical resource that learners can use for studying and research. It may include videos, audio, voice capabilities, and interactive features, enabling learners to study remotely [17].

To qualify as smart electronic courseware, the materials must incorporate advanced modern technology or artificial intelligence (AI) in mathematics education. These technologies include interactive features through sound and voice, dynamic interaction, object representation using 3D technology, augmented reality, image recognition, remote control capabilities, natural language processing, mathematical text extraction, and automated responses to mathematical content.

SEC in mathematics education is becoming increasingly popular. In particular, the COVID-19 pandemic accelerated its adoption to enhance educational resilience and prevent disruptions caused by such crises. SEC offers advanced features that empower learners to explore and construct mathematical knowledge independently capabilities that traditional electronic learning materials cannot provide.

### 2.2.2. Smart E-textbooks in mathematical education

According to studies by the Korea Advanced Institute of Science and Technology [18] and Nguyen Ngoc Giang [19], smart e-textbooks in mathematics education are a form of SEC. These e-textbooks feature electronic pages that can be accessed randomly and include multimedia elements such as text, hyperlinks, animated graphics, videos, and audio related to mathematical content. Smart e-textbooks emphasize interactive environments.

The first involves directional interaction, which includes navigation tools and features that allow users to move through e-textbooks easily. The second category is functional interaction, which enables users to quickly access content for mathematical instruction. The third option is multimedia engagement, which supports rapid and precise transmission of sounds, images, and computer-generated information, as well as online connectivity. The fourth option is dynamic interaction, allowing students to use interactive technologies to explore mathematics. For example, students can draw and manipulate graphics to better understand concepts, theorems, and exercises. The fifth option is interactive feedback, which provides immediate responses when students engage with the content, offering corrections or timely assistance when errors occur. The trace interaction ranks sixth. Trace interaction enables teachers to track user activity, such as test scores, and adjust instructional material and teaching approaches based on learner performance. Finally, consider the time-delay interaction, which allows students to receive feedback and communicate with the system after a set amount of time. A distinguishing feature of smart e-textbooks in mathematics education is their compatibility with electronic reading devices, which include personal computers, e-readers, tablets, and smartphones. Users interact with the content on devices such as iPhones, iPads, or other smartphones. These smart e-textbooks function in both online and offline environments.

Smart e-textbooks differ from traditional e-textbooks in that they integrate artificial intelligence technologies to enhance mathematics instruction. They interact with mathematical content, images, and devices using technologies such as fingerprint recognition, voice recognition, image recognition, and automatic information processing and analysis. Additionally, they provide automated decision-making assistance. Smart e-textbooks must have adaptable features to meet the teaching needs of mathematics educators.

### 2.2.3. Smart E-learning in mathematical education

According to Dao Thai Lai and colleagues [16], further adjustments have been made to state that SEC in mathematics education (smart e-learning) involves the application of e-learning system technology to promote intellectual integration and artificial intelligence. E-learning elements include a learning management system (LMS), system setup and configuration, course creation, student registration and management, delivery of learning content, tracking of learning progress, provision of feedback and learning support, and evaluation of learning outcomes in accordance with SCORM standards. A strong emphasis is placed on AI-powered management and teaching. E-learning offers several benefits due to AI technology, including its independence from geographic and time constraints. Learners can study based on their own strengths and personalities. E-learning becomes more engaging, adaptable, accessible, and frequently updated, while also facilitating collaboration and coordination between e-learning systems and teachers. When artificial intelligence tools such as ChatGPT, WebGPT, image recognition, voice recognition, and others are combined with the development of quantum computers, smart electronic learning materials (smart e-learning) will advance significantly in functionality, content processing, and interactivity. Smart e-learning features will be capable of understanding and addressing users' mathematical needs, thinking predictively, and helping learners study mathematics effectively.

### 2.2.4. Smart digital content in mathematical education

According to [20], further changes have been made to describe smart digital content in mathematics education as a type of mathematical learning material that adapts differently to each learner's situation. The context of mathematics education significantly influences the design of smart digital content. It is capable of being replicated without loss of quality. Smart digital content's mathematical material is digitized and securely encrypted using blockchain technology. As a result, the transmission and reception of mathematical instruction are discrete and precise, ensuring that the content reaches the intended recipient and task without the risk of tampering. Smart digital content offers an interactive environment powered by artificial intelligence. It incorporates AI technologies such as voice, image, and motion recognition to help learners more effectively acquire and assimilate mathematical knowledge. Additionally, smart digital content and e-learning materials are designed to be packaged and delivered to the appropriate individual for the task. This material does not degrade over time and remains consistent, as it is stored on the cloud and protected using blockchain technology. For example, content in digital dictionaries is preserved and delivered securely and promptly to mathematics teachers and students. An application of smart digital content includes using tools like ChatGPT for exploring solutions, verifying results, testing concepts, and evaluating topics related to statistical and probabilistic factors. Students can independently explore and learn about these factors through generative AI tools like ChatGPT, enabling them to construct their knowledge and understanding.

### 2.2.5. Smart digital learning resources in mathematical education

According to Dao Thai Lai and colleagues [16], further changes have been made to define smart digital learning resources as a type of learning material categorized into three tiers.

Level one involves key AI-based concepts and principles. Smart digital learning materials utilize visuals, sounds, graphics, animated images, mathematical teaching maps, grouping and splitting of mathematical teaching information, and the demonstration of connections between teaching components. These materials help learners study mathematics, emphasize differences in mathematical topics, and connect mathematical concepts with AI.

Level two focuses on structured problems with solutions. At this level, smart digital learning materials deliver consistent mathematical information to learners. They create models, address educational challenges, and engage students in learning mathematics through artificial intelligence. AI technologies, such as ChatGPT and Bing, are employed to make mathematical concepts and problems more comprehensible to learners.

Level three includes less structured, more complex problems with uncertain solutions. At this level, smart digital learning resources present learners with challenging scenarios that require solving intricate mathematical problems, conducting interactive simulations, addressing real-world problems, engaging in discussions with mathematical experts, and exploring case studies that employ discovery and solution-based methods. Artificial intelligence technologies analyze these scenarios, offering impartial and independent feedback to assist learners in accurately identifying problems. Moreover, AI analytics simplify complex problems, enhance self-learning, support knowledge creation, and improve mathematical skills and experiences.

## 2.2.6. Smart digital education in mathematical education

According to Dao Thai Lai and colleagues, additional changes have been made to describe smart digital education materials as technology-supported resources guided by artificial intelligence. These materials utilize mathematical learning tools and media to enhance learners' arithmetic experiences. Smart digital education employs sounds and visual images to engage learners by detecting voices, images, and movements on their device screens. It supports tailored, self-paced learning, with artificial intelligence elements guiding learners through different learning phases based on their progress and development. Smart digital education powered by AI enables learners to comprehend, evaluate, and process vast amounts of information, thereby deepening and enhancing their understanding. AI can assist teachers in customizing lessons, reducing teaching hours, and sharing math materials with students from diverse regions, nations, and cultural backgrounds. With AI integration, language and geographical barriers no longer hinder teaching and learning through smart digital education. Finally, smart digital education empowers instructors, students, and administrators to work more flexibly, fosters internal motivation, and facilitates more effective and efficient methods for studying, teaching, and managing mathematics.

### 2.2.7. Smart e-resources in mathematical education

According to Habiba and Chowdhury [7], we added further changes as we believe that smart e-resources in mathematics education provide rapid access. These resources are governed by technologies such as speech, mind, and image recognition. Unlike standard learning materials, smart e-resources utilize artificial intelligence for retrieval, offering an advanced level of accessibility. Smart e-resources can automatically update mathematical content. They self-edit and regularly supplement mathematical information, tailoring it to the cultural and contextual needs of each country, including diverse civilizations and religions. Each society has the potential to adapt and customize smart e-resources for its unique educational requirements. These resources offer unparalleled freedom in learning mathematical topics. Many mathematical teaching resources on smart e-resources are created using artificial intelligence technologies and are often free, making them community-based. This is particularly valuable for students in rural areas who face significant educational challenges. Smart e-resources enable advanced search capabilities for mathematical information. This feature can integrate technologies such as thought recognition, voice control, gestures, and self-analysis of user intent to deliver relevant mathematical search results. Smart e-resources can automatically link to other learning materials. They continuously update and self-learn, ensuring that educational resources remain current and advanced. The mathematical content of SECs in mathematics education includes text, graphics, audio, animations, and 3D models. Unlike traditional electronic learning resources, SEC content incorporates advanced artificial intelligence to self-edit and adapt. This content personalizes learning experiences by creating materials tailored to individual learners, enabling self-study and deeper comprehension of mathematics. Interaction with SECs relies on artificial intelligence technologies. Traditional electronic learning materials require manual interactions, such as commands, control buttons, and toolbars. In contrast, SECs use technologies like voice commands, gestures, remote control, image recognition, and fingerprint-based interactions to create a seamless and dynamic user experience. SECs integrate cutting-edge AI technologies that surpass the capabilities of traditional electronic tools. These tools continuously self-learn, selfupdate, and adapt to changes in mathematical knowledge, particularly at the secondary education level. Human-like cognitive features are becoming increasingly prominent, making SECs a dynamic and open form of electronic learning material. Unlike traditional electronic resources, which are static and require manual updates, SECs evolve autonomously. The transmission of SECs requires advanced devices. While traditional electronic learning materials are typically accessed through tablets, iPads, e-book readers, and mobile phones, SECs demand devices equipped with artificial intelligence technologies. These include smartphones and smart computers capable of interaction through voice, images, fingerprints, and gestures, enabling human-like communication. Smart e-resources in mathematical education represent a significant step forward in making learning more personalized, accessible, and interactive. By combining advanced AI technologies with innovative methods for delivering and interacting with content, SECs enable educators and learners to transcend traditional barriers and foster a deeper engagement with mathematics.

## **2.3.** Classification and comparison of types of smart electronic courseware in mathematics teaching

SEC in mathematics education includes seven types as follows: Smart Electronic Courseware in Mathematical Education, Smart E-Textbooks in Mathematical Education, Smart E-Learning in Mathematical Education, Smart Digital Content in Mathematical Education, Smart Digital Learning Resources in Mathematical Education, Smart E-Resources in Mathematical Education, and Smart Digital Education in Mathematical Education. Each type of electronic learning material has unique characteristics and distinctions. The characteristics and differences between these smart electronic learning materials are compared as follows:

+ Smart Electronic Courseware in Mathematical Education: This encompasses various forms such as teaching materials, images, lectures, tests, study records, worksheets, surveys, lesson plans, and more, all integrated with smart technologies like IoT, cloud computing, augmented reality, artificial intelligence, and others. Students can interact with Smart Electronic Courseware using advanced, modern technologies. Unlike Smart E-Textbooks, Smart Electronic Courseware is not associated with e-readers.

+ Smart E-Textbooks: Smart Electronic Courseware, in this context, takes the form of interactive pages featuring voice commands and natural language processing technologies. It integrates videos, audio, and images, enabling learners to engage with textbook content through advanced information technology. However, Smart E-Textbooks do not include lectures, worksheets, or surveys, which are part of Smart Electronic Courseware. Smart E-Textbooks are specifically designed for use with e-readers, unlike Smart Electronic Courseware.

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+ Smart E-Learning: Unlike Smart E-Textbooks, which are electronic books, Smart E-Learning refers to online learning technologies integrated with artificial intelligence. It includes features such as videos, lectures, study records, learning boards, learning management systems (LMS), system configuration, course creation, student registration and management, providing learning content, tracking learning progress, offering feedback, and assessing learning outcomes, all built on the platform of the Fourth Industrial Revolution.

+ Smart Digital Content: Not all electronic content qualifies as digital content. Some content merely transmits knowledge and skills using conventional multimedia tools, classifying it as electronic content. Smart Digital Content, on the other hand, integrates digital transformation technologies such as cloud computing, artificial intelligence, IoT, blockchain, and Big Data. It is fundamentally different from Smart E-Learning. Smart Digital Content includes not only intelligent learning materials but also other smart content related to various fields, such as resolutions, legal documents, laws, and economics, all integrated with advanced technologies.

+ Smart Digital Learning Resources: These are digital learning resources developed on artificial intelligence platforms. Data in Smart Digital Learning Resources is generated by tools such as ChatGPT, Claude AI, Gemini, Copilot, and other AI systems. While other digital resources may incorporate achievements of the Fourth Industrial Revolution, Smart Digital Learning Resources are exclusively created on AI platforms.

+ Smart Digital Education: These resources go beyond learning materials to include educational materials for classroom management, and interaction with parents and society, as well as digitized legal documents, decrees, and laws related to education.

+ Smart E-Resources: Smart E-Resources and Smart Electronic Courseware both support intelligent learning but differ in scope and purpose. Smart E-Resources encompass a broader range of materials, tools, and information, including books, videos, lectures, articles, software tools, websites, and references. These resources can be used independently or combined with various learning methods and are not necessarily designed for teaching specific subjects. In contrast, Smart Electronic Courseware typically refers to materials specifically designed for a particular course or program. These materials include lectures, exercises, tests, and systematically digitized teaching resources structured to serve a specific course. Smart Electronic Courseware guides learners through a structured learning process in a digital environment.

## 2.4. Features of smart electronic courseware in mathematics teaching

According to Teachfloor [17], further adjustments have been made to highlight the characteristics of SEC in mathematics instruction, which include the characteristics described in Figure 2.

Personalization: SEC in mathematics education utilizes learner-generated data to create customized learning experiences for each student. It analyzes available data to deliver tailored learning content, matching the capacity and cognitive level of individual learners. This approach enhances learning performance and provides lectures suitable to each learner's needs.

Automation: SEC automates various stages of the mathematics teaching process. For example, it can automatically grade exams, track each student's progress, and provide immediate feedback, making the learning process more effective and efficient.

Data Analysis and Learner Behavior: SEC analyzes data based on learners' performance in mathematical tests and online mathematical resources. It also tracks learners' behaviors to adjust teaching processes, ultimately improving the quality of mathematics education.

Continuous Learning: SEC continuously updates mathematical information to reflect advancements in science and technology. This ensures that learners always have access to the latest and most relevant information.



Figure 2. Features of SEC in mathematical education

Multimedia Learning: Learners gain access to diverse multimedia resources, including videos, audio, images, online lectures, and AI-integrated augmented virtual reality technologies, enriching their mathematics learning experience.

Interaction and Connection: SEC enables learners to interact with optimized mathematical content flexibly, quickly, and conveniently. Interaction occurs through voice, image, and gesture recognition technologies. SEC also facilitates connections between learners and teachers, tailoring suggestions to each learner's personality, strengths, and weaknesses.

Assessment and Feedback: SEC tracks students' mathematical learning progress through smart electronic learning profiles (e-portfolios). These profiles monitor learning patterns and common errors, offering suggestions to help learners improve and advance in their studies.

Remote Access: SEC allows learners from anywhere in the world, regardless of skin color, ethnicity, or religion, to access mathematical content at any time. This feature increases flexibility and accessibility in mathematics education.

Flexibility in Learning: SEC enables learners to study at their own pace, anytime. Its interactive features mimic real-person interactions, helping learners better understand problems while reducing anxiety about public praise or criticism.

Technology Integration: SEC incorporates the latest advancements in artificial intelligence, machine learning, deep learning, augmented reality, cloud computing, robotics, IoT, blockchain, big data, natural language processing, computer vision, voice recognition, text extraction, and

other innovative technologies. It also leverages breakthroughs in nanotechnology, quantum physics, and emerging sciences, diversifying learning delivery methods. The role of a mathematics teacher can even be fulfilled by a computer, robot, or AI-powered entity.

Comprehensive development goals: SEC promotes the comprehensive development of learners by addressing knowledge, skills, economic understanding, and social dimensions of mathematical content.

Cost savings: Stored on cloud computing platforms, SEC minimizes costs while allowing learners to access electronic learning materials easily and conveniently, regardless of their location.

## 2.5. The role of smart electronic courseware in mathematical education

According to Teachfloor [17], we have made additional corrections when we believe that SEC in mathematical education has the following roles:



Figure 3. The role of SEC in mathematical education

Helps improve learning efficiency, providing content and mathematical teaching methods suitable to the capacity and cognitive level of each learner.

Helps with automatic assessment and feedback, tracks learning progress, and helps learners understand strengths and weaknesses as well as ways to improve mathematical learning.

Helps continuously update math content according to daily advances in science and technology. This plays a huge role in learning. Learners always have access to the new and most relevant mathematical knowledge.

Helps with automation in mathematical education. Learners can study any mathematical content at any hour with the smart electronic learning materials system.

Helps learners learn remotely, and online, reduces the cost of learning mathematics, and becomes a global non-profit learning environment. This plays a big role in wellbeing.

Helps learners cooperate with each other in mathematical education as well as improves communication efficiency between learners and learners, learners and teachers, or learners and managers.

Helps support mathematical teaching for teachers. SEC can provide the right dose of math for each learner so that teachers can successfully pursue personalized learning.

Helps discover mathematical knowledge. SEC integrates artificial intelligence features to discover new knowledge and uses machine learning, augmented reality, computer vision, remote control, robotics, etc. to help learners enhance their experience in mathematical education.

Helps improve the quality of mathematical education. Smart electronic learning materials greatly improve mathematical education thanks to artificial intelligence technology, effectively supporting mathematical education. In particular, after the advent of AI products such as ChatGPT, Bing, etc., learning mathematics has had clear changes in the way of learning and teaching.

In short, SEC plays an important role in improving the learning and teaching process, helping learners and teachers have better and more effective learning experiences.

## **2.6.** The impact of smart electronic courseware on the way of teaching and learning mathematics at the high school level

According to Teachfloor [17], we have made additional corrections when we believe that SEC smart electronic learning materials in mathematical education have the following effects on teaching and learning mathematics at the high school level:



Figure 4. The impact of smart electronic courseware in mathematical education

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Influence on personalization of learning in mathematical education: The introduction of SECs in mathematics education significantly impacts learners by tailoring the learning process to individual strengths and limitations. SECs adapt to each learner's level, providing personalized learning experiences aligned with their vocation or interests. With integrated AI technology, SECs identify the learner's intelligence type and present problems and knowledge suited to that intelligence. For example, learners with a preference for mathematical logic are provided with logic-based problems, while those with artistic intelligence receive artistic mathematical problems. This approach promotes students' passion for learning and stimulates their interest in mathematics.

Influence on assessment and automatic feedback in Mathematical Education: SECs assess and provide feedback on learners' mathematics progress sensitively and pedagogically. By avoiding public disclosure of a learner's limitations, SECs reduce the likelihood of self-esteem issues and encourage learners to strive harder. Since SEC interactions are not human, they avoid the biases and negative emotions often associated with human interactions. SECs provide neutral and euphemistic feedback, positively influencing learners' personality development and emotional well-being.

Impact on saving time in learning Mathematics: With AI-integrated high technology, learners can process and absorb mathematical knowledge more efficiently. SECs make it easier to understand mathematics content compared to conventional electronic learning materials or paper books. This time-saving feature also benefits teachers and administrators by reducing classroom teaching time. For instance, a typical 45-minute high school lesson could be shortened to 30–35 minutes with the help of SECs and their advanced features.

Influence on types of learning and teaching subjects: SECs in mathematics education offer diverse learning methods, including video-based learning, audio resources, online classes, and modern approaches like AI- and robot-assisted learning. Learners can acquire mathematical knowledge and skills from real-life teachers or AI-powered tools and robots, expanding the possibilities of education.

Influence on technology: Beyond the existing technologies used in mathematics education, SECs prioritize the integration of artificial intelligence and advanced technologies, enhancing the teaching and learning process.

Influence on decision-making support for teachers and learners: SECs collect and analyze data using AI technologies, providing robust support for teachers' instructional decisions. This includes optimized predictions and selections, significantly improving outcomes compared to conventional electronic learning materials.

Impact on continuous learning of Mathematics: SECs ensure that mathematical knowledge and skills are continuously updated, keeping learners informed with the latest information and preventing outdated learning and teaching practices.

Influence on collaboration in teaching Mathematics: SECs leverage AI technology to optimize collaborative learning. AI groups learners with compatible personalities and similar learning styles, fostering effective cooperation and enhancing classroom interactions compared to traditional methods.

Influence on learning style: The advent of AI tools such as ChatGPT and Bing has transformed mathematical education. Learners now use "reminder learning" methods, where they provide prompts to AI for answers, refine the responses and complete solutions. This new approach has significantly reshaped learning styles and strategies.

# **2.7.** Exploiting smart electronic courseware in mathematical education and teacher training towards smart electronic courseware

SECs have a profound impact on teaching methods, content, instructional formats, and the teaching environment. Applying SECs to enhance the quality of mathematics education and address the diverse needs of learners is an essential task. In practice, there are various ways to utilize SECs in mathematics education. Learners can ask questions and receive immediate responses. While the answers may not always be correct, learners can refine the information or derive accurate solutions based on the provided feedback. This iterative process encourages critical thinking and problem-solving. SECs allow learners to command and control the system to optimize their learning experience. Artificial intelligence technologies create a flexible and adaptive learning environment in mathematics education, tailored to the unique qualities and abilities of each learner.

## 2.7.1. Using smart electronic courseware to help solve mathematical problems helps students learn independently

SEC is equipped with AI that can support students in self-study and self-discovery of knowledge. To solve certain problems, students can ask SECs for help in finding solutions to the problem. For example, a student can ask ChatGPT to provide solutions to the following problem:

Problem 1

Solve equation  $x^2 - 3x + 2 = 0$ .

Currently, SEC tools equipped with AI only correctly solve simple problems. SECs have not yet been able to solve complex problems or provide incorrect solutions. That's why learners need to criticize and verify the solution to the problem.

W What should you do if you want to be good at math? 0 0 7 Solution To become a good math person, you need to take the following steps: 1. Basic understanding: · Learn the basics of mathematics, including basic operations, arithmetic, geometry, and algebra. Understand basic knowledge of arithmetic, fractions, ratios, and percentages. 2. Build a strong foundation: · Learn basic algebra, geometry, and calculus. · Deep understanding of concepts and rules in mathematics. · Work with equations, systems of equations, inequalities, and related concepts. 3. Logical and creative thinking: · Develop logical thinking, analytical and problem-solving abilities. · Challenge yourself with complex math problems and problems. · Find ways to apply math in real life and solve everyday problems. © Regenerate 4. Learn from others: · Take a math class or join a math learning community. Seek support from a teacher, mentor, or other experienced person. · Seize opportunities to discuss and learn from others through books, websites, or online forums. 5. Practice: Do lots of math exercises to practice calculation and problem-solving skills. •Do real-life math problems to apply math knowledge to everyday life. 6. Prepare for exams and math competitions: •If you are interested in competitive math, participate in math exams and competitions. •Work hard to improve your skills and performance in competitions. 7. Patience and perseverance: •Learning math requires patience and perseverance. Sometimes, you may encounter difficulties, but the important thing is to never give up. ·Always be confident in your abilities and work hard to improve 8. Use learning tools and materials: • Use textbooks, online learning materials, and math software to learn and practice. · Use calculators and calculators to help you calculate and solve complex problems. G Regenerate

Here ChatGPT stops, and we continue to query and receive more results.



<ul> <li>I continue with some other suggestions and strategies for being good at math:</li> <li>1. Create a study plan:</li> <li>Develop a regular and structured study plan to focus on each aspect of mathematics.</li> <li>2. Learn from diverse sources:</li> <li>Don't limit yourself to a single source of learning. Learn from a variety of sources such a books, learning videos, online lectures, and online courses.</li> <li>3. Solve many types of problems:</li> <li>Make sure you solve different types of problems, from calculation problems to logic problems and brain games.</li> <li>4. Create a study group:</li> <li>Join a study group or find some classmates to discuss and solve problems together.</li> <li>5. Deeply engage in a specific field:</li> <li>If you have a particular passion or area of mathematics, delve deeper into it.</li> </ul>	ී Regenerate
<ul> <li>6. Practice by teaching others:</li> <li>An effective way to gain a deeper understanding of a subject is to teach it to othe explain and teach it to your friends or fellow students.</li> <li>7. Participate in online courses and courses:</li> <li>There are many free or paid online courses you can take to improve your math s</li> <li>8. Keep a positive mindset:</li> <li>Face the challenges and challenges you encounter with a positive mindset. See i opportunity to learn and improve.</li> <li>9. Practice regularly:</li> <li>Math is like any other skill - you need regular practice to maintain and improve you for the second evaluate yourself regularly to see if you are on track or adjustments.</li> <li>Remember that becoming a good math person takes time and effort. Never give</li> </ul>	ers. Try to kills. t as an your skills. need up and
always maintain passion and nationce in learning math	C Regenerate

The process of giving commands to SECs resembles brainstorming. This brainstorming process is iterative, with users receiving multiple answers. By filtering and eliminating irrelevant or unsuitable options, users can arrive at their desired results.

The examples mentioned above highlight only a fraction of the potential applications of SEC and tools like ChatGPT in mathematical education. One significant advantage of SECs is their ability to provide answers to problems, regardless of their complexity. For numerous mathematical problems, SECs assist by offering solutions, generating new problems, and creating similar questions. This capability is invaluable for both teachers and learners, as it reduces effort, saves study time, and supports personalized learning needs and practice.

### 2.7.2. Smart electronic courseware and teacher training

The emergence of SECs integrated with artificial intelligence tools highlights the critical need to apply AI technologies in mathematics education. This advancement also necessitates training mathematics teachers to effectively utilize SECs. Beyond traditional training methods, the following specific approaches are required as follows:

Training teachers to prompt SECs: Mathematics teachers need to develop the skill of crafting effective prompts for SECs. These prompts should be specific and clear neither too vague nor overly general so that SECs can understand and align with the intended objectives of the lecture. Simplicity and precision in prompts ensure successful implementation.

Training teachers to calibrate SECs: Current SEC tools for solving high school-level mathematical problems are prone to errors. Teachers need to be trained to identify and correct these inaccuracies to ensure the delivery of correct solutions in mathematical education.

Training teachers in data science for Mathematics: Since AI-integrated SECs rely on mathematical data, it is essential to train teachers with sufficient qualifications, expertise, and pedagogical skills to collaborate with SEC engineers. These teachers would play a crucial role in correcting and refining the SEC's functionality and contributing to teaching methodologies.

Training teachers in other SEC-related roles: Additional training is necessary for teachers to operate SECs, label mathematical data, train SEC systems, and effectively integrate SEC tools into mathematical education. This comprehensive training ensures that SECs are utilized to their fullest potential and that teachers can meet the evolving demands of AI-driven mathematics instruction.

## **3.** Conclusions

Smart electronic courseware in mathematics education has emerged as a learning material that garners significant attention and focus in both current and future research. A defining characteristic of SEC in mathematics education is its integration of modern information and communication technologies. It caters to the need for personalized learning by developing content tailored to each learner's strengths and weaknesses. In other words, SEC is designed to align with the unique intelligence profile of every learner. Additionally, SEC in mathematics education is an electronic learning material capable of self-improvement through the continuous processing of daily data. It plays a vital role in data analysis and decision-making for both learners and teachers. Learners today must acquire a new skill - prompting skills - to effectively interact with SEC systems. They need to pose problems in a way that SECs can accurately interpret and provide the correct answers. Accessing SEC is seamless thanks to cloud computing technology and the Internet of Things (IoT). Moreover, SEC in mathematics education is equipped with advanced features such as voice control, image recognition, fingerprint recognition, gait recognition, gesture recognition, and remote control, making it increasingly intelligent and user-friendly. These features significantly enhance its utility in teaching and learning mathematics. Unlike traditional electronic learning materials, which are static and closed, SEC in mathematics education can expand its content and knowledge autonomously. This adaptability has been further revolutionized by the advent of ChatGPT and other artificial intelligence tools, leading to notable improvements in the quantity and quality of SEC. As a result, the effective exploitation, understanding, and design of SEC in mathematics education, along with strategies for deploying SEC in practical teaching scenarios, will be two of the main trends in the near future.

#### REFERENCES

 Ministry of Education and Training, (2017). Circular 21/2017/TT-BGDDT Regulations on the application of information technology in online training and professional development for teachers, staff, and educational administrators. https://lawnet.vn/vb/Thong-tu-21-2017-TT-BGDDT-ung-dung-cong-nghe-thong-tin-trong-boi-duong-tap-huan-cho-giao-vien-4F5B5.html#dieu\_2-2 (in Vietnamese).

- [2] Ministry of Education and Training, (2018). *Circular issuing criteria for identifying specialized goods used directly for educational purposes*. https://thuvienphapluat.vn/van-ban/Giao-duc/Thong-tu-11-2018-TT-BGDDT-tieu-chi-xac-dinh-hang-hoa-chuyen-dung-phuc-vu-truc-tiep-cho-giao-duc-380049.aspx (in Vietnamese).
- [3] Tran TPT, (2015). Competency in developing and using electronic learning materials in teaching at secondary schools. *Hue University Journal of Science*, 60(8), 79-86 (in Vietnamese).
- [4] Abdurashidovich XA, Nigmanovna MF, (2019). Access to Electronic Educational Resources in the Education System. *European Journal of Research and Reflection in Educational Sciences*, 7(12).
- [5] Yang L, (2014). Integration and utilization of digital learning resources in community education. In L. Shaozi, J. Qun, J. Xiaohong, J. Park (Eds) Frontier and Future Development of Information Technology in Medicine and Education, ITME 2013, 2953-2959. *Springer Science+Business Media Dordretch*. https://doi.org/http://dx.doi.org/10.1007/978-94-007-7618-0\_375.
- [6] Hoang P & et al., (1988). *Vietnamese Dictionary*, Social Sciences Publishing House (in Vietnamese).
- [7] Habiba U & Chowdhury S, (2012). Use of Electronic Resources and its Impact: A Study of Dhaka University Library Users. *Eastern Librarian*, 23(1), 74-90. https://doi.org/10.3329/el.v23i1.12122
- [8] Hung JC, Hsu HH, Shih TK, Chang WC & Chiang DJ, (2010). A Smart Courseware System for distance education, *International Journal of Applied. Systemic Studies*, 3(2), 197-210.
- [9] Munir H, Vogel B & Jacobsson A, (2022). Artificial Intelligence and Machine Learning Approaches in Digital Education: A Systematic Revision. *Information*, 13(203). https://doi.org/https://doi.org/10.3390/ info13040203.
- [10] United States. Department of Education, Office of Educational Technology, (2023). Artificial Intelligence and Future of Teaching and Learning: Insights and Recommendations. Washington, DC.
- [11] Shu CS, Chih CC, Bor CK & Han YH, (2023). Mathematics intelligent tutoring system for learning multiplication and division of fractions based on diagnostic teaching. *Education and Information Technologies*, 28, 9189-9210. https://doi.org/https://doi.org/10.1007/ s10639-022-11553-z.
- [12] Shriram R, Bibhya S & Darshan SAK, (2022). Editorial: Analytics and Mathematics in Adaptive and Smart Learning. *Front. Appl. Math. Stat*, 8. https://doi.org/doi: 10.3389/fams.2022.839669.
- [13] Center for Research and Application of Educational Science, University of Education Vietnam National University, Hanoi, (2023), *MozaBook: A smart teaching and learning platform in the era of digital education.* https://cera.ued.vnu.edu.vn/mozabook-mot-nen-tang-day-va-hoc-thong-minh-trong-thoi-dai-giao-duc-so.html (in Vietnamese).
- [14] Le TA, (2021). Training on the use of the smart learning material system. http://thtanmai.edu.vn/lien-he/tap-huan-su-dung-he-thong-hoc-lieu-thong-minh.html (in Vietnamese).

- [15] Le MT, (2022). *Top 5 best algebra and geometry problem-solving apps on mobile phones*. https://www.thegioididong.com/game-app/top-5-ung-dung-giai-toan-dai-so-hinh-hoc-tot-nhat-tren-dien-1268267#subqmenu1 (in Vietnamese)..
- [16] Dao TL & et al., (2023). *Developing interactive e-books in the context of Education 4.0*. Science and Technology Publishing House (in Vietnamese).
- [17] Teachfloor, (2023). *What is Courseware?* https://www.teachfloor.com/elearning-glossary/what-is-courseware#strongdownsidesstrong.
- [18] Korea Advanced Institute of Science and Technology, (2012). *New smart e-book system is more convenient than paper-based books*. https://phys.org/news/2012-01-smart-e-book-convenient-paper-based.html#:~:text=The technology%2C called the %22Smart,paper-based books and magazines.
- [19] Giang NN, (2016). *Research on designing and using electronic textbooks in teaching geometric transformations on the plane through organizing discoverable activities.* Vietnam Institute of Educational Sciences (in Vietnamese).
- [20] Rowley J, (2008). Understanding digital content marketing, *Journal of Marketing Management*, 24(5-6), 517-540.