Electronics……Hi Smart Assistant (Action Research)

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Abstract

This research paper, which aims to solve the problems of teaching Electronics with AI tools, comprehensively explores the role of technology and artificial intelligence (AI) in Education. The research conducted by a team of students from Ain Shams University focuses on leveraging AI tools to enhance the teaching or learning experience in physics Education. The study begins by highlighting the challenges inherent in teaching electronics, including complex concepts, technical hurdles, and the need for interdisciplinary integration with subjects like physics, mathematics, engineering, and computer science. Recognizing the transformative potential of AI, the researchers propose utilizing AI as an assistant to overcome these challenges and enhance productivity and efficiency in the Educational domain. In this context, AI serves as an auxiliary motivator for students, offering personalized learning experiences, intelligent tutoring, and data analysis. Moreover, it was a source of entertainment and amusement, ensuring students remained engaged and enthusiastic throughout the Educational process. Artificial intelligence is revealed as a crucial component, playing a pivotal role in our lives in general and specifically within the learning environment, where it improves learning outcomes, strengthens students' weak points in understanding electronics, and enhances their overall learning and interaction. By integrating more than 10 AI tools, such as ExplainPaper, TutorAI, Book Creator, and others, the study demonstrates how these technologies can revolutionize traditional teaching methods and engage students in interactive and stimulating learning experiences. Through field training and practical application in the classroom, the researchers observed a notable shift in student engagement and participation when transitioning from traditional teaching methods to AI-powered approaches. Using AI tools increased student interest and enthusiasm in learning electronics and optimized lesson preparation, assessment methods, and overall teaching efficiency. The research findings underscore the importance of technology integration in Education to create personalized, engaging, and effective learning environments. By combining educators' expertise with AI tools' capabilities, the study advocates for a collaborative approach that enhances the teaching process and empowers students to better understand and retain concepts in electronics. In conclusion, the research highlights the transformative impact of AI in Education and recommends adopting modern AI tools to overcome challenges in teaching electronics, ultimately enhancing the Educational experience for teachers and students.

Key Words

Introduction

To begin with, let us understand what electronics is. Electronics refers to the branch of physics and technology (engineering) that focuses on designing circuits using transistors, diodes, and microchips. It also deals with the behavior and movement of charges in semiconductors, conductors, vacuums, or gases (Streetman, B. G., & Banerjee, S., 2015). Electronics is crucial for modern life and societal progress. The importance of electronics in our daily lives lies in its profound impact on various fields, driving technological advancements. It plays a vital role in communication, entertainment, medicine, energy, and the environment. The electronics industry has brought about significant advancements in communication, mainly through the manufacturing of smartphones and other modern devices, facilitating the efficient transfer of information between countries. Moreover, electronics contributes to the robust economies of leading technological nations like the United States, Japan, South Korea, and Germany (Gams, M., & Kolenik, T., 2021). Hence, electronics is an extensive field of study. However, learning electronics presents several challenges, including complex concepts, technical hurdles, rapid technological advancements, limited resources, lack of real–world context, and interdisciplinary integration with subjects like physics, mathematics, engineering, and computer science. We propose utilizing an assistant, specifically Artificial Intelligence (AI), to overcome these challenges. AI has become an indispensable tool in various domains, enhancing productivity and efficiency. In today's world, AI and Smart Assistants have become ubiquitous. They assist us with daily tasks and answer our queries, such as checking the temperature or time in Cairo, identifying the person with the highest IQ, or locating Bagnoregio. Before delving into how to use AI and Smart Assistants, let us first understand their underlying concepts. Let us begin with AI. Artificial intelligence (AI) simulates human cognitive processes using machines, particularly computer systems. The purpose of AI is to interact with humans, and its potential lies in revolutionizing human lifestyles, work, and leisure activities. In the business realm, AI has successfully automated tasks previously performed by humans, such as customer service, lead generation, fraud detection, and quality control (Bratko, I., 2011). AI systems demonstrate superiority over humans in certain areas, especially tasks involving repetition and meticulousness. For example, when reviewing extensive volumes of legal documents to ensure accurate completion of crucial fields, AI systems can swiftly and accurately accomplish these assignments with minimal errors. As we discuss the challenges in learning electronics, we will experience the role of an AI assistant in Education. AI plays a vital role in Education by offering personalized learning experiences, intelligent tutoring, data analysis, content creation, automated grading, language learning support, virtual reality (VR) and augmented reality (AR) experiences, content management, Special Education assistance, collaborative learning, and more. While AI can potentially enhance Education, it should complement effective teaching practices and human interaction. Educators are crucial in leveraging AI to create personalized, engaging, and effective learning environments (August, S. E., & Tsaima, A., 2021). Next, let us delve into Smart Assistants, software programs that utilize artificial intelligence to provide information and perform specific tasks. It can comprehend user text or speech

inputs and produce conversational and fluid responses using natural language processing and expansive language models. Smart Assistants can take various forms, serving as aids to accomplish specific tasks (Gharge, T., Chitroda, C., Bhagat, N., & Giri, K., 2019). Considering the tools of AI as smart assistants to teachers and students is a plausible approach that aligns with the core concept of a Smart Assistant. In summary, we have discussed the essence of electronics, its importance, the significance of AI, particularly in Education, and the concept of Smart Assistants. By integrating AI with Smart Assistants, we can tackle the challenges of learning electronics.

The Theoretical Framework

Computer-assisted instruction/learning (CAI/CAL) has evolved significantly since its emergence in the 1950s with Skinnerian-style 'linear programs.' Despite initially being led astray by Skinner's assertion that students' responses could be disregarded in linear programs, substantial progress has been made in the field (O'Shea & Self, 1983). The primary issue with early systems lay in their incapacity to offer comprehensive feedback or customization, stemming from their need for more awareness regarding the subject matter, audience, and instructional methods. CAI/CAL systems have progressed over the last three and a half decades. They are now commonly called 'Intelligent Tutoring Systems' (ITSs) to address this challenge. While achieving genuinely intelligent tutoring systems may still be distant, it is widely acknowledged that substantial strides have been taken in this direction (Hyacinth S. Nwana, 1990). The significance of intelligent tutoring systems has markedly surged over recent decades. There has been a remarkable uptick in the number of end users they can serve and the technological advancements in their environments, rendering them more sophisticated and readily deployable. (Bradáč, Vladimír & Kostolányová, Kateřina., 2016). Intelligent Tutoring Systems (ITS) represent an interdisciplinary endeavor exploring the development of Educational systems that offer personalized instruction akin to the approach of adept teachers. Extensive research in this domain has yielded effective techniques and systems capable of furnishing adaptive assistance for student problem-solving across diverse domains. However, additional Educational endeavors benefit from tailored computer-based support, such as examining examples, engaging with interactive simulations, and participating in Educational gaming. Providing personalized assistance for these activities presents distinct challenges, as it necessitates an ITS capable of modeling and adapting to student behaviors, skills, and cognitive states, often less structured and clearly defined than those encountered in traditional problem-solving contexts (Cristina Conati, 2009).

Tools of Research

In Fig. 1, we asked the smart AI assistant (Chat-GPT), "How can we overcome the challenges of teaching and learning electronics?"
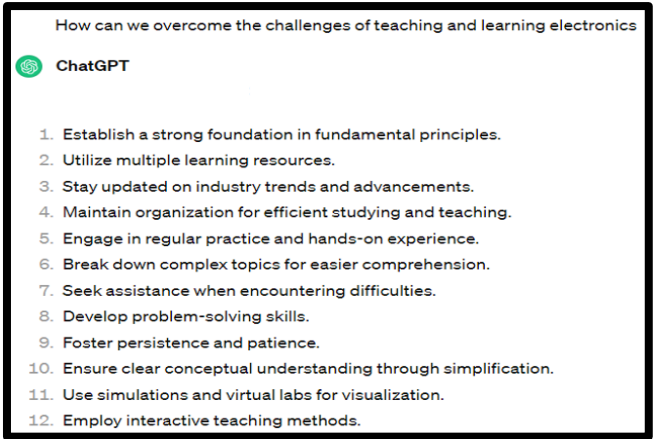
Fig.1: (Chat of Electronics with Smart Assistant (Chat–GPT))

According to the Smart AI Assistant answer in Fig.1, we decided to build a website using (Durable AI) to help students in electronics science. This website contains three primary partitions (Materials, Games, and Assistant), as shown in Fig.2.
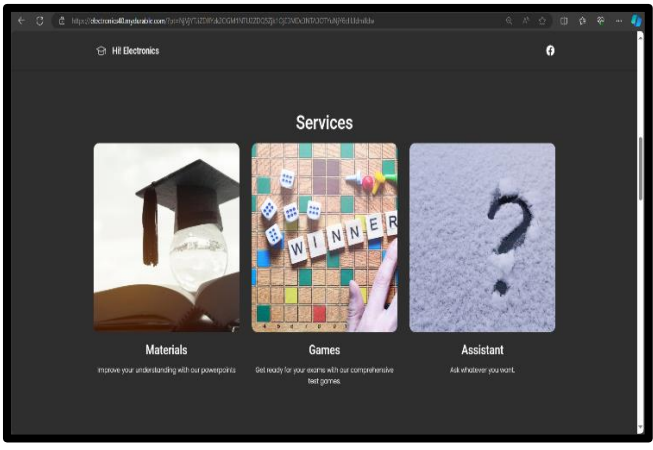

Fig.2: (The three primary partitions of our website)

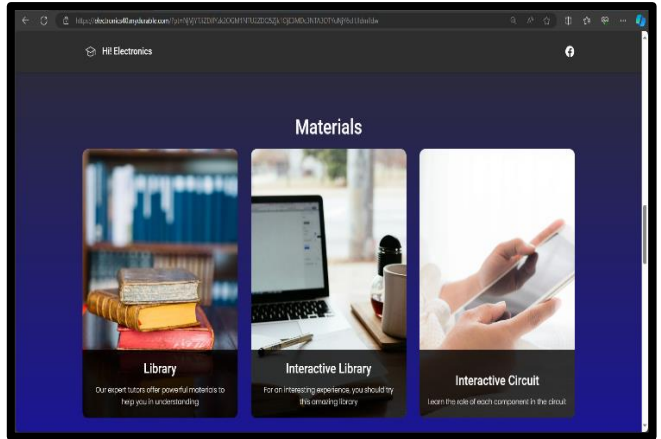The first partition Materials contains (Library, Interactive Library, and Interactive Circuits) as shown in Fig.3.

Fig.3: (The parts of Material partition)

In the library section, we used Google Drive and uploaded documents made by various applications and programs such as (Heuristica, Intellippt, Magic School, Quiz Wizard, Slides AI Vidnoz, and Wisdolia). In the interactive library section, we used (Book Creator). We used (Electric Circuit Studio, Genially) in the interactive circuits section.

The second partition, Games, contains games and competitions on diodes and transistors, as shown in Fig.4. In each section of Games, we used (Genially, Kahoot, and Wordwall).
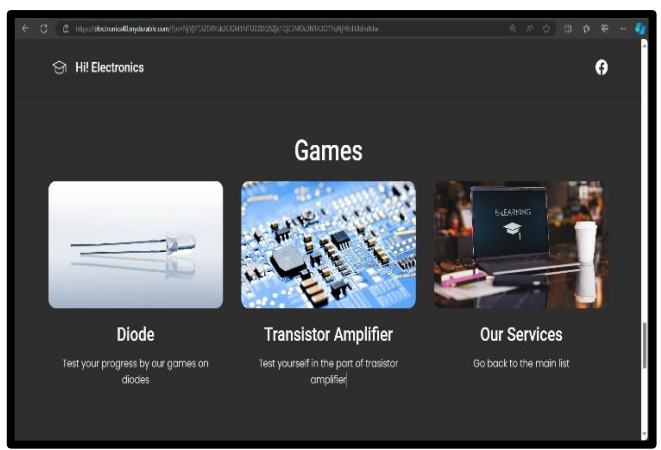

Fig.4: (The parts of Games partition)

In the last partition Assistant, we collected the most helpful tools for students in only one section, such as (Chat-GPT, Explainpaper, and Tutor AI) as shown in Fig.5.
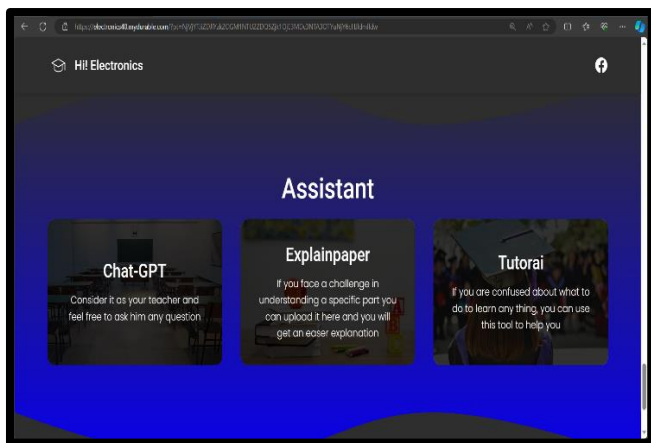

Fig.5: (The parts of the Assistant partition)

In the following part of this research, we will discuss each tool used in creating this helpful website and two platforms (Google Classroom and Nearpod). These help teachers create dynamic learning experiences and enable students to access resources and participate actively in their learning journey.

Durable AI (**Android and PC**)

Durable AI is an AI-powered website builder tool that aids individuals and businesses in crafting professional websites with ease, sans extensive coding knowledge. It features a user-friendly interface for effortless element addition and arrangement on web pages. It offers customizable templates and design options, facilitates content management, including text, images, and videos, ensures mobile responsiveness for seamless user experience across devices, and provides SEO optimization tools. While such tools offer numerous benefits, they pose limitations like restricted customization, basic functionality,

platform dependency, and subscription costs for specific features. For teachers, building a website with tools like Durable AI is crucial. It enables them to prove an online presence, highlighting their teaching experience, credentials, and Educational philosophy, serving as a digital portfolio for potential employers, colleagues, and parents. Teachers can use their websites to share academic resources such as lesson plans, study materials, and Educational videos, acting as a centralized hub for accessing Educational content. Additionally, websites serve as communication platforms for sharing updates, announcements, event calendars, and highlighting student achievements, which can boost motivation and provide recognition. Online assignments, assessments, and professional development initiatives can also be managed effectively through teacher websites, demonstrating their commitment to growth and facilitating collaboration and networking opportunities.

Heuristica (**Android and PC**)

An AI-powered tool aims to aid users in discovering new and relevant information aligned with their interests. Its features include personalized content delivery based on chosen topics, innovative technology ensuring an enhanced user experience, options for topic selection or personalized discoveries, a user-friendly interface accessible online from any internet-connected device, and AI-driven knowledge exploration facilitating autonomous exploration, discovery, or learning. However, drawbacks include potential limitations for individuals preferring independent research, the reliance on algorithms introducing the risk of inaccuracies or biases, and limited capacity to provide comprehensive analysis or context for

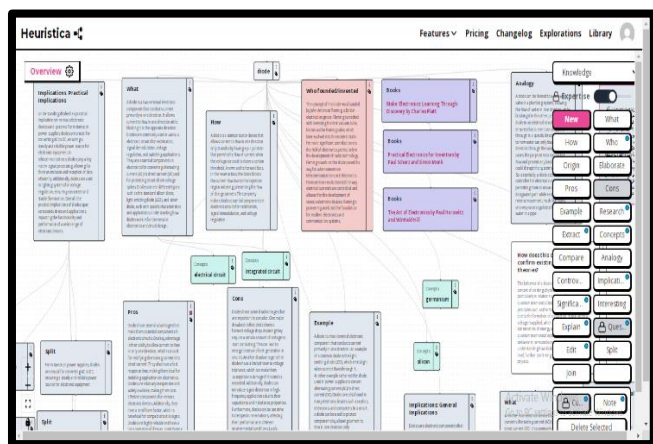complex subjects. As a sample of what this tool can do, see Fig.6.

Fig.6: (A mind map about Diode created by Heuristica)

Intellippt (**Android and PC**)

Intellippt AI is an online summarizing tool offering quick and easy usage. Its benefits include an accessible summarizing tool online, a user-friendly interface, personalized learning through customization of pace and style to match individual preferences, and an enhanced learning experience with immersive technologies like augmented reality, virtual reality, and interactive simulations. However, drawbacks include potential technical restrictions such as bugs or malfunctions leading to misinformation and dependency on reliable technology infrastructure like hardware, software, and internet access, which may disrupt students' learning progress. As a sample of what this tool can do, see Fig.7.

Fig.7: (A part of a summary about Transistor created by Intellippt)

Magic School (**Android and PC**)

Magic School helps with lesson planning, writing quizzes and assessments, unit planning, and others. Magic School AI offers several advantages for enhancing learning experiences. Firstly, it provides students an engaging and dynamic environment by simulating magical situations, spells, and creatures, ensuring secure and regulated learning. Secondly, it offers personalized instruction by assessing individual learning preferences, strengths, and weaknesses and adjusting the curriculum to provide appropriate challenges and assistance. Thirdly, it grants access to a vast reservoir of magical knowledge, offering thorough explanations and prompt responses to inquiries, fostering deeper comprehension. Lastly, it facilitates individualized training by customizing the curriculum and pacing to meet each student's needs, maximizing learning outcomes, and fostering a sense of accomplishment. However, Magic School AI also has its drawbacks. Firstly, it may encounter technical restrictions such as bugs or malfunctions, potentially providing students with misinformation and leading to misunderstandings. Secondly, its dependency on technology, including hardware, software, and

internet connection, may hinder students' progress in the event of technical problems or disturbances. As a sample of what this tool can do, see Fig.8.

Understanding Diodes: An Electrical Engineering Lesson

Objective:

Students will be able to explain the functionality of diodes in electrical circuits and analyze their properties.

Assessment:

Students will complete a circuit design task, incorporating diodes, and provide a written explanation of the diode's role in the circuit.

Key Points:

- Definition of a diode and its symbol representation
- Functionality of a diode in permitting current flow in one direction
- Characteristics of forward and reverse bias in diodes
- Applications of diodes in everyday electronic devices

Opening:

- Introduce the lesson by asking students to think about everyday objects that involve electronics.
- Engage students with a discussion on how electricity flows in these objects.

Fig.8: (A part of a lesson plan about Diode created by Magic School)

Quiz Wizard (**Android and PC**)

Quiz Wizard utilizes AI to assist students in creating multiple-choice questions, saving time, and enhancing comprehension. Its advantages include aiding in question creation, keeping time with AI-powered flashcards that offer personalized feedback, a user-friendly interface, personalized learning through customization of pace and style to meet individual preferences, and an immersive learning experience with augmented reality, virtual reality, and interactive simulations. However, drawbacks include potential technical restrictions leading to misinformation due to AI bugs or malfunctions and dependency on reliable technology infrastructure, where issues with hardware, software, or internet connectivity may disrupt students' learning progress. As a sample of what this tool can do, see Fig.9.

Fig.9: (A part of MCQs about Transistor created by Quiz Wizard)

Slides AI (**Android and PC**)

The AI-driven program supports educators in swiftly crafting engaging presentations tailored for classroom use, utilizing state-of-the-art technology to generate designs and slides from text input, with an automatic identification feature for relevant photos and graphics. The program presents numerous advantages by offering support for over 100 languages on its website. Firstly, it streamlines slide development and formatting by automating tasks, saving considerable time, and eliminating the need for manual intervention. Secondly, it efficiently creates slides by analyzing large datasets and extracting pertinent information. Thirdly, the AI automatically checks grammar, spelling, and formatting errors, ensuring polished and error-free presentations. Fourthly, it enhances learning experiences by incorporating visually appealing aids, fostering conceptual understanding, and boosting student retention. Additionally, the program aids educators in organizing content, highlighting key concepts, guiding the flow of lectures, and facilitating students' comprehension. Furthermore, visual aids such as diagrams, charts, and graphs clarify complex material, enhancing

knowledge transfer. Lastly, well-designed slides with captivating elements engage students and improve interaction and retention. However, a drawback of the program is its limited free usage, allowing only three-monthly PowerPoint presentations and requiring an internet connection. As a sample of what this tool can do, see Fig.10.
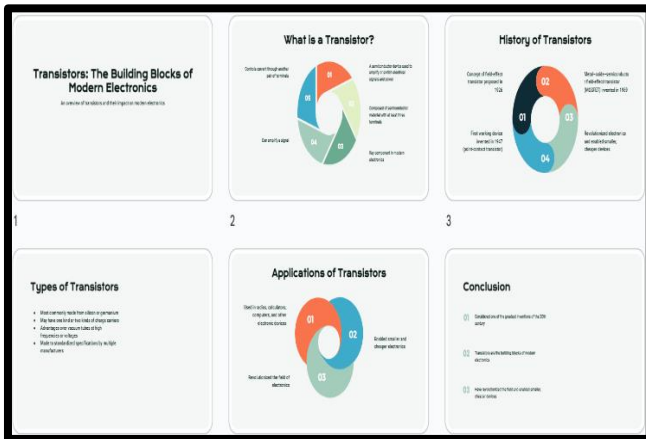

Fig.10: (Slides about Transistor created by Slides AI)

Vidnoz (**Android and PC**)

Vidnoz makes an artificial intelligence video for free using the hundreds of available avatars, templates, and sounds. It offers 470 sounds, 300 video templates, 140 languages, and 300 actual avatars. The program's significance lies in instruction, attracting attention, and facilitating the Educational process. Its drawback is the necessity of the internet. As a sample of what this tool can do, see Fig.11.

Fig.11: (A video on Transistor created by Vidnoz)

Wisdolia (**Android and PC**)

Wisdolia offers AI-powered flashcards for personalized learning feedback, aiding students in creating essay questions, saving time, and enhancing comprehension. Its benefits include assisting in generating essay prompts, keeping time with AI-powered flashcards that provide tailored feedback, quick and straightforward usage, personalized learning through individualized programs tailored to students' preferences, pace, and style, and an improved learning experience via immersive technologies like augmented reality, virtual reality, and interactive simulations. However, drawbacks include potential technical restrictions leading to misinformation and misconceptions due to AI bugs or malfunctions and dependency on technology, where issues with hardware, software, or internet connectivity may disrupt students' learning progress. As a sample of what this tool can do, see Fig.12.
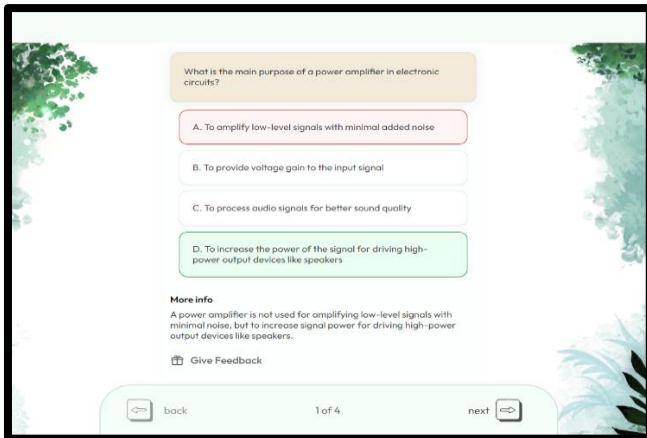
Fig.12: (A question on Transistor created by Wisdolia)

Fig.13: (An interactive e-book about Transistor created by Book Creator)

Book Creator (PC)

A book creator is a software or tool designed to assist users in organizing, composing, and formatting text into a coherent book structure, often allowing the incorporation of images and other media and customization of layout and styles. It aims to simplify the entire book production process, catering to novice and experienced authors through intuitive interfaces and diverse functionalities. Benefits include user-friendly interfaces facilitating professional-looking book creation, visual aids enhancing comprehension, interactive elements boosting engagement, accessibility across devices, and collaborative features for shared authorship. However, drawbacks such as learning curves, reliance on stable internet connectivity for cloud-based platforms, limited compatibility with devices or operating systems, and potential costs for accessing premium features or removing watermarks may hinder user experience and accessibility. As a sample of what this tool can do, see Fig.13.
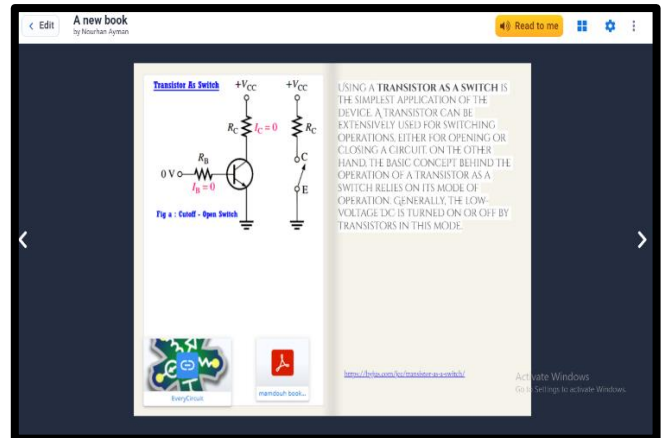
Electric Circuit Studio (Android)

Electric Circuit Studio allows users to virtually design, simulate, and analyze electrical circuits. It offers a user-friendly interface where students can drag and drop components, connect them, and observe the circuit's behavior in real time. The software typically includes various elements such as resistors, capacitors, inductors, voltage sources, and measurement tools. Users can modify circuit parameters, apply different input signals, and view voltage, current, and power simulation results. Electric Circuit Studio offers numerous advantages in Education. Firstly, it facilitates hands-on learning by providing a safe digital environment for experimenting with circuits, eliminating the need for physical components. Additionally, its visualization features make abstract concepts more tangible and understandable. The software's interactivity allows students to adjust parameters and observe immediate effects, enhancing engagement and understanding. Moreover, its accessibility from any internet-connected device enables remote learning and reduces specialized hardware requirements, improving inclusivity and cost-effectiveness. Teachers can quickly assess

student progress through assignments and quizzes based on circuit simulations. However, there are also drawbacks to consider. Virtual simulations cannot fully replicate the tactile experience of physical interaction, potentially limiting hands-on learning opportunities. Furthermore, students may need additional guidance to connect virtual simulations to real-world applications. Technical bugs, compatibility problems, or performance limitations may disrupt the learning process. Dependence on technology exposes both students and educators to potential disruptions from internet outages, updates, or hardware failures. Lastly, some students may find navigating the software and understanding complex concepts challenging without adequate instructor support. As a sample of what this tool can do, see Fig.14.
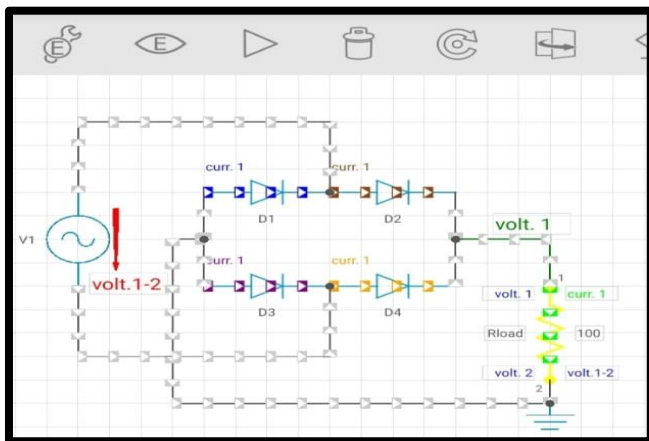

Fig.14: (A diode bridge full rectifier created by Electric Circuit Studio)

Genially (**Android and PC**)

Over the past few years, Genially has become increasingly popular as an online platform renowned for generating interactive and captivating content suitable for various Educational purposes, including classrooms, webinars, and presentations. With features such as templates,

animation tools, collaborative functions, and comprehensive analytics, Genially has proven effective in delivering high-quality solutions across Educational settings from K-12 to Higher Education levels. It is a valuable resource for educators who engage students in physical classrooms or remote environments. Genially's intuitive interface allows users to create multimedia content effortlessly, promoting the swift creation of visually appealing presentations without requiring coding knowledge. Through its multimedia capabilities, Genially enhances student engagement, fosters collaboration, stimulates creativity and provides insights into student progress. Additionally, specific versions offer analytics features that enable educators to track student engagement and performance, aiding instructional planning and assessment. As a sample of what this tool can do, see Fig.15 and Fig.16.
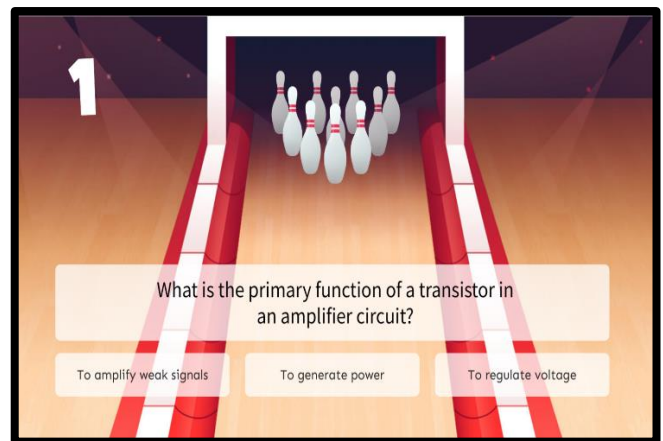

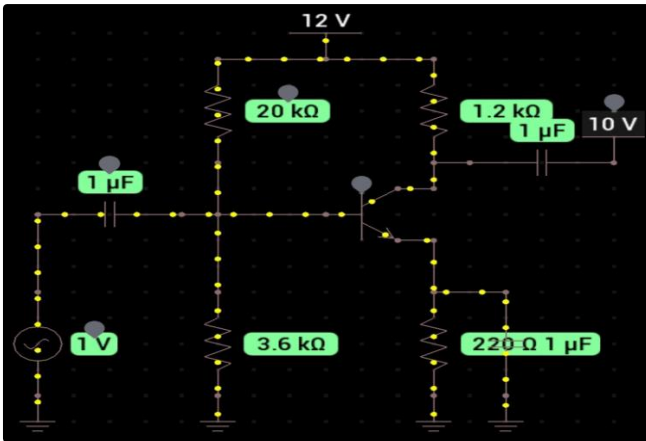Fig.15: (A game on Transistor created by Genially)

Fig.16: (An interactive stimulated circuit about Transistor As An Amplifier created by Genially)

Fig.17: (A competition about Diode created by Kahoot)

Kahoot (Android and PC)

Kahoot serves various functions, primarily focusing on learning and assessment, but also extends to entertainment, creating interactive quizzes and games, and team building. Its advantages encompass collaboration and teamwork through team-based play, accessibility, and differentiation, allowing students to review and practice material outside of class, enhanced classroom dynamics with excitement and fun, practical formative assessment providing real-time feedback for teachers to adjust teaching methods, variety and flexibility in question types and activity formats, data and analytics for insights into student performance, reduced grading time through automated grading, and customizable features like question addition, activity modification, and language options. However, it faces drawbacks such as occasional technical difficulties, limitations for comprehensive assessments of complex skills or knowledge, and a limited free plan with basic features, requiring a paid subscription for more advanced options like additional question types and increased player capacity. As a sample of what this tool can do, see Fig.17.
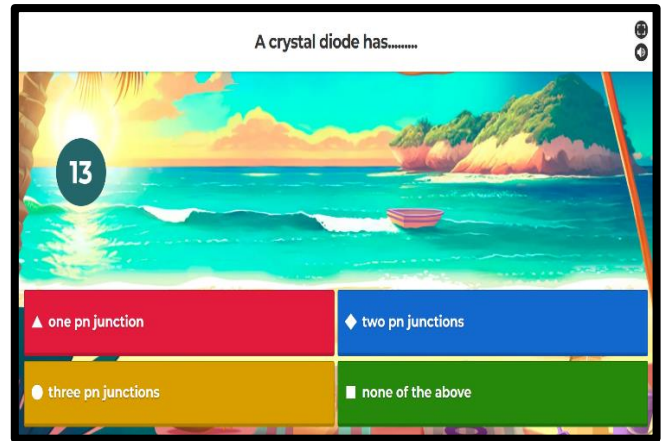
Wordwall (Android and PC)

Wordwall is a versatile website and app designed for creating interactive learning activities such as quizzes, puzzles, and games catering to various subjects, including vocabulary, grammar, math, science, and history. It is favored among teachers, educators, and homeschoolers for its advantages, including interactive learning through engaging activities, differentiation to accommodate various learning styles and abilities, assessment and feedback with immediate responses, collaboration and competition fostering engagement, versatility, and customization for diverse subjects and topics, data and analytics for monitoring student performance, and customizable features like adding pictures, setting quiz time, and rearranging questions and answers. However, it faces limitations with a limited free plan offering essential features, requiring a paid subscription for advanced options, and occasional technical difficulties like internet connectivity issues that may disrupt the learning process. As a sample of what this tool can do, see Fig.18.
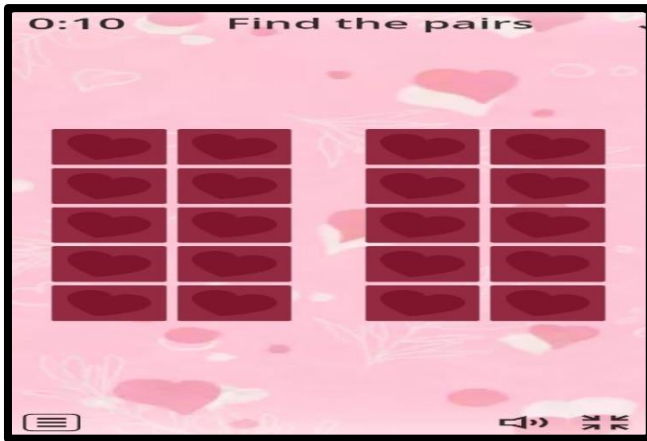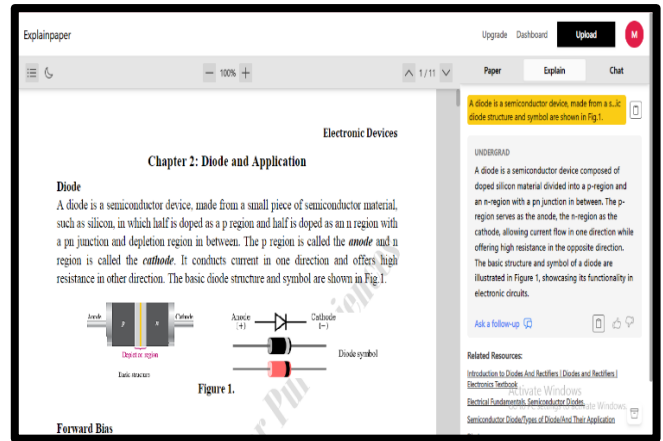
Fig.18: (A game about Diode created by Wordwall)

Fig.19: (An explained part about Diode created by Explainpaper)

Explainpaper (**Android and PC**)

The web–based tool aims to simplify information comprehension and save time for users. Upon signup, users can access a seamless Educational experience by uploading PDF documents or pasting links to begin reading mode. This mode offers three tabs—Paper, Explain, and Chat. The Paper tab swiftly summarizes research papers, with options to upgrade for detailed outlines. The Explain tab provides clear explanations of complex terms and equations, with the option to ask follow–up questions. Users can easily navigate pages and customize the reading mode. Premium users unlock advanced features in the Chat tab, facilitating paper summarization and significance assessment. However, limitations include restricted functionality in the free version, exclusive support for PDF files, lack of editing capabilities, reliance on web access, and the absence of supplementary features like content translation. These drawbacks may limit the app's versatility and convenience. As a sample of what this tool can do, see Fig.19.

Tutor AI (**Android and PC**)

The Tutor AI reinforces learning through interactive experiences like quizzes and flashcards. Its benefits include aiding students in creating multiple-choice questions, using AI–powered flashcards for personalized feedback and accelerated learning, and offering quick and easy usage with customizable content. Moreover, it facilitates individualized learning by analyzing vast data volumes and adjusting to students' preferences. Additionally, it enhances the learning experience through immersive technologies like augmented reality and virtual reality. However, drawbacks include potential technical issues and dependency on reliable technology infrastructure, which may hinder students' progress in case of disruptions. As a sample of what this tool can do, see Fig.20.

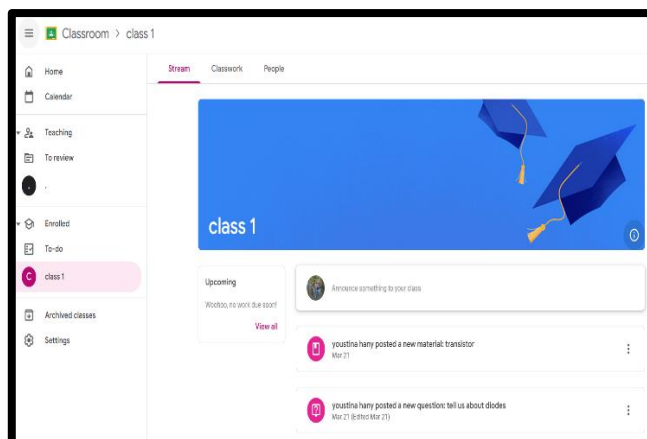Fig.20: (A created text about Transistor created by Tutor AI)

Fig.21: (A classroom created by Google Classroom)

Google Classroom (**Android and PC**)

Google Classroom, a free service by Google tailored for schools, simplifies the creation, distribution, and grading of assignments paperlessly, offering teachers a platform within the Google ecosystem to manage classes, tasks, and student communication. Advantages include its streamlined workflow, seamless integration with Google Apps fostering collaboration, real-time teamwork opportunities, efficient feedback and grading, accessibility from any internet-connected device, and robust security measures. However, challenges such as the digital divide hindering access, a learning curve for technology novices, dependence on technology leading to disruptions, limited offline functionality, and lingering data privacy concerns may affect its efficacy in Education. As a sample of what this tool can do, see Fig.21.

Nearpod (**Android and PC**)

Nearpod is an interactive Educational platform that revolutionizes classroom instruction by integrating multimedia content, real-time assessment, and collaborative features. With its interactive presentations encompassing videos, quizzes, polls, and simulations, Nearpod actively engages students in learning, fostering a more profound comprehension and retention of concepts. Teachers can instantly assess student comprehension through embedded quizzes and polls, adapt their teaching strategies accordingly, and track individual progress with detailed analytics. Versatile and accessible across devices, Nearpod accommodates various learning environments, including traditional classrooms and remote settings, while promoting collaboration and peer-to-peer learning through features like virtual field trips and group activities. Overall, Nearpod empowers educators to create dynamic and engaging learning experiences, enhancing student outcomes in today's digital age. As a sample of what this tool can do, see Fig.22.
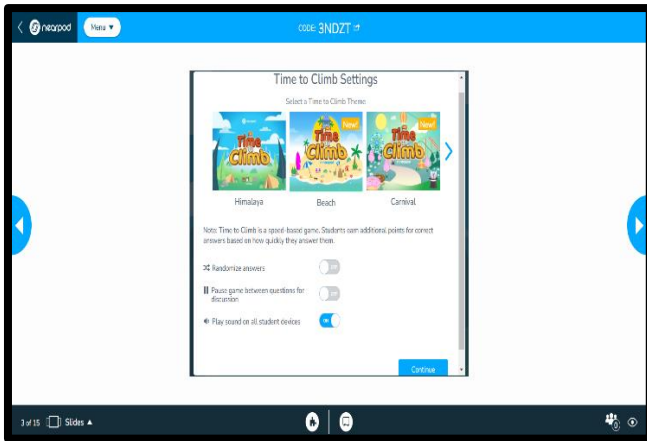
Fig.22: (A part of an interactive lesson about Transistor created by Nearpod)

Results of Research

Using the tools explained above, we created different materials (Website, Concept Maps, Summaries, Lesson and unit plans, Questions, Explanations, PowerPoints, Videos, Games, Interactive (Circuits, Books, and Lessons), Stimulated Circuits, Online Competitions, Virtual Classes) to help the students in the field of electronics. To experience all the materials created, scan the QR code shown in Fig.23.
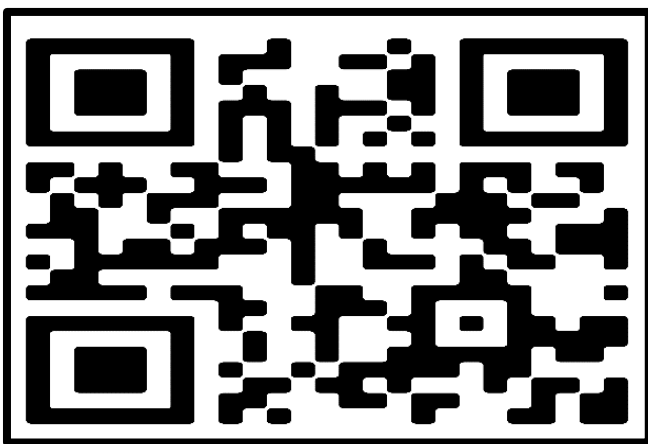

Fig.23: (The QR-Code of our website containing the whole created materials)

Interpretation of Results

We exploited our field training to apply our vision in the classroom despite the absence of most of the students and the weakness of the internet signal. Before applying the modern way discussed above, we used the traditional way and observed the boredom and the leakage of students' participation. After applying the contemporary way in which we used our website, having materials created with the help of AI, we observed the desire of students to participate in the lesson and the enthusiasm of students to learn more about the topic and do the stimulated circuits on their own. In addition to the entertainment felt by students, using modern ways to teach electronics saves the teacher time preparing the lesson and the assessment, allowing teachers to do more for their students.

Conclusion

"Technology will never replace great teachers, but technology in the hands of great teachers is transformational" by George Couros (2015). Using technology or AI tools makes the teaching and learning process more accessible for the teachers and more enjoyable for the students. After our study and research about the role of AI in overcoming the challenges of teaching and learning electronics, We highly recommend replacing conventional methods of preparing lesson plans with Magic School, transitioning from hardcover books to utilizing Book Creator, adopting Quiz Wizard for multiple-choice questions (MCQs), and integrating Wisdolia for essay questions. Additionally, we suggest replacing traditional methods of summarizing texts with Intellippt, utilizing Vidnoz for video recording, employing Heuristica to create concept maps, and leveraging Slides AI to develop presentations. Furthermore, we recommend using

Electric Circuit Studio for drawing circuits, Explainpaper for clarifying unclear concepts, TutorAI for addressing individual learning gaps, and Wordwall, Kahoot, and Genially for assessment purposes. For communication with students, we recommend transitioning from traditional methods to Google Classroom, and for online lessons, we suggest utilizing Nearpod as an alternative to conventional approaches.

Future Research Recommendations

Longitudinal Impact Assessment

Undertake longitudinal research to evaluate the enduring effects of AI integration in electronics Education. Analyze the sustained utilization of AI assistants to gauge their influence on student learning outcomes, knowledge retention, and academic performance over prolonged durations.

Comparative Analyses

Conduct comparative inquiries to assess the efficacy of diverse AI tools and platforms in augmenting the pedagogical experience within electronics Education. Scrutinize the strengths and weaknesses of various AI assistants to discern the most appropriate tools aligned with specific Educational objectives.

Student Perspectives Studies

Employ surveys or focus groups to elicit student feedback on their interactions with AI-powered Educational tools. Investigate student perceptions of AI assistants in electronics Education, encompassing usability, engagement, and overall satisfaction with the learning process.

Educator Training Initiatives

Develop and assess training modules for educators aimed at proficiently integrating AI tools into their instructional methodologies. Examine the impact of teacher professional improvement on the effective deployment of AI assistants in electronics Education.

Ethical Dimensions

Delve into the ethical considerations surrounding the utilization of AI in Educational settings, particularly concerning data privacy, algorithmic bias, and student agency. Explore strategies for promoting ethical AI usage in classrooms and mitigating potential risks associated with AI-infused learning environments.

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