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Developing a Model Based on Students' Perceptions of Using Artificial Intelligence Technologies to Support Self-Directed Learning

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Abstract

This study investigated the creation of a model based on students' opinions regarding the use of artificial intelligence (AI) technologies to facilitate self-learning for computer science and educational technology students. The objectives were to gauge students' knowledge of AI, evaluate how they used these tools for self-study, and pinpoint the difficulties and potential developments in the use of AI in higher education. The study used a questionnaire with 45 statements arranged along three primary axes: self-learning applications of AI, awareness of AI and its significance, and future trends and problems in its use. A sample of students from the Faculty of Specific Education provided the data, which was then evaluated using weighted averages, standard deviation, descriptive statistics, and student classification into LOW, MEDIUM, and HIGH categories. To find differences between the axes, ANOVA was also employed. The Random Forest approach was used to create a predictive model. A Calibrated Classifier was used to calibrate the results, and a Label Encoder was used to translate categorical traits into numerical values. This methodology was used to evaluate both individual and group performance and customize learning paths to students' skill levels. The findings demonstrated that students use artificial intelligence's capabilities to improve self-learning, time management, receiving feedback, and reviewing academic performance data, and they have a moderate to high level of understanding of the technology's significance. While student level analyses showed an increase in the HIGH category following system deployment, ANOVA results showed consistency in student assessment across the three dimensions. This demonstrates how well the paradigm enhances self-learning and fosters original thought. Additionally, the model improved the efficacy of self-learning and made it possible to offer tailored instructional advice. Expanding the system's deployment, creating faculty training programs, bolstering digital infrastructure, offering continuing student assistance, and promoting AI-enhanced collaborative learning were among the recommendations. Additionally, recommendations for further research were given, such as increasing the sample size, testing the system in various learning situations, creating sophisticated adaptive learning algorithms, researching collaborative learning, and assessing the system's long-term effects.

Keywords: *Artificial Intelligence Technologies, Self-Learning, Students' Perceptions, Model Development, Personalized Learning, Adaptive Learning.*

1. Introduction

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Over the past 20 years, the world has seen an unparalleled increase in the use of AI technology in a variety of spheres of life, especially education, which is the foundation of any growth in society. By enabling students to participate in self-directed learning through interaction with intelligent systems that take individual characteristics into account and offer prompt, tailored feedback, artificial intelligence (AI) has radically changed teaching methods and approaches (Nguyen, Tran, & Nguyen, 2023). In order to ensure successful and long-lasting learning, it is now crucial to investigate how to incorporate artificial intelligence (AI) tools like educational recommendation systems, smart assistants, and student learning analytics into university learning environments (Lee, Tan, & Teo, 2023).

In this regard, specialized education faculties are adopting contemporary teaching strategies that keep up with the swift advancements in technology. This is especially true for computer science and educational technology departments, which are expected to train instructors and instructional designers who can use technology to support educational objectives (OECD, 2023). According to this viewpoint, there is an increasing need to comprehend how students view AI technologies and whether they are prepared to use them as tools to facilitate self-directed learning. While unfavorable opinions of AI may impede its successful integration, positive attitudes help to promote its actual application in educational practices (Woodruff, Hutson, & Arnone, 2023). A critical first step in creating an intelligent, digital learning environment that takes learners' needs and preferences into account is creating a student-based model. According to the Global Education Monitoring Report Team (2023), learning models based on student feedback encourage the successful integration of contemporary technology in higher education and strengthen the legitimacy of practical application.

The success of every development project depends critically on students' comprehension of contemporary technology, particularly in institutions of specialized education that integrate theoretical knowledge with practical application. This emphasizes the significance of this study, which attempts to create a model based on how computer science and educational technology students view artificial intelligence technologies in promoting self-directed learning. Since it enables students to take charge of their education, select knowledge sources that suit them, and hone their critical thinking and problem-solving abilities, self-directed learning has emerged as a key idea in contemporary higher education (Almomani, Halalsheh, Al-Dreabi, Al-Hyari, & Al-Quraan, 2023). It is now feasible to create more accurate and efficient self-directed learning environments that better suit students' needs thanks to the development of artificial intelligence (AI) technologies like adaptive learning and predictive analytics-enhanced learning. However, learners' acceptance of the technology and their faith in its efficacy are crucial to these models' success (SH & Supriyono, 2023). In order to comprehend the elements influencing the adoption of these technologies and to inform future educational practices, it is imperative to investigate how students perceive the use of AI in self-directed learning (Chan & Hu, 2023).

As one of Egypt's top colleges for specialized education, Kafr Elsheikh University places a high value on creating smart learning environments and raising educational standards via the application of contemporary technologies. One of the faculties that blends creative, scientific, and technological fields is the Faculty of Special Education, which makes it a perfect setting for researching how children view artificial intelligence (AI) in the classroom. This is especially important for students majoring in computer science and educational technology, as they are the group most often exposed to the intelligent tools used in self-directed learning and e-learning. This study's significance also comes from its ability to close the research gap caused by the dearth of Arabic studies that discuss how university students see AI applications that facilitate self-

directed learning. Few research have examined the cognitive, psychological, and social aspects of students' acceptance of these technologies, whereas the majority have concentrated on the technical and applied aspects of AI in education. Therefore, by creating a framework that explains how AI can be applied in a way that improves learner autonomy and encourages self-directed learning, this research seeks to present an integrated model that connects the educational and technological components. Thus, the purpose of this study is to determine how educational technology and computer science students at Kafr El-Sheikh University's Faculty of Specific Education perceive artificial intelligence (AI) technologies and how they assist self-directed learning. A suggested paradigm that may be used to create intelligent learning environments in higher education institutions will then be developed using these impressions. In order to help students build 21st-century abilities, this model is anticipated to direct university decision-makers toward implementing AI-based instructional methodologies.

In light of the aforementioned, this study tackles the urgent need to incorporate AI technology into higher education from an educational viewpoint based on students' perspectives and experiences rather than just from a technical one. In keeping with Egypt's Vision 2030 for the development of innovation-based and digitally literate education, it also aims to create a workable framework for utilizing AI to improve self-directed learning and cultivate lifelong learning abilities.

1.1. Motivation:

The study's motivations stem from recent changes in the field of education, specifically the digital revolution and the quick advancement of artificial intelligence (AI) technologies. Education has become more and more dependent on technology to improve the quality of learning, encourage creative thinking, and help students develop their problem-solving abilities. One of the most popular contemporary trends is AI-supported self-directed learning, which lets students use a variety of digital tools to freely control their education. The most significant of these reasons are presented in an orderly and understandable way in the section that follows.

- The research is motivated by recent changes in education, especially the digital revolution and the quick development of AI technologies, since education now heavily depends on technology to improve learning quality, encourage creativity, and help students develop their problem-solving abilities.
- One of the most popular contemporary trends is AI-supported self-directed learning, which allows students to freely control their education utilizing a variety of digital resources.
- Since educational technology and computer science students are the group most directly related with technology and are anticipated to be pioneers in transferring and using AI tools in future educational contexts, the research aims to explore how they perceive AI technologies.
- There is a clear knowledge vacuum that this study aims to fill because prior research has mostly concentrated on the technical and applied

aspects of AI, ignoring the psychological and cognitive aspects of students' perspectives and motives toward adopting AI in self-directed learning.

- The research topic is in line with both the goals of Kafr El-Sheikh University to advance education and incorporate contemporary technologies into college programs, especially at the Faculty of Specific Education, and the Egyptian government's direction toward digital transformation and AI applications in education within the framework of Egypt Vision 2030.
- One practical step in creating more effective learning environments is to develop a model based on students' perceptions. This model will guide the design of educational courses and training programs that encourage self-directed learning and improve the efficiency of AI utilization.
- The study intends to offer a developmental vision that will assist educational institutions in successfully using AI in higher education, promote self-directed learning, attain equal educational opportunities, and enhance the quality of learning for computer science and educational technology students.

1.2. Contributions:

The goal of this research is to provide a variety of scientific and useful insights that will enhance educational literature and assist initiatives to advance university education in the context of contemporary technology. The following succinctly describes the most notable of these contributions:

- The study offers a thorough theoretical framework that connects the ideas of student perspectives, self-directed learning, and artificial intelligence. This gives earlier research that looked at each component independently a new perspective. Additionally, it advances the scientific understanding of the nature of learners' interaction with smart technology by elucidating the relationship between students' readiness and attitudes toward using artificial intelligence technologies and the efficacy of their application in university learning environments.
- Developing a model based on student views that can serve as a guide for creating AI-supported self-directed learning procedures in specialized education institutions is the applied part of this project. In order to create a balance between the technical and human components of learning, this paradigm offers a useful framework for incorporating artificial intelligence into the educational process.
- By using artificial intelligence (AI) technology as a tool for continuous learning, this research adds to national initiatives to improve the quality of university education. Students' 21st-century abilities, including

autonomous learning, critical thinking, and decision-making, are improved as a result. Additionally, it aids in directing educational policies toward the adoption of contemporary teaching strategies centered on students interacting with intelligent and engaging settings.

- Based on the anticipated outcomes, this study can assist in redesigning computer science and educational technology courses to incorporate AI applications as part of self-learning exercises. As a result, a dynamic learning environment built on data and astute student performance analysis is produced.
- This study paves the way for more thorough research in the future, both in assessing the suggested model's practical efficacy and in investigating how different university student groups see AI. Additionally, it can help create standardized assessments of students' opinions regarding the use of smart technology in the classroom.
- At the institutional level, this study provides a scientific model that may be used in education-specific faculties and other related faculties, supporting Kafr Elsheikh University's efforts toward digital transformation and innovation in university education. The university's standing in the areas of scientific research and educational advancement is strengthened as a result. In light of the aforementioned, it can be concluded that this research constitutes a qualitative contribution to the field of educational technology, both in terms of introducing a new model and in terms of integrating the theoretical and applied aspects of studying students' perceptions and their role in activating artificial intelligence techniques to support self-directed learning.

1.3. Project structure:

At the institutional level, this study provides a scientific model that may be used in education-specific faculties and other related faculties, supporting Kafr Elsheikh University's efforts toward digital transformation and innovation in university education. The university's standing in the areas of scientific research and educational advancement is strengthened as a result. In light of the aforementioned, it can be concluded that this research constitutes a qualitative contribution to the field of educational technology, both in terms of introducing a new model and in terms of integrating the theoretical and applied aspects of studying students' perceptions and their role in activating artificial intelligence techniques to support self-directed learning.

1. Related Work:

One of the most important elements of any scientific inquiry is the theoretical framework, which serves as the benchmark for interpreting the phenomenon being studied and directing the

investigation's actions in order to accomplish its goals. This framework covers the theoretical ideas associated with the three primary research axes: artificial intelligence in education, self-learning, and students' perceptions of educational technology, given the nature of the study, which focuses on creating a model based on the perceptions of educational technology and computer science students at the Faculty of Specific Education, Kafr El-Sheikh University regarding artificial intelligence technologies in supporting self-learning. Next, the analysis and research gap of earlier works that tackled the current study issue.

2.1 . Theoretical Framework:

This study's theoretical approach is focused on self-directed learning and artificial intelligence. By offering individualized learning experiences, evaluating student behavior, and facilitating independent learning through adaptive learning systems, intelligent tutoring systems, recommendation systems, and predictive analytics, artificial intelligence supports higher education. Simultaneously, self-directed learning is essential for fostering students' independence, critical thinking, and problem-solving abilities, and its efficacy rises when combined with AI technologies. Students' opinions about AI and educational technology are crucial to the success of self-directed learning because they affect the adoption and efficient use of these tools. This emphasizes how crucial it is to comprehend students' perspectives in order to create clever teaching models that successfully and sustainably promote self-directed learning in academic settings.

2.1.1 Artificial Intelligence:

One of the main characteristics of the Fourth Industrial Revolution is artificial intelligence (AI). It consists of a collection of software and systems that can mimic human thought processes, learn from mistakes, and make decisions on their own. According to recent research, artificial intelligence (AI) is becoming more and more important in the development of education since it helps analyze learner behavior and provide individualized instruction based on each student's needs and cognitive abilities (Tuomi, 2018). AI applications are employed in many areas of higher education, enhancing the educational process' efficacy and learning experience. Predictive analytics, which aids in the early detection of learning difficulties and enhances academic performance, intelligent tutoring systems, which offer immediate support and intelligent feedback during learning, adaptive learning systems, which adapt to the learner's abilities and pace of knowledge acquisition, and educational recommendation systems, which suggest appropriate learning content based on students' interests and needs, are some of the most well-known applications. (Yoon, Fels, Roll, Tang, and Seo, 2021). These technologies emphasize how crucial it is to use artificial intelligence as a supporting component for self-directed learning, in which the student takes center stage in the educational process and is given the ability to direct their own learning path with the assistance of intelligent systems that communicate with them on a constant basis. This demonstrates how artificial intelligence and successful self-directed learning in a university setting are closely related. (Tuomi & Holmes, 2022).

Numerous technologies are employed in education, the most prominent of which is machine learning, which analyzes learner data, forecasts performance levels, and creates customized learning plans; Sentiment analysis, which helps understand students' attitudes and feelings during learning; recommendation systems, which recommend suitable educational content based on

each student's behavior and interests; educational chatbots, which offer immediate support and respond to student inquiries around-the-clock; and expert systems, which offer educational consultations or assess learner performance in accordance with preprogrammed rules based on human expertise. Yağcı (2022). By empowering students to take charge of their education, specify their learning objectives, and select the methods that work best for them, these technologies have also improved self-directed learning. For instance, predictive analytics systems offer precise forecasts on a student's chances of success or their need for extra assistance, while adaptive learning systems assist in tailoring learning materials to each learner's needs. Additionally, educational robots and intelligent assistants like Google Bard and ChatGPT offer an interactive learning environment that makes knowledge easier for students to acquire and simplifies difficult concepts. (Gligorea, Cioca, Oancea, Gorski, Gorski, & Tudorache, 2023).

Despite these advantages, there are a number of obstacles to the use of AI in education, such as faculty and students' ignorance of its significance, privacy and data protection concerns, inadequate technology infrastructure in some institutions, and the requirement for teachers to receive continual training on how to use these tools effectively. (Pisica, Edu, Zaharia, & Zaharia, 2023) In order to create flexible and customized learning environments where the student becomes the center of the educational process, higher education will increasingly rely on artificial intelligence technology in the future. This helps create new educational models that encourage self-directed learning, foster creativity and critical thinking, and enable data-driven educational decision-making. (Guerra 2023).

2.1.2 Self-Directed Learning:

One of the most popular ideas in education today is self-directed learning. It is predicated on the notion that students are principally in charge of overseeing their educational journey, including goal-setting, information source selection, time management, and progress assessment. The goal of self-directed learning is to cultivate critical thinking, independence, problem-solving, and decision-making skills—all of which are necessary to meet the demands of the knowledge society. Additionally, it lessens students' total reliance on the teacher as their main knowledge source by enabling them to take charge of their own education (Knowles, 1975; Morris, Bremner, & Sakata, 2023). A number of essential characteristics set self-directed learning apart from conventional teaching techniques. The development of research and problem-solving skills through methodical information gathering and processing; independence in choosing what and how to learn; self-motivation based on intrinsic motivation to finish learning tasks; and self-evaluation to review performance and modify learning strategies to achieve optimal results are some of these. In 2022, Visiers-Jiménez et al. A key component of university students' skill development is self-directed learning. Through information analysis and creative application, it fosters the growth of critical and creative thinking. Additionally, it increases the degree of educational independence by enabling students to make their own educational decisions and strengthens lifelong learning abilities to stay up with scientific and technological breakthroughs. Additionally, it helps students perform better academically because research indicates that students who actively participate in self-directed learning typically outperform those who depend on conventional teaching methods (Thornhill-Miller et al., 2023). Self-directed learning is now even more successful when combined with e-learning resources and artificial intelligence thanks to recent technical developments. With the help of intelligent tools, students can monitor their

academic progress and obtain level-specific instructional recommendations. Additionally, these systems develop interactive learning environments that encourage students to study on their own and investigate information in novel ways, increasing their motivation and capacity for self-directed learning (Ilić, Mikić, Kopanja, & Vein, 2023).

The potential of these systems to tailor the learning process for each student, increasing autonomy and more effectively accomplishing learning objectives, highlights the confluence of self-learning and artificial intelligence. Students require sophisticated tools to assess their performance, pinpoint their areas of strength and weakness, and direct them toward relevant learning materials. This further supports the significance of researching how students view the use of AI to facilitate self-learning in higher education, particularly in departments of computer science and educational technology and faculties of specialized education, where self-learning is crucial to keeping up with the practical nature of courses and the quick speed of technological advancement (Kim, Lee, & Cho, 2022). One of the key elements that determines the effectiveness of any educational process based on contemporary technology is the attitudes and perceptions of students regarding the usage of artificial intelligence and educational technology. Positive attitudes boost students' enthusiasm for self-directed learning and autonomous knowledge exploration, as well as their acceptance of educational tools and their efficient use of them. On the other hand, unfavorable opinions may prevent these tools from being adopted and used to their full potential (Timotheou et al., 2022). Students' perceptions of technology use are a reflection of their mental attitudes, ideas, and beliefs. This includes how comfortable and confident they are utilizing digital tools, as well as how well they comprehend the advantages of technology in accomplishing learning goals. Ease of use, anticipated educational benefits, psychological attitudes about change and adjusting to new tools, and the extent of reliance on technology in everyday learning activities are all included in these perceptions (Madanian et al., 2023).

Personal factors like prior knowledge, experience, and self-confidence; educational factors like teacher support, course design, and assessment methods; technical factors like tool usability and system stability; and sociocultural factors like university and societal attitudes toward innovation and the use of technology in education all have an impact on students' perceptions (Singh et al., 2022). Studying students' perspectives is crucial for improving technology use effectiveness, identifying challenges and possibilities related to using smart tools, and strengthening the integration of technology and education. This helps create engaging and suitable learning environments that support students' internal motivation (Mahmoud, 2023). Because computer science and educational technology students constantly deal with smart tools, it is especially crucial to examine their perspectives. This enables researchers and designers to create intelligent educational programs that are tailored to the needs and skills of students, improve the efficacy of incorporating artificial intelligence into self-directed learning, and direct educational policies toward the best use of technology in creating creative and sustainable learning environments (Alam & Mohanty, 2023). It is clear how self-directed learning and artificial intelligence are integrated in this setting. Students can track their academic progress, assess their strengths and shortcomings, and find relevant educational resources with the help of smart technology. This encourages academic freedom and more effectively accomplishes learning goals. Thus, the foundation for creating intelligent instructional models that successfully and sustainably promote self-directed learning in higher education is an understanding of students' views (Akgun &

Greenhow, 2021).

2.2 . Literature Review:

In order to uncover research gaps and provide a solid scientific foundation for the issue of the current study, prior research is essential to any scientific endeavor. Self-directed learning, the application of artificial intelligence (AI) technologies in education, and students' opinions of educational technology have all been the subject of several research:

In her analysis of AI's role in education, Fitria [2021] emphasized how AI tools facilitate learning by automating repetitive processes like grading, monitoring attendance, and creating tests and reports. This enables educators to concentrate on innovative and instructional activities that enhance students' abilities and character. The study also highlighted the necessity for the education sector to adapt to AI in order to increase education quality without undermining the crucial role of teachers. Intelligent learning technologies, including educational robots, promote learning effectiveness and engagement. Using more than 400 research publications published in prestigious educational journals, Guan et al. [2020] provided a historical overview of the use of artificial intelligence (AI) and deep learning (DL) approaches in education during a twenty-year period. In order to investigate the development of research themes pertaining to the use of AI and DL in education, the researchers performed a computational content analysis, finding significant terms linked to AI-adapted teaching in each decade. The study also brought attention to methodological changes and new developments in educational research, such as the emergence of analytical learning models and student data analytics and the fall of traditional technology-enhanced instructional design research. Based on more than 400 research articles published in prestigious educational journals, Guan et al. [2020] provided a historical analysis of the use of deep learning (DL) and artificial intelligence (AI) approaches in education during a 20-year period. In order to investigate the development of research themes pertaining to the use of AI and DL in education, the researchers performed a computational content analysis, finding significant terms linked to AI-adapted teaching in each decade. The study also emphasized methodological changes and new developments in educational research, such as the rise of analytical learning models and student data analytics and the fall of traditional technology-enabled instructional design research. Dimitriadou & Lanitis [2023] examined how AI and new technologies are now being used in smart classrooms, with an emphasis on automated performance evaluation, smart teaching aids, and better classroom management. They presented prospective insights into the prospects and constraints of implementing AI technology in smart learning settings and carried out a SWOT analysis pertaining to the adoption of AI in education. The difficulties experienced by international students pursuing higher education abroad were discussed by Wang et al. [2023]. They investigated how these students' education was affected by AI applications, including chatbots, adaptive testing, personalized learning, and predictive analytics. They highlighted the risks and constraints associated with these applications, including privacy, cultural differences, language ability, and ethical considerations.

The role of AI in medical education was highlighted by Mir et al. [2023], who examined its contributions over the previous ten years in areas like language processing, reasoning, planning, cognitive modeling, virtual inquiry systems, remote learning, recording educational lessons, and improving non-analytical human aspects of medicine. The function of AI in higher education was discussed by Zawacki-Richter et al. [2019], who emphasized that it is a developing field with unclear pedagogical applications for educators. They identified four primary areas of AI

applications—student prediction and ranking, assessment and measurement, adaptive and personalization systems, and intelligent teaching systems—after conducting a systematic review of 146 studies published between 2007 and 2018. However, they noted a deficiency in critical analysis of challenges and ethical aspects. Slimi [2023] affirmed AI's influence on higher education, emphasizing how it may enhance instruction, learning, and evaluation while concentrating on ethics, necessary competencies, and graduates' chances for the future. The study showed how AI automates administrative and assessment work, customizes teaching strategies, gives quick feedback, and gives students professional skills. Chan [2023] collected data from 180 professors and staff members and 457 students at Hong Kong universities in order to address the creation of an AI education policy in higher education. In order to enhance learning outcomes and guarantee appropriate infrastructure, privacy, security, and training, the study suggested a policy framework that covered pedagogy, governance, and operation. According to Grassini [2023], in the last ten years, technology developments, especially artificial intelligence (AI), have drastically changed educational processes. The study looked into ChatGPT and other generative AI models, as well as how they affect education, transparency, and students' analytical abilities. Academic and industrial interest in AI in education (AIEd) is growing, according to Chaudhry & Kazim [2021]. Their study focused on lowering the workload of teachers, offering individualized instruction, enhancing evaluation techniques, creating intelligent teaching systems, and taking ethical considerations into account. AlGhamdi [2022] investigated how AI may be used in education to accomplish sustainable development in accordance with Saudi Vision 2030. AI's contributions to enhancing education, assisting administrators, and resolving issues in the educational sector were shown by the systematic review of 17 papers.

Zhao [2023] reviewed applications of AI in education, including data analysis, content recommendation, automated assessment and feedback, virtual teachers, smart chats, personalized/adaptive learning, natural language processing, and improved accessibility. The study highlighted the advantages for students as well as the challenges that lie ahead. With an emphasis on teacher workload reduction, individualized learning, intelligent teaching systems, ethical dimensions, and COVID-19 implications, Chaudhry & Kazim [2021] also examined radical shifts led by AI and predicted it will drive the next digital transition in education and work life. While discussing AI's actual impact on teaching and learning processes at the beginning of the twenty-first century, Bates et al. [2020] concentrated on the technology's potential to transform higher education, outlining outcomes like improved learning, increased access, enhanced retention, reduced costs, and shorter study durations. The impact of AI on teaching and learning in higher education was investigated by Popenici & Kerr [2017], who highlighted issues and recommended future study areas while concentrating on emerging technologies, student learning strategies, and institutional approaches. In a comprehensive evaluation of AI applications in higher education, Crompton & Burke [2023] examined 138 research and identified important areas such as intelligent assistants, teaching systems, assessment, prediction, and student learning management. In their evaluation of AI applications in automated assessment, intelligent teaching, collaborative learning, and personalized learning, Kamalov et al. [2023] emphasized the necessity for safeguards and ethical issues. Formative assessment, automated correction, and teacher training were highlighted in González-Calatayud et al.'s [2021] study on AI in student assessment. In their investigation of university students' intents to learn AI, Wang et al. [2023] demonstrated the impact of expectancy-value beliefs and supportive surroundings on learning intentions. In their examination of AI integration in smart classrooms, Dimitriadou & Lanitis [2023] focused on automated assessment, learning support, classroom management

tools, and SWOT analysis of AI adoption. Pawar [2023] looked at AI-enhanced learning for intelligent teaching, adaptive platforms, personalized education, and data-driven analytics, showing gains in learning outcomes and engagement. In order to assist teacher learning, Janssen et al. [2023] emphasized the importance of goal-setting in teaching methods by demonstrating how numerous goals mediate perception and context. In a meta-analysis of structured self-learning (SRL) programs, Theobald [2021] found gains in motivation, cognitive methods, and academic achievement. According to Aldosari & Alsager [2023], self-evaluation helps EFL students become more resilient, creative, and autonomous learners. According to Kerimbayev et al. [2023], student-centered methods combined with contemporary technology enhance online learning quality, SRL, and interaction. Tekkol & Demirel [2018] found good relationships between university students' attitudes toward lifelong learning and their capacity for self-directed learning (SDL). Self-paced, self-directed learning enhances cognitive function, emphasizing metacognitive techniques, according to Tullis & Benjamin [2011]. Rea et al. [2022] showed that although students are aware of good learning tactics, they seldom employ them. They suggested improving study habits and confidence. The importance of digital competences, self-control, and autonomous learning in embracing digital learning was highlighted by Scheel et al. [2022]. SDL techniques that help students define objectives, evaluate their progress, plan activities, and ask for feedback were covered by Robinson & Persky [2020]. According to Geng et al. [2019], blended learning environments improve learning engagement, social interaction, and technology readiness. In order to foster lifetime learning abilities, Charokar & Dulloo [2022] used guided self-learning in medical education. Goal-setting training enhances SRL and achievement motivation, as demonstrated by Hematian et al. [2016]. Structured SRL interventions improve academic achievement and strategy utilization, as shown by Akdeniz [2022]. A review of technology-assisted self-learning in low- and middle-income nations by Major et al. [2021] shown benefits when learning adjusts to student levels. AI applications that promote SRL were emphasized by Jin et al. [2023] and Tapalova & Zhiyenbayeva [2023], with a focus on cognitive and behavioral organization, individualized feedback, and ethical considerations. Dogan et al. [2023] highlighted how AI enhances adaptive and individualized learning in online environments, whereas Adiguzel et al. [2023] illustrated how ChatGPT may help SDL and teachers. AI techniques improve individualized, interactive SRL experiences while resolving ethical and technical issues, according to Namjoo et al. [2023]. Technology-assisted individualized learning was emphasized by Schmid et al. [2022] as a means of raising the caliber of instruction. AI technologies that support learning personalization, cognitive analysis, adaptive assessment, and ethical issues were highlighted by Zhang & Aslan [2021]. The role of AI and machine learning in digital classrooms, especially during COVID-19, was demonstrated by Shaikh et al. [2021]. ChatGPT's role in higher education was examined by Hasanein & Sobaih [2023], who noted the necessity of precise regulatory frameworks. Adaptive AI systems offer individualized learning experiences, as Kabudi et al. [2021] showed. AI's contribution to inclusive education, which supports students with a range of requirements, was emphasized by Toyokawa et al. [2023]. AI improves motivation, achievement, and structured SDL abilities, particularly in technology-based settings, according to Wei [2023].

2.2.1 Literature Analysis:

Academic interest in artificial intelligence (AI) applications in education has grown significantly in recent years, especially in light of the trend toward self-directed learning and technology-enabled education. Although the goals, approaches, and sample sizes of earlier research in this area have differed, their analysis identifies a number of key points of agreement and disagreement

that underscore the necessity of the current investigation. A examination of earlier research revealed a variety of research methodologies concerning the application of AI in education. According to studies by AlGhamdi (2022), Alenezi (2023), and El-Sayed (2021), AI technologies help create interactive, personalized learning environments that improve students' capacity to manage their own learning, raise educational standards, and foster critical thinking and problem-solving abilities. Nevertheless, some of these research were restricted to examining the overall educational benefit without exploring students' perspectives, while others concentrated on the technical components. Research on this subject was done in 2019 by Zawacki-Richter et al. (Qadir, 2022) investigated how students felt about the usage of AI in the classroom, highlighting the importance of positive awareness and adequate technological expertise for the successful integration of AI in higher education. Nevertheless, the majority of their research was descriptive and lacked explanatory models that would have clarified the connection between students' motivation, perceptions, and preparedness to use these technologies for self-directed learning. Parallel to this, research by Holmes et al. (2021) and Chen et al. (2023) concentrated on creating theoretical models for incorporating AI into higher education, emphasizing the significance of striking a balance between technological and human components. However, their relevance in local situations was constrained by their dependence on theoretical evaluations devoid of field evidence. Arab studies, including those by (Al-Hawari, 2022) and (Abdel-Hamid, 2023), advocated for the incorporation of AI into teacher preparation programs while highlighting the low awareness among students and teachers of its potential to enhance self-directed learning. The lack of an applicable framework based on students' perspectives in these studies, however, justifies the necessity for more thorough research on this topic in Egyptian educational contexts.

2.2.2 Link to Current Research:

The aforementioned investigation emphasizes how crucial it is to investigate how students see artificial intelligence (AI) technologies, especially in educational institutions that are ideal for incorporating technology into the classroom. Nevertheless, the majority of earlier research on AI either approached it from a technical standpoint or from a general educational perspective, failing to successfully combine these two aspects into an explanatory model that takes into account the opinions of the students. As a result, the current study is significant because it aims to create a model based on how students at Kafr El-Sheikh University's Faculty of Specific Education perceive the role of AI technologies in promoting self-directed learning. This method blends the applied (creating a model that may be used in university teaching) and theoretical (students' motives and perspectives).

2.2.3 The Research Gap:

The necessity for more thorough and in-depth research in this field was highlighted by a review and analysis of earlier works on artificial intelligence (AI) and its assistance for self-directed learning. Despite being among the groups most frequently exposed to and using educational technology in academic practices, the literature revealed a dearth of studies addressing the perceptions of students in faculties of specialized education regarding the use of AI technologies to support self-directed learning. Additionally, it was observed that there are no applied or explanatory models that systematically connect students' motivation, attitudes, and actual readiness to use AI technology in self-directed learning activities. This makes it more difficult for researchers to comprehend how students engage with these tools. The evaluation also showed that the majority of earlier research ignored the human and psychological aspects of students' attitudes and dispositions toward using these technologies in their autonomous learning in favor

of concentrating on the technical and practical aspects of AI. The literature also showed that there aren't many field studies in Egyptian higher education institutions that aim to offer useful and applicable solutions, especially in faculties of specialized education, which offer the best setting for fusing technology with instruction. By creating a model based on the opinions of students at Kafr El-Sheikh University's Faculty of Specific Education, the current study seeks to close these gaps in knowledge and science. The purpose of this model is to make clear how self-directed learning can be supported and made more successful by using artificial intelligence (AI) technology. In line with Egypt's Vision 2030, which aspires to create a contemporary educational system based on innovation and the integration of human and technology aspects, it intends to provide an applied vision that helps improve the quality of university education.

3 Methodology of the Proposed System:

The goal of this research's methodology is to give educational technology and computer science students a clear foundation for creating an intelligent system that uses artificial intelligence (AI) techniques to enable self-directed learning. The technique is based on the analysis of student data gathered from a 40-item questionnaire addressing three key themes: the application of AI in self-directed learning, the problems and future trends in its implementation, and awareness of AI and its importance. In order to provide precise indicators of each student's learning needs, the process also involves evaluating individual and group student performance and categorizing their levels using LOW, MEDIUM, and HIGH scales. The approach, which relies on quantifiable performance indicators to guarantee the enhancement of the quality of self-directed learning, focuses on combining statistical analysis of quantitative data with the application of AI algorithms to tailor educational content and enhance individual learning routes. The design and development of the system are explained as follows.

(1) Loading data and specifying columns

```
df = pd.read_excel(file_path, engine="openpyxl") if file_path.endswith('.xlsx') else pd.read_csv(

# استخراج الأعمدة
question_cols = [col for col in df.columns if col.startswith("x")]
num_students = len(question_cols)
num_questions = len(df)
df["Total"] = df[question_cols].sum(axis=1)
```

1-Loading the data file:

- If the file is EXCEL → Use pd.read_excel
- If it's CSV → Use pd.read_csv

2-Extracting the survey questions:
- Assumes all questions begin with the letter "x."
- For example: x1, x2, x3, … etc.

3-Calculating the number of questions and rows:
- Num students: Number of columns for questions (a logical error in the

naming, but the code treats it as the number of questions).
- Num questions: Number of survey rows (each row = one question.(

4-Calculating the total for each question:
- Sum the answers of all students for each question..

(2) Defining the boundaries of the LOW / MEDIUM / HIGH classification

```
min_total = num_students * rating_min
max_total = num_students * rating_max

low_th = min_total + (max_total - min_total) * (1/3)
med_th = min_total + (max_total - min_total) * (2/3)
```

-The algorithm attempts to create three evaluation levels based on student responses:
a. MIN (lowest possible score(
b. MAX (highest possible score(
Then, the field is divided into three equal levels:

Level	arithmetic range
Low	From the min to two-thirds of the distance
Medium	Between one-third and two-thirds of the distance
High	top third

(3) Classify each question into a category: LOW-MEDIUM-HIGH

```
def classify(total):
    if total <= low_th:
        return "LOW"
    elif total <= med_th:
        return "MEDIUM"
    else:
        return "HIGH"

df["Category"] = df["Total"].apply(classify)
```

-The classify function takes the total number of answers for a given question.

-Then it compares this to the criteria calculated by the code.

-The result: a new column, Category, which specifies the level of each question.

(4) Calculating the basic statistical values for each question

```
df["Aggregated_Avg"] = df[question_cols].mean(axis=1)
df["Weighted_Avg"] = df[question_cols].apply(lambda x: np.average(x), axis=1)
df["Std_Error"] = df[question_cols].std(axis=1) / np.sqrt(num_students)
```

1-Aggregate Average
- The arithmetic mean of all students for each question.

2- Weighted Average
- The same average but in the form np.average (here there are no weights, so it is equal to the standard average.(

3-Standard Error (SE(
- Standard error = Standard deviation ÷ √(number of students(
- Used to measure the accuracy of the average.

(5) Analysis of the axes (S – D – F)

```
axis_stats = {}
for axis_code, axis_name in axis_names.items():
    subset = df[df["المحور"] == axis_code]
    agg = subset["Aggregated_Avg"].mean()
    wgt = subset["Weighted_Avg"].mean()
    std = subset["Std_Error"].mean()
    high_ratio = (subset["Category"] == "HIGH").mean()

    axis_stats[axis_name] = {
        "Aggregated_Avg": agg,
        "Weighted_Avg": wgt,
        "Std_Error": std,
        "High_Ratio": high_ratio
```

- It compiles its related questions.
- It calculates:
  - Average of question averages
  - Average of weighted averages
  - Average of standard errors
  - Percentage of questions rated HIGH

-Result: A complete report describing the performance of each axis

(6) Conducting ANOVA between axes

```
df["محور_اسم"] = df["المحور"].map(axis_names)
anova_model = ols("Weighted_Avg ~ C(محور_اسم)", data=df).fit()
anova_result = anova_lm(anova_model)
```

–The code builds a one-way ANOVA model.
- Objective: To test whether the differences between the three axes are statistically significant.
- Dependent variable: Weighted
- Independent variable: Axis

The result determines:
- Is the difference between the axes significant?
- The p-value
- The F-statistic

(7)Student analysis within each axis

```
student_scores = subset[question_cols].sum()
...
categories = student_scores.apply(classify_student)
counts = categories.value_counts(normalize=True) * 100
```

- The total score for each student within this category is added together.
- Students are categorized as:

a. LOW
b. MEDIUM
c. HIGH

- The percentage for each category is calculated.

(8) Analysis of students at the full questionnaire level

```
total_scores = df[question_cols].sum()

total_categories = total_scores.apply(classify_total)
total_counts = total_categories.value_counts(normalize=True) * 100
```

- Each student's score is calculated across all questions in each section.
- It is then categorized (LOW/MEDIUM/HIGH).
- Result: The students' distribution across the overall survey level.

(9) Save the results in an Excel file and a text file.

```
output_path = "analyzed_output.xlsx"
df.to_excel(output_path, index=False)

with open("results.txt", "w", encoding="utf-8") as f:
```

a. Save a copy of the data after adding the new columns.
b. Write a summary of the results in the results.txt file:

- Axis Statistics
- ANOVA Results
- Student Analysis within Each Axis
- Overall Level Analysis

3.1 Introduction:

The purpose of this study is to shed light on the design and development process of the suggested system, which uses artificial intelligence technologies to facilitate self-directed learning for computer science and educational technology students. An examination of questionnaire data gathered from a sample of students at Kafr El-Sheikh University's Faculty of Specific Education served as the foundation for the system design. With an overall mean of 2.35, the data indicated that students' awareness of artificial intelligence ranged from medium to high. Students' comprehension of real-world AI applications in self-directed learning and their potential role in education varied, according to the research. An AI model that can anticipate students' learning requirements and adapt instructional materials to each student's awareness level was created using this data.

3.2 Design of the Proposed System:

The suggested solution is intended to improve self-directed learning by utilizing AI technologies. It is made up of a number of integrated, linked parts. An awareness and knowledge evaluation module, which collects detailed information on students' awareness of AI and its educational applications, is the first step in the process. The three main pillars of this examination are knowledge of AI technologies and their significance, how these technologies promote self-directed learning, and the difficulties and potential developments of AI use in education. The adaptive learning and predictive model module then makes use of machine learning algorithms to provide each learner with individualized instructional materials according to their degree of awareness and system participation. Each student's strengths and weaknesses are determined by the predictive model, which then directs them to the most appropriate material. Accurate indications of academic achievement and system interaction are produced by the Analysis and Reporting Unit, which evaluates student performance. The homogeneity of student replies was reflected in the ANOVA analysis results, which revealed no statistically significant differences across the axes ($F = 0.118$, $p = 0.888$).

3.2.1 Experimental Methods and Tools:

A 40-item survey was used to gather information about students' knowledge of artificial intelligence's (AI) role in self-directed learning. In order to assess academic accomplishment and interaction, student performance records were also kept during the system trial. These records served as training data for the prediction model. Following data collection, the metadata was transformed into numerical values for statistical analysis, missing or invalid values were eliminated, and the data was cleansed. To ascertain the distribution of student responses for each dimension, pooled means, weighted means, and standard deviations were computed. Descriptive statistics were used to show awareness levels at each level, ANOVA was used for inferential analysis to see whether there were significant differences across the dimensions, and AI algorithms were used to customize instructional materials to students' levels.

3.3 Data Collection:

To guarantee the accuracy of the suggested model, information was gathered from several sources. This comprised information from the 40-item survey, which evaluated three primary aspects: knowledge of AI technologies and their significance, how AI technologies assist self-directed learning, and the difficulties and potential developments in AI application. A sample of students from the Faculty of Specific Education were given the questionnaire, and quantitative data, such as pooled and weighted averages and standard deviations, were gathered. Additionally, students were divided into two groups based on their awareness level: High and Medium. In order to monitor engagement and enhance adaptive learning algorithms, system usage logs were recorded along with student performance data from self-learning exercises and tests. Small groups participated in laboratory tests to compare performance before and after the system was put into place and assess its efficacy. The system design and the choice of the best algorithms were also influenced by earlier research.

Table 1: Distribution of themes, number of items, and level of awareness

Theme	Number of items	Level of awareness
Awareness of Artificial Intelligence Technologies and Their Importance	15	Moderate - High
Artificial Intelligence Technologies in Supporting Self-Learning	15	Moderate
Challenges and Future Trends	10	Limited

3.4 Data Analysis Methods:

Using pooled and weighted means and standard deviations, descriptive statistical analysis was utilized to categorize students into High and Medium levels for each axis of awareness and participation. ANOVA analysis was also used to assess for differences between the axes. The results revealed no significant differences, demonstrating response homogeneity. In order to

identify patterns and concepts pertaining to the application of artificial intelligence, qualitative content analysis of observations and open-ended responses was also carried out. In order to tailor self-learning materials and maximize performance according to each student's awareness level, AI algorithms were also trained on student data.

3.5 System Implementation Procedures:

Setting up a complete computer environment with software tools and adaptive learning algorithms, as well as uploading all instructional materials and digital resources into the system, were all part of the system implementation procedures. The learning experience was then customized by entering student data that was taken from the questionnaire and prior performance statistics. After that, self-learning algorithms were used to categorize pupils based on their degree of AI awareness, direct them toward relevant content, and create a customized learning route for each student based on their areas of strength and weakness. Lastly, the effectiveness of the system was assessed by tracking student interaction and recording new data. Self-directed learning and student engagement using AI technologies improved, according to preliminary findings.

3.6 Evaluation and Criteria:

Both quantitative and qualitative criteria were used to assess the system's efficacy. The high proportion of replies following system implementation and the cumulative and weighted averages for each axis were among the quantitative criteria. Analyzing how students behaved when interacting with the system and evaluating their own fitness for the learning path were examples of qualitative criteria. Improved averages and a higher high percentage indicated the model's effectiveness. The outcomes following system adoption were compared with the initial data using statistical analysis tools like ANOVA.

Table 2: System Evaluation Criteria

Content	Standard type
The combined average and weighted average for each axis, and the percentage of high responses after application.	Quantitative
Analyzing student behavior during interaction, and self-assessing the suitability of the learning path	Qualitative
Averages improved and the percentage of High increased	Measuring success
ANOVA and pooled means to compare results before and after application	Analysis tools

4. Presentation of Experimental Results:

Students' opinions about adopting artificial intelligence (AI) technology to assist self-directed learning were examined along three primary axes using data from a questionnaire given to students in the Educational Technology and Computer Science Department.

Axis 1: Understanding AI technologies and their significance. The findings demonstrated that the majority of students have a moderate to high degree of understanding regarding the principles of artificial intelligence and its uses in educational technologies. Students understand the value of AI in enhancing the caliber of digital learning environments and encouraging innovative thinking, according to an analysis of the combined and weighted averages. Additionally, a sizable portion of students fall into the HIGH category, indicating a high degree of awareness and understanding, according to the classification into LOW, MEDIUM, and HIGH groups.

Axis 2: Self-Directed Learning with AI Technologies. The findings demonstrated that students use AI technologies to improve their programming abilities and create instructional materials. Throughout the learning process, these tools assist learners in setting clear learning goals, efficiently managing their time, and getting instant feedback. A large proportion of students fell into the HIGH group, according to statistical analysis, demonstrating how well AI can support self-directed learning and increase student independence. Third Axis: Difficulties and Prospects for AI Use. Students noted a number of difficulties, such as the expensive price of some AI products, a lack of practical awareness, and restricted technological skills. They also stated that they thought a well-defined plan and the creation of digital infrastructure were necessary for incorporating AI into education. According to the ranking results, the majority of students think that investing in AI offers a chance to advance the field of educational technology and raise the standard of future educational achievements.

General Statistical Analysis: The distribution of student responses for each axis was ascertained using pooled and weighted means as well as the standard error. Additionally, a one-way ANOVA was performed to compare the three axis' differences. The homogeneity of student responses and the constancy of their views regarding AI in self-directed learning were reflected in the results, which revealed no statistically significant differences ($F = 0.118$, $p = 0.888$).

Analysis of Individual Student Levels: Students were divided into LOW, MEDIUM, and HIGH categories both within each axis and throughout the questionnaire. Following the pilot program's implementation, the number of students in the HIGH category increased, showing stronger student awareness and engagement with AI technology as well as better achievement of self-directed learning objectives. The experiment's findings strongly suggest that the suggested system, which is based on how students view the application of AI, can enhance academic performance, encourage self-learning, and increase interaction with AI tools and technologies in digital learning environments.

4.1 Experiment Implementation:

Students in the Department of Educational Technology and Computer Science participated in a pilot study of the suggested system for assisting self-directed learning using artificial intelligence (AI) technologies, adhering to a set of methodical and structured procedures to guarantee the precision and dependability of the outcomes.

Adaptive learning algorithms, digital learning resources, and raw data taken from a questionnaire and students' prior performance records were all part of the comprehensive computer environment that had to be set up for the pilot.

Students' answers to 45 statements covering three axes—awareness of AI technology, use of AI in self-directed learning, and future problems and trends—were input. Additionally, academic performance records from quizzes and self-directed learning activities were included.

After classifying students into LOW, MEDIUM, and HIGH categories based on their AI awareness levels using clever learning algorithms, the system customized learning materials for each student. While creating individualized learning paths to suit each student's needs, this content concentrated on strengthening strengths and addressing deficiencies. All data produced by the usage of instructional tools and smart technologies was collected, and student interaction with the system was tracked during the trial time. This aided in improving the dynamic content adaption algorithms and evaluating student adherence to designated learning pathways.
Lastly, LOW, MEDIUM, and HIGH categories were examined for each axis and the full questionnaire, and a preliminary evaluation of student performance was carried out using pooled and weighted averages. In comparison to the initial data prior to the system's adoption, the results demonstrated a clear improvement in students' awareness of artificial intelligence technology and enhanced student independence in self-learning, with a higher number of students categorized in the HIGH category.

Table (3) Experimental results of students' awareness of artificial intelligence technologies

Theme	Level of Use/Awareness	Percentage	Average	Aggregate	High Ratio
Awareness of Artificial Intelligence Technologies and Their Importance	High	58.33%	2.35	0.03	0.73
Awareness of Artificial Intelligence Technologies and Their Importance	Moderate	41.67%			
Artificial Intelligence Technologies in Supporting Self-Learning	High	38.67%	2.31	0.03	0.53
Artificial Intelligence Technologies in	Moderate	61.33%			

Supporting Self-Learning					
Challenges and Future Trends	High	16.67%	2.29	0.02	0.40
Challenges and Future Trends	Moderate	83.33%			

4.2 Analysis of Results:

In order to comprehend students' awareness, their use of smart technologies, and upcoming challenges in the fields of computer science and educational technology, data generated from the application of the proposed system to support self-directed learning using artificial intelligence (AI) technologies was analyzed. The questionnaire's themes, students' performance within each subject, and the questionnaire as a whole comprised the three primary levels of analysis.

Examination of the Three Themes: The average student results for the first theme, which dealt with knowledge of AI technologies and their significance, were comparatively high. The majority of pupils demonstrated a solid grasp of the significance of AI in creating e-learning tactics and raising the caliber of virtual learning environments. A sizable portion of students were in the HIGH group, demonstrating their solid understanding of AI principles and real-world applications. The second subject, which dealt with the use of AI technology in self-directed learning, demonstrated how well students use these tools to set objectives, track their progress, and get quick feedback. Additionally, a significant portion of pupils were in the HIGH group, indicating their capacity to improve their level of learning independence. The third subject, which dealt with future trends and problems, showed that students understood the significance of incorporating AI into future teaching methods as well as potential obstacles including few technology resources and the high cost of some technologies. The LOW, MEDIUM, and HIGH categories showed a relative balance that reflected the different degrees of student understanding of upcoming opportunities and difficulties.

Student Analysis within Each Axis: The LOW/MEDIUM/HIGH classification technique was used to classify students based on their level within each axis. Following the system's adoption, the percentage of students in the HIGH category clearly increased, showing higher student awareness and engagement with AI technology as well as improved self-learning abilities.

Analysis of Overall Questionnaire Level: Students were divided into three groups once their scores were compiled along all axes. The results demonstrated the efficacy of the suggested method in improving academic achievement, self-motivation, and interaction with AI technologies, since the great majority of students fell within the MEDIUM to HIGH range.

General Statistical Analysis: The distribution of student responses was ascertained using pooled and weighted means and standard error. In order to compare differences between

the three axes, a one-way ANOVA was also performed. The findings revealed no statistically significant differences ($F = 0.118$, $p = 0.888$), indicating the homogeneity of student responses across the various axes. The findings show that the suggested method effectively increased students' understanding of artificial intelligence, improved their capacity for self-learning, and promoted their engagement with intelligent learning resources. The research goal of creating a model based on students' perceptions of AI use was supported by the analysis, which also revealed that students were capable of using AI technology in autonomous learning while exhibiting an awareness of upcoming obstacles and trends.

4.3 Comparison of Results with Previous Studies:

The current study's findings demonstrate that students in the department of Educational Technology and Computer Science have a moderate to high level of awareness about artificial intelligence (AI) technologies and successfully use them to support self-directed learning while also being aware of potential future challenges and opportunities for growth. These results are consistent with a number of earlier research that examined how AI may improve education and self-directed learning.

AlGhamdi's (2022) study, for instance, found that using AI-powered smart learning systems boosts students' autonomy and self-motivation. This finding is in line with the current findings, which indicate that a greater proportion of students in the HIGH group use AI technology. Additionally, in order to guarantee the successful customisation of instructional content, Alenezi's (2023) study stressed the significance of evaluating students' awareness of AI technologies prior to deploying smart learning systems. The present system's design took this into account by dividing students into LOW, MEDIUM, and HIGH categories.

Additionally, El-Sayed's (2021) research showed that incorporating artificial intelligence (AI) into self-directed learning enhances engagement with digital learning materials and academic success. In comparison to the original data, the present analysis demonstrates better student performance along all three axes and a greater proportion of students in the HIGH group.

Although the current study is comparable to earlier research, it makes a unique contribution by creating an integrated model based on students' opinions of AI. In order to customize self-directed learning materials for every student, this approach applies machine learning and classification algorithms in conjunction with awareness analysis, the usage of smart technologies, and future challenges. This component has not been the subject of prior research with the same degree of integration and usefulness.

The comparison shows that the current study's findings complement the body of research on how AI can improve self-directed learning while also making a unique contribution by incorporating students' perspectives into the creation of an interactive, customized AI-based learning model.

4.4 Discussion of the Significance of Results:

The study's findings highlight how crucial it is to incorporate how students view the use of artificial intelligence (AI) technology while creating self-learning environments. The results demonstrate that students use AI's tools to improve their autonomous learning and have a moderate to high level of understanding of the technology's significance. These findings highlight the relevance of smart technology in enabling tailored learning and customizing educational content to each student's level by demonstrating how students may use AI to encourage autonomy, personal planning, and close monitoring of academic success.

The study also showed that gaps in knowledge and real-world applications of AI can be found by examining the three axes (awareness, application, and future difficulties). This makes it possible for the suggested system to create customized learning pathways to close these gaps. The system's dependability in forecasting each student's learning demands was reinforced by ANOVA, which verified the lack of statistically significant disparities across the axes, demonstrating the homogeneity of students' perceptions and the balance of their replies.

At the individual student level, the findings indicated that the system's efficacy in increasing awareness and fostering self-learning skills is demonstrated by the higher proportion of students in the HIGH category following its deployment. Additionally, leveraging data to classify students and tailor information guarantees more dynamic and adaptive learning, boosting their motivation and engagement.

These findings show that the suggested methodology, which combines student perspectives, statistical analysis, and the use of artificial intelligence to customize learning routes, provides a qualitative improvement over earlier research from both an academic and practical standpoint. This feature is a useful component for creating individualized self-learning, enhancing the caliber of educational results, and encouraging student autonomy and creativity in the fields of computer science and educational technology.

The study's conclusions emphasize the significance of creating intelligent learning systems based on student perceptions, where artificial intelligence can be used for data analysis as well as to offer a customized learning experience that improves academic performance and encourages students' self-improvement and creative thinking. This emphasizes how important the findings are both theoretically and practically for promoting future learning.

4.5 Limitations and Potential Errors:

Although the suggested approach for assisting self-learning through artificial intelligence techniques has demonstrated positive results, there are several restrictions and possible mistakes that could impact the results' interpretation or generalizability. These include the small sample size and dependence on a particular field (students in the Department of Educational Technology and Computer Science at the Faculty of Specific Education, Kafr El-Sheikh University), the use of subjective questionnaires that could be impacted by personal prejudices, and the experimental system's short trial periods and constrained laboratory setting. Individual differences in students' technical proficiency and system interaction are also possible, as are little mistakes in data processing or the use of categorization methods. These limitations highlight the necessity of interpreting the results cautiously and emphasize the significance of carrying out additional research with larger samples, a variety of learning contexts, and longer durations to guarantee the validity and generalizability of the results.

5.Practical Implications, Recommendations, and Future Directions:

The goal of the current study is to create an integrated educational model that takes into account how students see the use of artificial intelligence (AI) technology to facilitate self-directed learning. This model seeks to gauge students' understanding of the significance of artificial intelligence (AI), how they use these tools for learning, and the difficulties and emerging trends they encounter when doing so. The suggested system makes it possible to tailor instructional materials to each student's needs, which improves learning efficacy, fosters creativity, and develops the technical know-how required to keep up with the rapid advancements in digital technology.

5.1 Practical Implications of the Results:

The results of this study indicate a variety of useful applications that can have a substantial impact on students' self-directed learning in computer science and educational technology as well as the development of AI-based university programs. By classifying students according to their AI awareness into LOW, MEDIUM, and HIGH levels, the suggested model makes it possible to create individualized learning pathways that build on strengths and solve shortcomings, improving learning effectiveness and student autonomy.

The outcomes also help to raise the standard of instructional materials and make them more interactive. Each student's level-appropriate content can be delivered by smart learning platforms, which also efficiently organize learning and offer quick feedback. Additionally, using AI enables students to apply their technical and problem-solving abilities, encouraging critical and creative thinking and preparing them for the needs of the digital labor market.

The results also emphasize how crucial it is to help faculty members become more adept at using AI tools and methods to assess student performance and create intelligent learning pathways. Workshops and specialized training programs can help achieve this. The study's conclusions can also be used by educational institutions to assess knowledge and skill gaps among students and to enhance institutional and academic planning, including technology infrastructure and the availability of digital resources to promote lifelong learning. Monitoring individual progress and precisely identifying learning needs are made possible by implementing an integrated artificial intelligence system that delivers accurate data on student performance. This encourages data-driven instructional choices to improve student learning and content engagement. As a result, the study shows that putting the suggested model into practice improves the effectiveness of self-directed learning and customizes it for each student, resulting in a smart learning environment that fosters both academic and personal growth while offering useful tools to improve the caliber of higher education through artificial intelligence technologies.

5.2 Recommendations:

A set of academic and practical recommendations can be made to improve the efficacy of self-learning and advance education in the fields of computer science and educational technology based on the study's findings about students' awareness of artificial intelligence (AI) technologies and their use of these technologies in self-learning. These suggestions include creating training programs for faculty members to strengthen their abilities in incorporating AI into learning path design and content customization; extending the use of the suggested system to a greater number of students across various disciplines to guarantee the thoroughness of the results and improve

data reliability; strengthening the university's digital infrastructure by offering cutting-edge gadgets, sophisticated software, and a reliable internet connection to support AI applications; offering students ongoing support and direction to ensure the efficient use of smart technologies and the organization of their independent learning; promoting AI-supported collaborative learning to improve social skills and interactive learning; and, lastly, routinely assessing and measuring the system's impact to adjust and improve the smart education system and ensure the sustainable development of self-learning and meet students' evolving educational needs. These suggestions show that incorporating AI into education entails strengthening faculty and student capacities, enhancing infrastructure, and guaranteeing ongoing evaluation of the efficacy of self-learning, all of which improve educational quality and help students meet their personal and professional learning objectives.

5.3 Guidelines for Future Research:

The study's conclusions include a number of crucial recommendations for further investigation into the application of artificial intelligence (AI) in educational technology and computer science fields to facilitate self-directed learning. These include testing the system in various learning environments, such as distance learning and blended learning, to evaluate its efficacy in various contexts; increasing the sample size to include students from multiple universities to ensure the generalizability of results and to understand individual differences; and combining quantitative and qualitative assessment tools to provide a more complete picture of the learning experience and the efficacy of AI use. To enhance the system's capacity to precisely personalize material, it is also advised to create sophisticated adaptive learning algorithms, such as deep learning and reinforcement learning, and investigate the effects of AI-assisted collaborative learning on social interaction and academic achievement. In order to maximize system deployment, a long-term assessment is also recommended to ascertain the durability of self-directed learning outcomes and to look at organizational and technological issues like scarce digital resources and university regulations. These recommendations offer a thorough foundation for creating more efficient intelligent learning systems with an emphasis on long-term impact analysis, collaborative learning integration, and personalization. This will foster innovation in higher education through the use of AI technologies and improve the quality of self-directed learning.

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