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Effect of a Proposed Program Based on Artificial Intelligence in Developing Academic Achievement in the Digital Skills Course for First-Grade Intermediate Female Students

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Abstract
The study aimed to identify the impact of a Proposed Program Based on Artificial Intelligence in Developing Academic Achievement in the Digital Skills Course for First-Grade Intermediate Female Students. To achieve the study objectives, the researcher applied the experimental approach with its semi-experimental design, and she designed one data collection: an achievement test in the digital skills course. The research community included all first-grade intermediate students who are regular in the first semester of the academic year (1444 AH) in Olia district in Riyadh.The research sample consisted of (48) students from (140) intermediate school divided into two groups ،a control group and an experimental group. The researcher concluded the following findings: There is a statistically significant difference at the significance level ($\alpha \leq 0,05$) between the average scores of the experimental group students and the control group students in the post-application of the achievement test in digital skills for the benefit of the experimental group. Thus, the research proved the positive impact of teaching using an artificial intelligence-based program in developing academic achievement in the digital skills course among first-grade intermediate students sets of recommendations were reached: Increasing the interest of the authors of the digital skills course in employing the educational program based on artificial intelligence in the lessons of the digital skills course ،and expanding its application to different educational stages ،and other educational materials.

Keywords: Artificial Intelligence - Academic Achievement - Female Students - Digital Skills.

Introduction

The 21st century has witnessed remarkable advances in information and communication technology, leading to a significant scientific and cognitive revolution. This progress has driven social institutions to explore the most effective methods and strategies to harness these developments in various fields such as education, training, healthcare and business.

The integration of technology in education contributes to deeper and more lasting learning experiences, broadens students' access to knowledge, promotes collaboration and teamwork, enhances observation and problem-solving skills, and encourages independent learning. In addition, technology stimulates student interest, increases classroom engagement, accommodates individual learning differences, overcomes spatial and temporal constraints, and optimizes effort (Al-Balawi, 2020). Accordingly, researchers have emphasized the importance of using educational technologies to improve the quality of education, achieve mastery learning, reinforce educational goals in a shorter time frame with fewer resources, strategically reduce the cost of education without compromising quality, and maximize the return on the learning process (Abu-Ghazaleh, 2018).

Based on these benefits, many countries have adopted technology in education to achieve the United Nations Sustainable Development Goals (SDGs) to improve the quality of education (2015), which indicates a fundamental change in the components of the educational process (Selwyn, 2019/2020). In this regard, the Ministry of Education in Saudi Arabia has undertaken curriculum reforms to keep pace with the rapid evolution of technological

applications. These reforms aim to provide a curriculum with a high degree of knowledge, interactivity, and flexibility, which will ultimately increase student motivation, focus, and academic achievement (Faulkner & Latham, 2016).

Curriculum development serves as an effective tool to advance societies and achieve their goals, especially in computer science education, a field characterized by constant renewal and transformation (Al-Ibrahim & Al-Muhaizaa, 2019). Bower and Falkner (2015) emphasized that computing is no longer taught only as information and communication technology (ICT), but has evolved into computer science, transforming students from passive consumers to active creators and innovators who can understand and interpret the technologies and phenomena around them.Among the most important emerging technologies, one of the pillars of educational advancement and a key avenue for curriculum development is artificial intelligence (AI) (Shawahin, 2021). AI has introduced unprecedented roles and functionalities that have fundamentally changed the educational landscape. AI systems are designed to model and replicate human intelligence using sophisticated technologies that are capable of solving complex problems in a more humane manner (Al-Balawi, 2020). The integration of AI in educational institutions is critical to promote personalized learning and active engagement while accommodating individual differences among students. AI-powered educational systems tailor learning experiences to each student's performance and skill level, assess their strengths and weaknesses, and recommend personalized learning materials to enhance their academic progress. As a result, AI will have a profound impact on curriculum design, replacing traditional textbooks with digital learning media and introducing knowledge-rich, contemporary curricula. In light of these advances, this study proposes the development of an AI-based program aimed at improving students' academic achievement. This initiative seeks to leverage the capabilities of AI to improve educational outcomes, optimize learning processes, and better equip students for the demands of the digital age.

Research Problem

Academic achievement is the final outcome of the educational process, and is of great importance as it determines the extent to which educational goals and pedagogical objectives are achieved. Several educational and professional associations, such as the International Society for Technology in Education (ISTE) and the Saudi Society for Educational and Psychological Sciences (Justin) at King Saud University (Al-Omari, 2019), have emphasized the continuous improvement of students' academic achievement and the development of skills and competencies that enable them to play an effective social role that meets the demands of the modern era.

The issue of academic achievement has been extensively studied, with numerous research findings pointing to the persistence of low academic achievement among students. Studies confirm that this phenomenon is prevalent in many countries and poses a significant challenge to educators, supervisors, administrators, and policy makers (Al-Asatl & Afaneh, 2010; Al-Habsi et al., 2020; Al-Ruhaili, 2021; Al-Saeedeen & Al-Sarour, 2021; Abdullah & Al-Bashir, 2015). Similarly, the researchers, as computer science teachers in Riyadh, noticed the low academic performance of female students through direct classroom observations. Several challenges contribute to this problem, including the uniform delivery of curricula to all students without considering their individual differences in abilities, skills, and learning pace. In addition, many teachers rely on traditional teaching and assessment methods, especially in computer science courses, as highlighted in studies by Al-Obaikan & Al-Hanaki (2016) and Al-Hanaki & Al-Arfaj (2020). Consequently, several studies, including those by Al-Obaikan & Al-Hanaki (2016) and Al-Duraibi & Al-Okaili (2017), have recommended the adoption of modern teaching methods based on digital technologies to address individual differences and overcome the limitations of traditional teaching and assessment approaches.

In this context, artificial intelligence (AI) has emerged as an applied field of computer science that seeks to study and replicate human intelligence. Numerous conferences have recommended the integration of AI technology in education as an innovative tool to enhance teaching and learning. These conferences include the International Conference on AI and Education, the AI and Education: Challenges and Prospects Conference, and the Innovation and AI in Education Conference. Several studies have supported AI applications in education, including Al-Yajzi (2019), who emphasized that AI technologies help identify essential skills required by the labor market in line with Saudi Vision 2030, while addressing individual learning differences and promoting self-directed learning. Similarly, Al-Omari (2019) highlighted the positive impact of AI in improving students' academic performance.

Given that AI-driven technologies can effectively address students' individual differences and improve their academic performance, this study seeks to develop an AI-based program aimed at improving student performance. This initiative is in line with modern technological advancements, responds to recommendations from academic conferences and previous studies, and explores the impact of an AI-based instructional program on improving academic achievement in the Digital Skills curriculum for first-year middle school students.

Research Questions

The purpose of this study is to answer the following research question:

What is the impact of an AI-based instructional program on improving academic achievement in the digital literacy curriculum among first-year middle school female students?

Research Hypotheses:

This study will test the following hypothesis:

There is no statistically significant difference at the significance level ($\alpha \leq 0.05$) between the mean scores of students in the experimental group and those in the control group on the post-test achievement test for the Digital Skills subject.

Research Aims:

The study aims to investigate the impact of an AI-based instructional program on improving academic achievement in the Digital Skills curriculum among first-year middle school female students.

Research Significance

1. **Theoretical Significance:**

- This study contributes to the enrichment of Arab

educational research by addressing global and local changes in artificial intelligence (AI).
- It is in line with modern educational trends that advocate the integration of AI applications in the field of education.
- The study provides a theoretical framework on AI in computing education, including its role in teaching and learning processes, its applications in computing education, its connection to learning theories, its impact on the elements of the educational process, and adaptive learning in the digital literacy curriculum.

2. Practical significance
- The study benefits teachers and supervisors of digital literacy curriculum and other subjects by addressing the limitations of traditional teaching strategies, leading to improved teaching methods that take into account technological advancements and individual student differences, and ultimately improving academic achievement.
- It proposes a scientifically and practically tested AI-based instructional program that addresses individual student differences, promotes active learning, places students at the center of the educational process, and encourages them to take responsibility for their own learning and task completion.
- The results of the study can help educational policymakers in Saudi Arabia to improve and develop various components of the educational process, including teachers, students, curricula, and classroom environments.

Research Scope
- **Scope**: This study is limited to examining the impact of a proposed AI-based program on improving academic achievement in the cognitive domain at the levels of recall, comprehension, and application. The study focuses on Unit 3: "Introduction to Programming" from the Digital Skills curriculum (1444 AH edition) for first-year middle school students. The intervention uses an AI-powered chatbot tool, and the research variables were measured using an academic achievement test.
- **Location**: The study was conducted at the Middle School (140) for Girls in Riyadh, Saudi Arabia.
- **Timeframe**: The research was conducted during the first semester of the academic year 1444 AH, which is the period during which the study tool was applied to the sample.

Research Terminology

Effect: Effect is defined as "the result of a desirable or undesirable change that occurs in the learner as a result of the educational process" (Al-Habsia, Al-Salmi & Al-Najjar, 2020, p. 22). Operationally, effect is defined as the degree of change in the academic achievement of first-year female students in Intermediate School No. 140 in Riyadh as a result of instruction using Artificial Intelligence (AI) technology.

Artificial Intelligence (AI): Ulinwa (2008) defines AI as "the programming of computers using artificial intelligence languages to enable them to perform tasks that simulate human intelligence". Operationally, AI is defined as an intelligent educational program developed by the researchers, designed in a question-and-answer format to provide information to first-year middle school female students in a specific cognitive domain (recall, comprehension, application). The program mimics a human teacher by analyzing students' prior knowledge, learning styles, and cognitive abilities, providing instructional guidance, offering different instructional strategies, diagnosing weaknesses, and providing tailored remediation. It adapts its interactions based on individual differences, while the teacher's role remains one of guidance and facilitation.

Academic achievement Aderman (2007) defines academic achievement as "a student's ability to demonstrate mastery of the educational experiences designed for him or her. Operationally, academic achievement refers to the extent to which first-year middle school female students acquire knowledge at the levels of recall, comprehension, and application in the Digital Skills subject. It is measured by scores on an achievement test (a researcher-developed assessment for the current study).

Previous studies related to artificial intelligence

Al-Omari (2019) conducted a study that aimed to explore artificial intelligence chatbots and their role in enhancing the cognitive aspects of the science subject for sixth grade female students in Jeddah. The study used a cognitive test as a research instrument, and adopted a quasi-experimental design. The ADDIE model was used in the design of the chatbot, and the results showed its effectiveness in improving the cognitive aspects of the students, which positively influenced their learning outcomes in the achievement test.

Similarly, Al-Yajzi (2019) investigated the use of AI applications in supporting higher education in Saudi Arabia. This study contributes to the research map of educational technology, especially in light of Saudi Vision 2030, which emphasizes the use of technology in education. The study used an inductive methodology with a descriptive-analytical approach. The findings included that the use of AI applications in educational interactions positively influenced learner engagement. The study recommended that curricula be revised to integrate AI-related technologies, especially in engineering, mathematics, and science courses, and suggested that training programs be developed for both faculty members and students to enhance their skills in using AI applications.

In a study conducted in China by Zhao et al. (2019), the researchers investigated the impact of online AI-based teaching systems on students' academic performance. The study used a critical descriptive approach, analyzing studies that used online AI-based teaching systems. The results showed that the use of AI-based online teaching systems had a significant and positive impact on students' academic achievement.

Al- Jerawi (2020) aimed to explore the impact of using artificial intelligence technology in an e-learning environment on the development of future thinking skills and academic achievement in science among female middle school students. The study followed a quasi-experimental design and included a sample of 40 students from the third year of middle school in a private school in Riyadh. To achieve the research objectives, an e-learning environment based on AI technology was developed, along with an achievement test to assess students' science knowledge, a future thinking scale, and a future thinking test to measure students' performance in future thinking skills. The study

used the ADDIE model to design the learning environment. The results indicated that the use of AI technology in the e-learning environment had a positive effect on the development of both future thinking skills and academic achievement in science. The study recommended that educators use AI technology and integrate future thinking skills more extensively in science subjects.

This finding is corroborated by the study of Hassan (2022), which aimed to investigate the role of artificial intelligence in developing critical thinking skills and scientific attitudes among second year female high school students in the physics curriculum in Al-Kharj. To achieve the objectives of the study, the researchers used a descriptive-analytical approach. The study sample consisted of 40 students from the science stream. The research instruments included a critical thinking test, an AI scale, and a scientific attitudes scale. The study revealed several key findings, including the positive impact of artificial intelligence on the development of critical thinking skills and scientific attitudes. Based on these findings, the study recommended emphasizing the development of critical thinking skills at all levels of education, regularly updating curricula to incorporate relevant skills, integrating different AI programs, and ensuring a cohesive approach to educational experiences across levels rather than treating them as isolated entities.

Hassnawi (2022) conducted a study aimed at exploring the importance of integrating artificial intelligence technologies in kindergarten education as a modern approach that improves the quality of education for this age group. The study used a descriptive survey approach, which was considered the most appropriate for the research. The researcher designed a questionnaire that was administered to a sample of 30 kindergarten teachers in the city of Yanbu. The results showed that the integration of AI technologies contributes to the development of the child's personality, addresses behavioral, psychological, and learning issues, enhances the child's language and cognitive skills, and improves the teacher's competence. Therefore, the integration of AI technologies is considered crucial for improving the quality of education.

Previous studies related to academic achievement

The study by Fahaim et al. (2020) examined the impact of using electronic mind maps on the geography achievement of fifth grade students. The study used a quasi-experimental design with a post-test as the research instrument and a sample of 47 female students. The results showed statistically significant differences in favor of the experimental group on the post-test scores.

The study by Najdi and Al-Ghamdi (2022) aimed to evaluate the effect of using differentiated instructional strategies on improving academic achievement in science among fifth grade female students. The study used an experimental design with a sample of 118 female students. Their performance was measured both pre- and post-test in terms of recall, comprehension, and application. The results showed statistically significant differences in favor of the experimental group on the post-test. The study recommended the importance of using differentiated instruction in science education, given the strategy's suitability to the nature of the science curricula developed and its role in engaging students in the learning process.

Research Methodology and Procedures

Research Method

Based on the research problem and the questions arising from it, and after reviewing previous studies, the quasi-experimental method was adopted due to its relevance to the nature and objectives of the research. According to Al-Assaf (2016), it is defined as: "The application of a particular factor to one group, while another group is not exposed to it, in order to determine whether the independent variable has an effect" (p. 339).

Research Design

The present study utilized one of the quasi-experimental designs, specifically the design that includes an experimental group and a control group with pre- and post-test measurements. This design is widely regarded as one of the most common in experimental research in education and social studies, as indicated by Campbell and Riecken (1968) and Cook and Campbell (1979). In this design, two groups (at least) are selected based on their similarity on relevant variables. One group is the experimental group and the other is the control group. The experimental group will be taught using an AI-based educational program (developed by the researchers), while the control group will receive conventional instruction. Research tools will be applied in two stages: pre-test (before the AI-based educational program is implemented) to verify the equivalence of the groups and control for variables, and post-test (after the AI-based educational program is applied). Statistical analysis is then conducted to test the research hypotheses. This is illustrated in Figure (1).

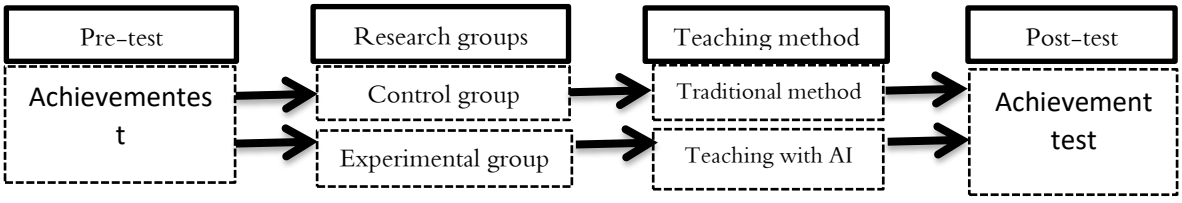

Fig. 1: The quasi-experimental design of the study.

Research Population

The research population consisted of all first-year female students in the first semester of the academic year (1444 AH) from secondary schools under the supervision of the Education Department in Al-Olya. The total number of students was 1,354 according to the statistics provided by the Planning and Development Department of the General Directorate of Education in Riyadh (Planning and Development Department, personal communication via email, researches@riyadhedu.gov.sa, September 20, 2022).

Research Sample

Sample Description*:* The research sample consisted of 52

female students divided into two groups: a control group and an experimental group. These students were enrolled in the first year of middle school at Al-140 Secondary School in Riyadh during the first semester of the academic year 1444 AH. After applying the research tools to the sample, valid responses were accepted for statistical analysis and invalid responses due to absenteeism, interruption, or health problems were excluded. Consequently, the final number of valid samples was 48 students.

The sample was selected from the research population using a multi-stage cluster random sampling technique. This method involves the random selection of areas, groups, or clusters such as schools, classrooms, or educational regions where all members have similar characteristics (Abu Alam, 2011). Random assignment to groups is an important step in conducting studies with a quasi-experimental design that includes both pretest and posttest and includes a control group (Abbas et al., 2017). Random assignment ensures equivalence between the groups, which means that the experimental and control groups are comparable in all variables except for the independent variable being studied (Al-Assaf, 2016).

Search Variables:

- **Independent Variable**: The proposed AI-based educational program.
- **Dependent Variable**: Academic achievement of first-year female middle school students.

Research Materials:

To achieve the research objectives, an AI-based educational program was developed that is capable of automatically adapting to users according to their needs and preferences, taking into account individual differences. This was achieved by using an AI-based software tool (chatbot) that uses Natural Language Processing (NLP) and Machine Learning (ML) to facilitate human-machine interaction in a way that simulates human behavior. It is also known as a talkbot, chatterbot, bot, IM bot, or interactive agent (Hassan, 2022). The following steps were taken in the development of the program:

1. **Determining the criteria for the AI-based educational program**
2. **Selecting the tool for developing the AI-based educational program**: There are many AI-based educational tools, each of which is different according to its purpose, such as Smart Sparrow Platform, Area9 Lceum Platform, Alef Platform, Reading Progress, Meeting Script, Power BI, and Chatbot. The AI-based software tool (chatbot) was selected for the current study due to its suitability based on the following considerations: The program is designed for student-centered learning, with the teacher's role limited to guidance and support. It accommodates individual differences among students and allows them to engage in dialogue with the program, a key feature of AI-based programs. It also provides diagnostic, formative, and summative assessments, while allowing students multiple attempts to reach the correct answer. This is consistent with the principle of learning by trial and error and the principle of assessment for learning.
3. Stages of the design of the AI-based educational program: After reviewing the theoretical literature on the design of educational software based on models, the design of the AI-based educational program was conducted according to the general instructional design model (ADDIE), as it is the most suitable for this research for the following reasons: This model is one of the most comprehensive and widely used in instructional design, and all other instructional design models revolve around these five stages. The differences between the models lie in the focus and extent to which each stage is presented. This model provides the designer with a procedural framework to ensure that instructional products are highly efficient and effective in achieving objectives. The ADDIE model has five stages:
4. **Analysis**: Analysis of content, student characteristics, and system needs, including task analysis, problem identification, and practical solutions, as well as analysis of student needs, content objectives, place and time, materials, budget, and student abilities. This stage is the starting point for all steps in the model.
5. **Design**: The design stage involves specifying the procedures and requirements for the educational process, including goals, strategies, and various instructional methods, as well as assessment to achieve these goals. Researchers emphasize the importance of all stages of the ADDIE model. However, in order to clarify the methodology, more emphasis is placed on the Design stage, as it allows to present the structure of the intelligent program and its educational scenario, as well as its development before implementation. Therefore, the design stage of the AI-based educational program was detailed from a comprehensive perspective, covering the following aspects: the pedagogical design aspect, the technical design aspect, and the design of the integration of AI technology into the educational environment.
6. **Development phase:** This is the stage where the design process is translated from a blueprint and scenarios into ready-to-use educational materials through educational technologies and supporting resources. The actual production of the AI-based educational program was carried out using various programming languages and design and production software tools.
7. **Implementation stage:** In this stage, the educational tool was used in practice, ensuring that the necessary conditions were met, including the availability of equipment and other supporting aspects.
8. **Evaluation stage:** This stage involves measuring the effectiveness and efficiency of the AI-based educational program. Evaluation is ongoing and occurs at all stages of the instructional design process, including after implementation. It is carried out in two steps (Ibrahim, 2015).

Research tool: Achievement Test

The achievement test was designed according to the steps outlined by Al-Dosari (2001):

1. **Defining the objective of the test:** The objective of the test is to measure the academic achievement of first-year female middle school students in the cognitive aspects that are constructed based on the cognitive goals in accordance with Bloom's taxonomy (remembering, understanding, applying) for the third instructional unit of the digital skills curriculum for first-year middle school students, first semester, titled "Introduction to Programming," as prescribed by the

Ministry of Education in Saudi Arabia for the academic year 1444H.

2. **Content Analysis:** Qudah (2016) emphasizes that content analysis is a set of techniques and procedures designed to classify the study material into main topics, and then break them down into measurable objectives. The "Introduction to Programming" unit was analyzed with the topic as the unit of analysis and the cognitive objectives based on Bloom's Taxonomy (Remembering, Understanding, Applying) as the categories of analysis, as detailed in Appendix (B, p.136).
3. **Create the Specification Table:** The specification table is a plan that links the essential content elements (topics) to the objectives and specifies their relative importance. It reflects content validity and has two dimensions. The first dimension is vertical and indicates the topics of the unit and the relative weight of each topic. The second dimension is horizontal and represents the cognitive objectives based on Bloom's Taxonomy (Remembering, Understanding, Applying) with the relative weight assigned to each level. Based on this, the test items and scores were distributed. (Appendix D, p. 188).
4. **Determining the Type of Test and Formulating the Items:** Test items were written in an objective format and divided into two types of questions: True/False and Multiple Choice. The criteria for constructing objective questions were followed in formulating the test items. It was ensured that each test item measured a specific level of Bloom's cognitive taxonomy (remember, comprehend, apply).
5. **Providing Test Instructions:** To ensure reliable results, students were provided with a set of instructions that included an explanation of the purpose of the test, the time allotted for the test, and instructions on how the student should respond. The instructions were carefully designed for comprehensiveness, clarity, and precision, and specified exactly what students were expected to do. (Appendix R, p. 192).
6. **Preparing the Test Item Answer Sheet:** The final version of the test consists of 16 items, with each correct answer worth one point and incorrect or unanswered items worth zero points. This means that the maximum score for the test is 16 and the minimum score is zero. (Appendix Z, p. 198).
7. **Psychometric Characteristics of the Tool (Validity and Reliability):** The indicators and evidence related to the logical analysis and internal structure of the tool confirm its suitability for use. These include: expert validity (face validity), internal consistency, and reliability using Cronbach's alpha coefficient.
    a. **Face Validity of the Test (Apparent Validity):** The initial version of the test was submitted to a panel of subject matter experts for review (Appendix C, p. 149). The experts were asked to provide feedback and suggestions on the following issues: clarity of the test instructions, scientific and linguistic accuracy, clarity of the questions for students, and appropriateness of the questions for the cognitive level they were intended to measure. Based on the panel's feedback, the test was revised to improve its quality and better meet the research objectives. The experts' endorsement and modifications serve as evidence of the validity of the instrument. After ensuring the validity of the test, a pilot study was conducted by administering the test to a sample (outside the main research sample but from the same population) consisting of 30 first-year female secondary school students from 91st Secondary School in Al-Olaya Educational District, Riyadh. The objectives of the pilot study were: to evaluate the clarity of the test instructions and items, to calculate the internal consistency of the test, to determine the reliability coefficient of the test, to evaluate the difficulty and discrimination indices of the test items, and to measure the time required to complete the test.
    b. **Internal Consistency of the Test:** To ensure the internal consistency of the achievement test, the Kuder-Richardson Formula 20 (KR-20) was used because it is one of the most widely used formulas for assessing the internal consistency of test items. This method examines the extent to which questions within a test are correlated with each other, with a correct response scored as 1 and an incorrect response scored as 0. The KR-20 formula used in this study is as follows (Kuder & Richardson, 1937):

$$KR_{20} = \frac{K}{K-1}\left[1 - \frac{\sum pq}{\sigma^2 X}\right]$$

Given that:
K: The number of test items.
∑pq: The sum of the product of the proportions of correct answers for each test item and the proportions of incorrect answers for each test item.
$\sigma^2 X$: The variance of the total scores on the test.
After applying the equation to the data from the pilot sample, the results indicated that the instrument has a high internal consistency for the purposes of the current study, with a total value of (0.812). According to Ismail (2004), internal consistency is considered high when the value falls between (0.80-0.90).

c. **Reliability Using Cronbach's Alpha Formula:** The reliability of the achievement test was measured using Cronbach's alpha formula after administering it to the pilot sample, as shown in Table (5):

Table 5: Cronbach's Alpha Coefficient for Measuring the Reliability of the Achievement Test.

Nr.	Distance	Number of phrases	Stability coefficient
1	Remembering	***7***	0.812
2	Understanding	5	0.779
3	Application	4	0.713
Overall Constancy		16	0.812

Table (5) shows that the achievement test has an acceptable level of reliability for the current research purposes, with an overall reliability coefficient value of (0.812), which indicates high reliability. The reliability coefficients for the

dimensions of the achievement test ranged between (0.713 - 0.812), which are considered high reliability coefficients that allow confidence in the results obtained after applying the test to the research sample (Nunnally, 1978).

8. Calculation of difficulty and discrimination coefficients

Statistical indicators (discrimination and difficulty coefficients) help assess the validity of each question. The level of difficulty of each item in the test can be determined by calculating the mean of the correct answers using the following formula (Al-Dosari, 2001):

Difficulty Coefficient = (Number of students who answered the item correctly / Total number of students).

The difficulty coefficient of the test items was calculated as shown in Table (6).

The discrimination ability of the test items between high and low performing students can be determined by calculating the discrimination coefficient for each item using the following steps (Al-Abdulkareem & Al-Ruwais, 2015):

1. Rank the students' scores from the highest to the lowest.
2. Divide the scores into two groups: 50% represent the high scores and 50% represent the low scores.
3. Determine the number of students who answered each item correctly in each group.
4. Use the following formula: Discrimination Coefficient = (Number of correct answers in the high group - Number of correct answers in the low group) / Number of students in either group. The discrimination coefficients for the test items were calculated as shown in Table (6).

Table 6: Difficulty and Discrimination Indices for Test Items in the Achievement Test.

Paragraph	Difficulty coefficient	Discrimination coefficient	Paragraph	Difficulty coefficient	Discrimination coefficient
1	0.37	0.45	**9**	0.59	0.46
2	0.79	0.21	**10**	0.32	0.26
3	0.55	0.83	**11**	0.51	0.86
4	0.22	0.46	**12**	0.60	0.22
5	0.30	0.29	**13**	0.41	0.39
6	0.47	0.29	**14**	0.76	0.68
7	0.40	0.39	**15**	0.23	0.32
8	0.77	0.39	**16**	0.71	0.69

Table (6) shows that the difficulty coefficients of the test items range between (0.22 - 0.79), which is considered acceptable for the purposes of the current research. Shuaib & Shuaib (2016) and Obeid et al. (2012) state that the acceptable difficulty coefficients range between (0.20 - 0.80). On the other hand, the discrimination coefficients of the test items ranged between (0.21 - 0.86), which are also considered acceptable for the purposes of the current research. Obeid et al. (2012) emphasized that if the discrimination coefficient of an item is (0.20) or higher, it indicates that the item has good discrimination and should be retained.

9. Calculate the test duration

To calculate the appropriate test duration, the average time spent on the test was calculated using the following formula:

Appropriate Test Duration = (Time the First Student Finished + Time the Last Student Finished)/2.

The first student finished in 11 minutes, while the last student took 37 minutes. Therefore, the appropriate time to complete the quiz was 24 minutes. The final version of the test is shown in the Appendix (R, S1-92).

Procedures for Applying the Research:

These are the practical steps taken to collect data on the research problem to answer its questions and test its hypotheses. The application of the research experiment to the experimental and control groups went through three phases: preparation phase, experimental phase, and post-experimental phase, which are detailed as follows:

Experimental Treatment:

1. **Preparation for the Experiment**

- Reviewing previous studies and relevant literature on the topic of artificial intelligence and academic achievement, with the aim of analyzing and benefiting from them in preparing the theoretical framework, research tools and materials, and using them to address the problem and answer its questions and test its hypotheses. Based on this, the research plan was developed.
- **Building the Research Tool:** The research tool was a knowledge test for the third unit of the Digital Skills curriculum for first-year middle school students in the first semester. Its content validity was verified by presenting it to a group of experts from the faculties of curriculum and teaching methods at Saudi universities, as well as computer science supervisors and teachers. Their feedback was collected regarding the appropriateness of the test for application and to ensure the clarity and correctness of the items, after which the test was modified accordingly.
- **Construction of the research material:** An educational program based on artificial intelligence technology was developed, which is capable of automatically adapting to users in a way that matches the needs and preferences of the students. The program was designed using methods derived from the principles of artificial intelligence. The design of the educational program followed the established criteria for AI-based programs from the study of Al-Jerawi (2020). The chosen tool for the program was an AI-driven chatbot, and the design of the educational program followed the ADDIE model, which was considered the most appropriate for this research. It was implemented using the intelligent chatbot system developed on the Flow XO platform, using programming languages such as JavaScript and Python, and supported by AI specialists. The program was then reviewed by a group of experts from Saudi universities specializing in curriculum, teaching methods, computer science and artificial intelligence, as well as computer science supervisors and teachers. Their feedback was used to ensure that the program

met the standards for AI-based educational programs and was modified accordingly.

- **Conducting the Pilot Study for the Research Tool (Knowledge Test)**: The pilot study for the research tool (the knowledge test) was conducted on a sample outside the main research sample but within the same community. This pilot sample consisted of 30 female students from the first-year middle school at School 91, part of the Riyadh District's Office of Education, on 22/03/1444H. The pilot study aimed to achieve the following objectives: understanding the clarity of the instructions and test items, calculating the internal consistency of the test, computing the reliability coefficient of the test, determining the difficulty and discrimination coefficients of the test items, and calculating the test duration. Additionally, the AI-based educational program was tested on the pilot sample to ensure its appropriateness and ease of use, and to gather student suggestions regarding the program and any additions they thought should be included in the final version. Based on the results, the research tool and material were revised and finalized.
- **Selecting the Research Sample**: The research sample was randomly selected from the first-year middle school classes. The first class (1/4) represented the experimental group, and the second class (1/2) represented the control group.
- **Controlling the Research Variables and Ensuring Group Equivalence**: To enhance the equivalence between the two groups, the researchers not only used random selection for the groups (which is one of the most important methods for controlling external variables) but also controlled the key external variables that were expected to influence the research outcomes. The process of controlling the variables included the following:
    - **Subject teachers**: The researchers themselves taught the students in both the experimental and control groups.
    - **Level of Teacher Performance:** Efforts were made to ensure that all members of the research sample received the same level of instruction from the teacher. The teacher taught both groups with the same level of effort and interaction, and the only difference between the groups was the independent variable (the AI-based educational program).
    - **Educational content:** All students in both the experimental and control groups studied the same educational content (Unit 3, "Introduction to Programming," from the Digital Skills curriculum for first-year middle school students, 1444H edition).
    - **Lesson duration:** The duration was standardized for both groups (experimental and control), with a total of five lessons of 45 minutes each.
    - **Academic achievement:** A pre-test (knowledge test) was administered to students in both groups at the beginning of the study. An independent sample t-test was used to verify that there were no statistically significant differences between the two groups (control and experimental) and that both groups were equivalent in terms of academic achievement.
    - **Isolation**: The control group was isolated from exposure to the effects of the independent variable (the AI-based educational program) by ensuring that they did not have access to or experience with the program.
- **Preparation of the experimental group:** A meeting was held with the students in the experimental group to explain the goals of the research and to inform them that they would be learning the curriculum in a different way using artificial intelligence. A link to the AI-based educational program was provided to each student through Microsoft Teams prior to the start of class so that they could access the program from the school's computer lab. Any questions were answered by providing a way for students to communicate with the teacher.

Phase Two: Implementing the Experiment

- **Pre-test Application of the Research Tools**: The pre-test for both the experimental and control groups was conducted on 24/03/1444H. When administering the pre-test, the following points were emphasized: clarifying the purpose of the tools, instructing students to read the instructions carefully before starting, and ensuring they answered the test items honestly. Afterward, the data were statistically processed using the Independent Sample T-Test (T-test) to compare the means between the two groups, as shown in Table (8).

Table 8: Results of the Independent Sample T-Test for the difference between the mean scores of the experimental group and the control group in the pre-test of the knowledge test.

Group	Nr.	Mean	Standard Deviation	"t"	Sig.
Control	**24**	8.54	1.93	0.65	0.51
Experimental	**24**	8.12	2.47		

From table (8) it can be seen that the significance level of the t-test for the measure is 0.51, which is not statistically significant at the level ($\alpha = 0.05$). This means that there is no difference between the mean scores of the experimental group and the control group in the pretest of the knowledge test. This confirms the equivalence of the two groups (experimental and control) in terms of academic achievement.

- The application of the research material, which is the AI-based educational program, began on 27/03/1444H and ended on 09/04/1444H, with a total of five lessons. During this period, the experimental group was taught. At the beginning of each lesson, students accessed the program by clicking on the link provided to them in their Microsoft Teams accounts. The researchers ensured that all students were logged into the program during the lesson in the school computer lab. Throughout the lesson, the researchers' role was to continuously monitor and observe, provide students with necessary support, and guide their thinking. They

also answered any questions the students had about the AI-based educational program, helping to clarify any misconceptions or incorrect ideas before the students could apply them incorrectly.

- During the implementation of the experiment, it was observed that the students were enthusiastic from the first lesson. They responded well to the instructions, actively participated in the experiment, and showed a keen interest in exploring the content of each part of the unit. They expressed a strong desire to continue the curriculum using artificial intelligence technology.
- Discussion with students in the experimental group: In each lesson, students in the experimental group were involved in discussions about the new experience, its benefits, positives, and the difficulties they faced in implementing it. One of the main positive aspects of the experience was that it provided a new and enjoyable way of learning that allowed students to learn independently. The program adapted to each student's style and abilities, and based on her responses, she was able to move from one learning situation to another at her own pace and within her own abilities. On the other hand, some of the challenges included the inability of some students to deal with technical issues, as well as technical problems with the computers, such as interruptions and slow Internet connections.
- Posttest Application of the Research Tool: The post-test for the experimental group was administered at the end of the teaching process on 12/04/1444H.

Phase Three: Post-experimental phase:

In this phase, the data were analyzed using the Statistical Package for the Social Sciences (SPSS), and the results were interpreted and discussed. Based on the findings, appropriate recommendations and suggestions were made.

Procedure for the control group

1. **Preparation for the Experiment:** Obtaining official permission to conduct the research. Visiting the school where the research would be conducted and randomly selecting the control group from the first-year middle school classes.
2. **Implementation of the experiment**

- The pre-test for the control group was administered on 24/03/1444H. During the administration of the pretest, the following points were emphasized: explaining the purpose of the instruments, instructing the students to read the instructions carefully before starting, and ensuring that they answer with complete honesty. Then, the data were statistically processed using the Independent Samples T-test between the two groups for the research tools, as shown in Tables (7) and (8).
- The content was taught to the control group using the traditional method from 27/03/1444H to 09/04/1444H, with a total of five lessons. Teaching was done using direct and interactive methods such as lectures, discussions, and dialogues. Microsoft PowerPoint presentation software and a Data Show projector were used as visual aids, which took up about three-quarters of the class time. The remaining time was spent on activities with the students, followed by the assignment of homework, which was corrected orally or on the board during the next class if a detailed answer was required.
- The post-test for the control group was administered at the end of class on 12/04/1444H.

3. **Post-experimental phase:** In this phase, the data were analyzed using the Statistical Package for the Social Sciences (SPSS), and the results were interpreted and discussed. Based on the findings, appropriate recommendations and suggestions were made.

Statistical Methods

The data were processed using SPSS and the Effect Size program as follows:

- Frequencies, means and standard deviations were calculated to make comparisons between the means of the groups.
- The Independent Samples T-test was used to determine the significance of the differences between the mean scores of the control and experimental groups in the pretest and posttest of the knowledge test, which addressed the first and second research questions.
- Eta-Squared (η^2) was used to calculate the effect size of the independent variable on the dependent variables, addressing the first and second research questions.
- Kuder-Richardson Formula 20 (KR-20) was used to measure the internal consistency of the knowledge test.
- Cronbach's Alpha was used to measure the reliability of the knowledge test.

Research Findings and Discussion

Answering the main research question and discussion: To answer the main question: "What is the effect of the proposed AI-based program on academic achievement in the digital literacy course for first-year middle school students?", the following hypothesis was formulated:

Null Hypothesis: There is no statistically significant difference at the ($\alpha = 0.05$) level between the mean scores of the experimental group and the control group in the post-test of the Digital Skills course.

To answer the question and test the validity of the hypothesis, an Independent Samples T-test was used to examine the difference between the mean scores of the experimental and control groups in the post-test of the knowledge test. Table (11) shows the results.

Table 11: Results of the Independent Samples T-test for the difference between the mean scores of the experimental and control groups in the knowledge test posttest.

Group	Nr.	Mean	Standard Deviation	"t"	Sig.
Control	**24**	9.62	2.49	2.11	0.04
Experimental	**24**	11.33	3.03		

Table (11) shows that the mean scores of the experimental group in the knowledge test are higher than the mean scores of the control group. The statistical significance level for the T-test is (0.04), which is statistically significant at the ($\alpha = 0.05$) level. This means that there is a statistically significant difference between the mean scores of the experimental group and the control group in the post-test of the knowledge test in favor of the experimental group,

which has a higher mean score of (11.33).

This result leads to the rejection of the null hypothesis and the acceptance of the alternative hypothesis, which states: "There is a statistically significant difference at the (alpha = 0.05) level between the mean scores of the experimental group and the control group in the post-test of the digital literacy knowledge test".

This result indicates the positive effect of the AI-based educational program in improving academic performance in the Digital Skills course among first-year middle school students.

After confirming the effect of the independent variable (the AI-based educational program) on the dependent variable (academic achievement), the effect size was calculated using the eta-squared (η^2) formula based on the T-test value and degrees of freedom. Table (12) shows the eta-squared value and the effect size on academic achievement.

Table 12: Results of eta-squared (η^2) for the effect size of AI-based program on academic achievement.

df.	t	η2	effect size
44	2.11	0.09	middle

It is evident from Table (12) that the effect size of the independent variable (AI-based educational program) on the dependent variable (academic achievement) was 0.09, which is a medium effect size (Cohen, 1988). This means that 9% of the variance in the students' test scores can be attributed to the AI-based educational program, while the remaining variance is attributed to other uncontrolled factors.

Discussion of Results for the Sub-question of the Main Question:

The results of the second hypothesis test showed a statistically significant positive effect of the AI-based educational program on improving academic achievement in the digital skills course among first-year middle school female students, with a significant increase in the mean post-test scores of the experimental group that studied using the AI-based program, compared to the mean post-test scores of the control group that studied using the traditional method. In addition, the medium effect size of the AI-based educational program on academic achievement was noted.

These results align with several studies that indicated the positive impact of AI in enhancing academic achievement which found that AI as a design variable in e-learning contributed to cognitive achievement in designing educational scenarios for educational technology students. Additionally, the study by Abu Shamala (2013) revealed the effectiveness of teaching using an AI-based program in enhancing academic achievement and inductive thinking in information technology among eleventh-grade female students in Gaza. Another study by Leddo et al. (2016) confirmed the positive effect of integrating AI in video-based education on academic achievement in a mathematical engineering course. The study by Jena (2018) highlighted the effectiveness of AI-based neural networks in academic achievement, retention of learning, and correcting misconceptions among students in the science course. Zhao et al. (2019) demonstrated that online AI teaching systems had a significant and positive effect on students' academic achievement. Likewise, the study by Al-Jerawi (2020) confirmed the positive impact of AI in e-learning environments on academic achievement in science, and the study by Al- Abdullat (2020) showed the positive effect of AI-based educational software on computer science achievement for tenth-grade students.

In the same context, these results are consistent with the study by Kowalski et al. (2017), which confirmed the role of (Chatbots) in improving academic achievement, with 70% of students benefiting from the chatbots, and it positively impacted their academic performance, with a preference for using them in future learning. Similarly, the study by Fyer et al. (2017) highlighted the positive impact of chatbots on language education, with 74% of students enjoying learning through chatbots, engaging better with their peers and teachers, and overcoming challenges such as time constraints and shyness, which enhanced their academic performance. The study by Al-Omari (2019) revealed the effectiveness of chatbots in developing cognitive aspects of sixth-grade female students, contributing to improving their learning outcomes in academic tests. The study by Kseiba (2010) also showed that students who used an intelligent adaptive teaching system demonstrated improved grades compared to those who used the non-AI version.

Explanation of Research Questions Results:

In light of the above results, the positive effect on academic achievement in the digital skills course among first-year middle school students, attributed to the implementation of the AI-based educational program, can be attributed to several factors:

The educational program focused on the students' role and interaction within the educational environment, considering their characteristics, leading to attention to individual differences among them. It helped increase their motivation to learn through personalized interactions. The AI program adapted to each student's abilities, preferences, and learning style, and provided responses based on their input, offering a personalized learning experience that assessed their performance, strengths, and weaknesses.

Al-Omari's study (2020) confirms that AI-based consideration of individual differences plays a significant role in improving cognitive learning and academic achievement.

The results can also be attributed to the lesson organization method. Each lesson began with an engaging introduction to the topic, followed by a diagnostic pre-assessment, an exploration of learning styles, and a presentation of the lesson content, along with formative assessments through activities based on explanation, inference, and problem-solving, with appropriate feedback. The end of the lesson involved a final assessment. This approach provided students with significant opportunities to interact with the lesson content, making the learning process more active rather than passive, which contributed to their academic achievement (ISTE, 2016).

The chatbot tool's ability to present rich educational content made it easier for students to grasp the material and retained the learning effect longer than traditional methods. Furthermore, the chatbot tool facilitated interaction for students who were reluctant to reveal their names, boosting their confidence and enabling them to ask questions and express their thoughts freely without fear of judgment (Fyer et al., 2017). This interactive, two-way conversational interface based on natural language helped students acquire the required concepts and maintain focus and attention

during the learning process. The flexibility and adaptability of the system increased their motivation, helping them acquire the necessary knowledge in the digital skills course (Al-Jerawi, 2020). This type of interaction is more effective than the traditional classroom, which may contain distractions that hinder the learning process (Kowalski et al., 2017).

The positive results are also due to the innovative and appropriate lesson presentation method, which engaged the students and motivated their participation and immersion in learning, which is in line with the findings of Benotti et al. (2014). They noted that the chatbot tool successfully attracted students' attention, motivating their participation and immersion in computing concepts taught at the secondary school level in Argentina. Moreover, Fyer et al. (2017) found that 74% of students enjoyed learning through the chatbot tool, which improved their engagement with their peers and teachers and helped overcome issues like time constraints and shyness.

Additionally, the chatbot tool provided students with continuous feedback and constructive comments, helping them correct their mistakes and assess their learning progress. This aspect was not available in traditional methods, contributing to their academic achievement. This was confirmed by the study by Al- Abdullat (2020) and Kowalski et al. (2017), which highlighted the positive impact of chatbots on student performance, with 70% of students benefiting from the tool and preferring its use for future learning.

The positive results can also be attributed to the AI tool's ability to identify gaps in the digital skills course based on students' performance in activities and tests. When many students answered a question incorrectly, the AI tool could identify the problem and explain why the students struggled with the question, allowing teachers to focus more on those areas, improving their teaching effectiveness. This is consistent with the findings of Bii et al. (2018), which showed that AI technologies in education helped improve students' understanding and academic achievement.

Research Limitations

1. The researchers encountered challenges during the development of the AI-based educational program, such as:
    - A limited number of Arab programmers skilled in AI.
    - High cost of building the program with Arab programmers.
    - Collaboration with a Russian programmer, requiring coordination with a technical expert to build the program with a diverse team.
2. The AI-based program required substantial educational planning and a team consisting of an education expert, instructional designer, and AI specialist.
3. Limited technical preparedness in computer labs, which led to delays in conducting the experiment.
4. The experiment required more than five teaching sessions, but the official curriculum distribution from the Ministry of Education for the third unit ("Introduction to Programming") is limited to five sessions, necessitating adherence to this limitation.

Recommendations

Based on the research results, the following recommendations can be made:

- Use AI technology in education to enhance students' academic achievement, as confirmed by the research findings.
- Increase the integration of the AI-based educational program into all digital skills courses to improve academic achievement.
- Expand the application of the AI-based program across various educational levels and subjects.
- Develop continuous training and development plans for using AI technologies in the educational process.
- Enhance students' and teachers' skills in using computers and the internet, providing them with training on various technological skills.

Research Suggestions:

- Conduct a foresight study on the opportunities and challenges facing AI innovation in education in Saudi Arabia.
- Conduct a correlational study to explore the relationship between various AI techniques and human intelligence.
- Conduct an experimental study to explore the impact of AI-based education on other variables not covered in the research, such as intelligence, critical thinking, problem-solving skills, creative thinking, learning retention, and life skills.
- Conduct an experimental study to explore the impact of a proposed AI-based program according to different instructional design models (e.g., TPACK, SAM, ASSURE, or PDCA) on other variables such as motivation, 21st-century skills, and its application in other subjects and educational stages.
- Conduct an experimental study to explore the impact of a proposed AI-based program on specific groups, such as gifted students or those with special needs.
- Conduct a study on the current use of AI in education in Saudi Arabia and explore the obstacles limiting the application of AI in educational processes.

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