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Analysis and Visualization of Big data and Information Using Generative Artificial Intelligence Technology

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Abstract

The current research aims to develop the skills of analysis and visual representation of big data and information through the use of generative artificial intelligence technology among graduate students in the course "Computers in Education." To achieve this goal, a quasi-experimental approach with a two-group design was used, and a random sample of graduate students at the College of Education, King Khalid University, was selected. The number of the experimental group was 32 students, and the number of the control group was 32 students. The experimental group was trained using the fourth version of generative artificial intelligence technology. A test was prepared for the skills of analyzing and representing data and information. The "t" test was also used, and the effect size was calculated to analyze the research results. The results indicated that the use of generative artificial intelligence technology, with its various platforms, has contributed significantly to the development of the skills of analysis and visual representation of big data and information.

Keywords: Big Data, Data Analytics, Generative AI, Visualization.

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1. Introduction

Various institutions rely on analyzing and representing data by collecting, modeling, and classifying it using various digital statistical techniques, the most important of which in the current era is generative artificial intelligence technology. The analysis may be descriptive or quantitative in order to make sound scientific decisions. This data can be represented visually through shapes, charts, and two- and three-dimensional visual graphs. This may lead to a greater and deeper understanding of this data and interaction with it, and then making sound scientific decisions.

Data and artificial intelligence technology are closely linked. Through this technology, data can be analyzed and used effectively to extract patterns and information that are useful in making decisions or improving the performance of systems. ChatGPT may be used to analyze data related to user behavior on social media platforms using machine learning techniques. Systems can identify users' interests and direct appropriate content to them, which can lead to a better user experience and improve interaction between users and the platform [1]. Generative artificial intelligence is an artificial intelligence-powered chatbot created by OpenAI, a non-profit company. It was released on November 30, 2022. Less than a week after the launch of this robot, OpenAI founder Sam Altman announced that the number of users had exceeded one million. What distinguishes ChatGPT is its ability to simulate human conversation through quick and engaging responses via a free and easy-to-use web interface.

Thus, ChatGPT will be part of our daily lives [2]. ChatGPT has been pre-trained on massive amounts of text data, which means it has already accumulated a huge amount of knowledge about the world. It can easily understand and respond to a wide range of questions and requests, allowing an individual to ask it a question or request something from it and it will respond to you based on its pre-existing knowledge. ChatGPT relies on deep learning technology to understand the context of the conversation and answer questions in a better way. The language of conversation may be any spoken language or one of the computer programming languages [3].

Through the OpenAI platform, the ChatGPT application can be used to help students organize their thoughts and generate new creative ideas and plans in order to enhance and develop their creativity and innovation skills. Students can also collaborate with the teacher to discuss and analyze ideas and information obtained from generative artificial intelligence technology, and then obtain deep and useful ideas and information. It can also contribute significantly to producing creative ideas that serve society. The learner can also use ChatGPT to create an article on a specific topic, design a presentation followed by an audio recording and edit it, generate illustrative images, and design avatars on a specific topic, and design integrated e-lessons, and many other uses of modern generative artificial intelligence platforms. Therefore, it can be said that the ChatGPT platform is a platform for preparing individuals for future professions.

The generative artificial intelligence Chat Generative Pre-Trained Transformer (ChatGPT) and its various applications represent one of the methods that can help in knowing what the learner can and cannot do, and generative artificial intelligence technology can analyze and represent data in a creative way and then help in decision-making and discovering patterns.

In this regard, the study of Halaweh [4] concluded that ChatGPT technology can be used to evaluate the credibility of learning content and develop creative thinking skills; This is done by the teacher designing digital content for a specific topic, then the students evaluate the information contained in it and verify its accuracy. It can also be used to improve students' writing and generate new ideas and information. The study Sok and Heng [5] concluded that it is an opportunity to provide educational support, evaluate learning, creativity, and innovation. The study by Abu Shanab and Fayyad [6] concluded that generative artificial intelligence has an important role in enhancing the creativity of designers and supporting them in design, advertising, and improving the quality of their production. It can also analyze data and provide suggestions for appropriate modifications. The study recommended the need to benefit from generative artificial intelligence applications in improving advertising photographs and enriching the creative design of advertising design elements.

Al-Hadi [7] pointed out that training traditional AI systems on large amounts of data to identify patterns and the ability to perform certain tasks can help individuals and organizations alike, but generative AI ChatGPT goes one step further by using advanced and complex systems and models to create new outputs in the form of a model, drawing, text, or voice based on human natural language prompts. Thus, generative AI models and their applications can be used in text generation, video generation, programming code generation, data generation and representation, language translation, and others.

The digital transformation has led to a significant and massive increase in the volume of data and the emergence of what is known as Big Data, which is revolutionizing business; as it is expected that global data by the year (2025 AD) will be about (180) trillion terabytes, in order to exploit this amount of data, generative artificial intelligence applications are relied upon to analyze and represent it, as the expensive feature of many institutions currently is the use of artificial intelligence technology in the analysis and representation process in order to help in making smart decisions and encouraging global competition [8].

On the other hand, Asbar Forum International [9] focused on an important aspect in the current era, which is data visualization, and this aspect has come a long way. In this era, it is not a matter of putting a set of data in Microsoft Excel, then creating a chart or graph. This was in the past. Now there are entire companies such as Tableau Software that specialize in helping individuals and organizations better understand their data, through an interactive and creative visual representation of it, no matter how large the data is. Tableau Software has won several awards, including the best in the field of visual representation of big data and information by DM Review.

The visual representation of big data and information aims to identify outliers or trends. If we have a table with (100) records, the matter is easy, but if we have a table with (100) million records, the matter is difficult in dealing with this record; Therefore, visual representation of data enables individuals and organizations to understand data and identify trends quickly and more easily than simply looking at raw data [10]. In this regard, Al-Hadi [11] indicated that generative artificial intelligence applications can be used to enter data, analyze huge sets of big data, and represent them visually. One of the most important artificial intelligence initiatives is the UNESCO initiative, which developed its own Deep Learning library and made it open source to analyze and process the data it collects about customer views. This library is a recommendation engine; Amazon uses it to provide recommendations, and Facebook uses it through the People You May Know feature [12].

Building an intelligent system capable of extracting high-level representations of data is essential at present, and in recent years, deep learning has become the main driver of innovative solutions in the field of artificial intelligence, which is a subset of machine learning methods also referred to as representational learning. Representational learning or feature learning is a

method that gives the machine the ability to automatically discover relationships from raw data. This ability and task are the main advantage of deep learning, which is carried out in the form of different non-linear layers in the network structure [13].

Abdel Fattah [1] indicates that the application of deep learning can analyze large amounts of data in greater depth, and reveal new insights, as well as deep learning can understand unstructured data that machine learning methods find difficult to process. Shoman [14] concluded that generative artificial intelligence and digital control can be used in the ceramics industry by analyzing data and extracting patterns to design new and innovative ceramic products. From the above, it can be said that data analysis in higher education institutions can help in making the right decision, as well as understanding student behaviors and the problems they face while studying e-courses and working to solve them. It also helps in providing support to outstanding students and providing them with appropriate enrichment. It also helps educators to redesign their e-courses according to scientific foundations. Therefore, it can be said that data analysis and visual representation can help improve the learning environment with all its elements and develop it for the better.

2. Research Problem

Mussarrat [15] indicate that Arab universities possess large amounts of data, yet the problem of analyzing and representing this data in terms of size, coordination, and diversity continues; as data focuses on the technical dimension, while smart data is more concerned with the analytical dimension, the value of data, and its integration into decision-making processes and academic prediction in various educational institutions. Floride [16] indicates that the real problem with data is the ability to analyze, represent, and understand this data; in order to exploit the results of this analysis to improve the quality of human life and develop knowledge. Data was created to evolve, and the only way to deal with it is to be aware and knowledgeable about how to analyze this data and how to benefit from it well. Al-Hadi [11] confirms that interest in analyzing and representing data in universities is still weak in practice, as there are many theoretical writings on data and its analysis, but the ability of educational institutions to analyze this data is still very weak.

In this regard, the results of the study Horst [17] concluded that data processing, analysis and representation in higher education institutions is still in its infancy, despite its importance and the development of its methods and various benefits, which can provide us with the results of the correlations between different patterns that show the weaknesses and strengths for development decision makers to do what is useful in evaluating performance within the educational institution for the quality of educational outputs and outcomes.

From the above, the problem of the current research was identified in the weakness of the skills of analyzing and representing big data and information among university students; Therefore, the current research seeks to address this weakness by using generative artificial intelligence technology to develop creativity skills in analyzing and representing big data and information in order to discover patterns and assist in decision-making.

3. Research Questions

The current research attempted to answer the following questions:

1- What is the impact of using generative artificial intelligence technology on developing analysis and visual representation of big data and information among graduate students?

3.1. Research Hypotheses

The current research attempted to verify the validity of the following hypotheses:

1- There is no statistically significant difference at the level (0.05) between the average scores of the experimental group and the control group in the post-application of the test of analysis and visual representation of big data and information in the course "Computers in Education" for graduate students?

3.2. Research Objective

The current research aims to develop the skills of analysis and visual representation of big data and information in the course "Computers in Education" for graduate students at the College of Education through the use of generative artificial intelligence technology with its various platforms.

3.3. Research Importance

1- Directing the attention of university education officials to the need to pay attention to employing generative artificial intelligence technology in the field of university education.
2- Directing the attention of those in charge of university education to the need to pay attention to the skills of analyzing big data and information and representing it in all aspects of the educational process.
3- Directing the attention of officials to the use of generative artificial intelligence technology and deep learning techniques to discover patterns and links between data and thus help in making the right decision.

3.4. Research Determinants

The current research was limited to the following determinants:

1- The following generative artificial intelligence platforms:
https://chat.openai.com/ (run ChatGPT4)
https://pixverse.ai/login (for professional video design)
https://www.zarla.com (design logos, packaging, and products)
https://whimsical.com/ (for electronic mind map design)

https://durable.co/ (professional website design)
https://codepen.io (design a smartphone application)
https://www.tutorai.me/ (design smart electronic content)

2- Course "Computer in Education - 6000Tech-2.
3- Data analysis and representation skills:

- Understanding data
- Data purification
- Using data analysis tools
- Designing the shape or chart
- Interpreting the results

4. Method and Procedures

The current research utilized a quasi-experimental approach based on a two-group design with pre- and post-application of research tools.

4.1. Research Procedures

To identify the effect of generative artificial intelligence technology on developing the skills of analysis and visual representation of big data and information among graduate students at the College of Education, King Khalid University, the following was done:

First: Selecting the research sample: The research sample was selected from the "graduate" students at the College of Education, King Khalid University in a random manner, represented in two groups: the first experimental group, numbering (32) students, was trained through generative artificial intelligence platforms, while the second experimental group, numbering (32) students, was trained in the usual way at the university through the Blackboard platform available at the university. To ensure the equivalence of the two groups, the research tools were applied pre-application, and the results were as shown in Table 1.

Table 1.
Results of the (t) test for the creativity tests and the data analysis and representation tests in the pre-application.

The tool	Number	The group	Average	Standard deviation	Degree of freedom	Value(T)	Significance level	Significance
Digital Creativity test	1. 32	Experimental	2.75	0.92	62	1.763	0.083	Not Significant
	2. 32	Control	2.41	0.62				

Table 1 shows that the calculated (t) value (1.763) in the information analysis test is not significant, at the level of (0.05), which shows that there is no statistically significant difference between the two groups in the pre-application of the information analysis test and its visual representation, which shows the homogeneity of the two groups.

Second: Preparing Research Materials

1- Designing a learning environment based on generative artificial intelligence technology:

To design a learning environment based on generative artificial intelligence technology, some previous studies were reviewed, such as Al-Muhammadi [12] and Mansour [18], and the general ADDIE design model was followed as follows:

4.2. The First Stage: Analysis

The following procedures were carried out in this stage:

- Determining the general objectives of the learning environment based on generative artificial intelligence technology; The general objective of this environment is to develop the skills of analyzing and representing data and information in the course (Computers in Education - 6000 Tech-2) in the research sample.
- Determining the characteristics of learners: Graduate students at the College of Education, King Khalid University, are studying the course "Computers in Education - 6000 Tech-2" in the second semester of the academic year (2023/2024 AD) and belong to one environment with similar conditions. Their skills in using computers and the Internet are almost similar. The number of students in the first experimental group was 32, and the number of students in the control group was also 32.
- Capabilities of the educational environment: Artificial intelligence technology was used. Generative (ChatGPT4, GPT Plus).
- Educational material: The training content was defined in the form of 6) training units.

4.3. Stage Two: Design Stage

The design stage includes defining the procedural objectives of the learning environment based on generative artificial intelligence technology and developing a comprehensive vision of the content, learning strategy, various activities appropriate for it, and evaluation methods, as follows:

A- Procedural objectives of the learning environment based on generative artificial intelligence technology:

Topic One: Designing a video with artificial intelligence (https://pixverse.ai/login):
After completing this content, the student should be able to:

- Discuss what generative artificial intelligence is design a two-dimensional video from text.
- Design a two-dimensional video from images.
- Use the website https://runwayml.com
- Design a professional three-dimensional video.

Topic 2: Designing logos and packaging for products (https://www.zarla.com):
After completing this content, the student should be able to:

- Design a creative logo.
- Design a closure for educational or commercial products.
- Design an advertisement for digital marketing.

Topic 3: Designing electronic mind maps (https://whimsical.com):
After completing this content, the student should be able to:

- Know what electronic mind maps are explain the importance of electronic mind maps.
- Design an interactive electronic mind map.
- Publish the electronic mind map.

Topic 4: Website design: https://durable.co
After completing this content, the student should be able to:

- Know what website design is use the website https://durable.co
- Use ChatGPT to get codes.
- Design an interactive educational website.

Topic 5: Designing a Smartphone App (https://codepen.io)
After completing this lesson, the student should be able to:

- Discuss what smartphone apps are use ChatGPT to get CSS codes.
- Use ChatGPT to get JavaScript codes.

Topic 6: Designing Smart Electronic Content (https://www.tutorai.me)
After completing this lesson, the student should be able to:

- Know what smart electronic content is design an interactive electronic unit.
- Use the tutorai.me website.
- Design interactive electronic activities.

B- Content of the learning environment:

The content of the learning environment based on generative artificial intelligence technology included the following topics:

- Topic 1: Designing a video with artificial intelligence
- Topic 2: Designing a logo and product packaging
- Topic 3: Designing electronic mind maps
- Topic 4: Designing a website
- Topic 5: Designing a smartphone application
- Topic 6: Designing smart electronic content

C- Learning strategy and activities followed in artificial intelligence platforms:

In light of the procedural objectives and the content of the learning environment, the learning strategy using generative artificial intelligence technology proceeded according to the electronic lecture method, implementing all practical and training activities on the computers available in the college and reviewing all results.

D- Evaluation methods:

Evaluation methods varied to include the pre-evaluation at the beginning of each topic to identify previous learning, the formative evaluation during each content to guide students' learning and provide feedback, and the final evaluation, which is done after completing the study of all training content designed according to generative artificial intelligence technology; to identify the development of analytical skills and visual representation of big data and information in the computer course in education.

4.4. Stage Three: Development Stage

In this stage, researchers used some of the following artificial intelligence technology platforms:

- https://chat.openai.com/ (run ChatGPT4)
- https://pixverse.ai/login (to design a professional video)
- https://www.zarla.com (design logos, packaging, and products)
- https://whimsical.com/ (to design electronic mind maps)
- https://durable.co/ (design a professional website)
- https://codepen.io (design a smartphone application)
- https://www.tutorai.me/ (design smart electronic content)

4.5. Stage Four: Implementation Stage

In this stage, the electronic content was applied to artificial intelligence technology for (32) users, and how to access generative artificial intelligence technology and the tasks required to be performed were also explained.

4.6. Stage Five: Evaluation Stage

In this stage, the content was displayed, and the training designed according to generative artificial intelligence technology was conducted on a group of specialists in the field of educational technologies and information technologies. Measurement tools were also applied, represented by the data analysis and representation test, after studying all the training content for the research sample students.

4.7. Preparing Research Tools

1- Preparing the data analysis and visual representation test: This test was prepared according to the following steps:

A- The objective of the test:

The test aimed to measure the skills of data analysis and visual representation through the use of generative artificial intelligence technology among graduate students at the College of Education, King Khalid University, in the course "Computers in Education".

B- Dimensions of the test:

After reviewing the research and studies that focused on the field of data analysis and representation, the main elements of the test were identified, and their number reached (15) for each skill (three sub-skills) and each skill measures the skills of data analysis and information and its representation, which are: understanding data, purifying data, using data analysis tools, designing shapes, charts and drawings, and interpreting results.

C- Test correction method: Each test skill was corrected according to the following:

Each test skill was given one mark, so the total mark for the data analysis and representation test was (15) marks.

D- Presenting the initial version of the test to a group of arbitrators: After completing the preparation of the test, the test was presented to a group of specialists in the field of educational technology, information technology, and psychology, and their opinions clarified the suitability of the test for the research sample, with the linguistic reformulation of some questions in the skill of designing shapes, charts, and graphs.

E- Exploratory application of the test: After knowing the opinions of the arbitrators, the test was applied to a survey sample of (22) postgraduate students at the College of Education, King Khalid University, to determine the validity of the linguistic formulation of the test, the suitability of the test levels for the students, and to calculate the stability of the test.

F- Calculating the test reliability:

After presenting the test to a group of arbitrators and testing it exploratory on (22) students, the test reliability was calculated using the "Pearson" equation and it was found to be approximately equal to (0.91), which is an appropriate percentage for the test reliability.

- Final form of the test:

  After formulating the test and presenting it to a group of arbitrators and controlling it statistically, the test became valid for final application.
- Pre-application of research tools:

  The research tools represented in the analysis test and visual representation of data were applied to the research group in the second semester of the academic year (2024 AD).
- Implementation of the research experiment:

  After clarifying the purpose of the experiment, the researchers implemented the research experiment in the second semester of the year (2024 AD) at the College of Education during approximately (6) weeks. The number of members of the research group reached (32) students who were taught the course "Computers in Education" through the use of generative artificial intelligence technology, version four.
- Post-application of measurement **tools:**

  After completing the application of the research experiment, the measurement tools represented in the analysis test and visual representation of data were applied, pre- and post-application to the two research groups, corrected and monitored.

5. Research Results and Discussion

After monitoring the students' grades in the post-application of the analysis and visual representation test for big data and information in the "Computers in Education" course, the research questions were answered as follows: The answer to the first question, which stated: What is the effect of using generative artificial intelligence technology on developing the analysis and visual representation of big data and information among graduate students?

To answer this question, the following hypothesis was formulated: There is no statistically significant difference at the (0.05) level between the average scores of the experimental group and the control group in the post-application of the analysis and visual representation test for big data and information in the "Computers in Education" course among graduate students?

To test the validity of this hypothesis, statistical processing was carried out using the (T) test for two independent samples to compare the scores of the application of the data and information analysis and representation test. Table 2 shows the results of applying the "t" test to indicate the significance of the differences between the average scores of the experimental group and the control group in the test of data and information analysis and representation in the "Computers in Education" course.

Table 2.
The value of "t" and its statistical significance between the average scores of the students of the experimental and control groups in the test of data and information analysis and representation.

The group	The tool	Number	Average	Standard deviation	Degree of freedom	Value(T)	Significance level	Significance
Experiment	Data analysis and representation test	32	4.31	0.99	62	8.49*	0.001	Significant
3. Control		32	2.60	0.55				

Table 2 shows that the calculated (t) value is (8.49), which is significant at the level of (0.05) and the significance of both sides, and the degree of freedom is (62), which indicates the existence of statistically significant differences between the experimental and control groups in the post-application of the test of data and information analysis and representation in the course "Computers in Education".

Thus, the first hypothesis of the research hypotheses was rejected; as there is a statistically significant difference at the level of (0.05) between the average scores of the experimental group and the control group in the post-application of the test of analysis and visual representation of big data and information in the course "Computers in Education" among graduate students in favor of the experimental group that uses the technology of artificial intelligence generation, version four. This result is consistent with the results of the study of Abdul Latif et al. [19], Mansour [18], and Mussarrat [15]. As an example, a file (Data.xlsx) for students' activities and midterm and final exams was sent to ChatGPT4, and many things were asked of it, including giving five random statistics and putting them in a table, and the results were as follows:

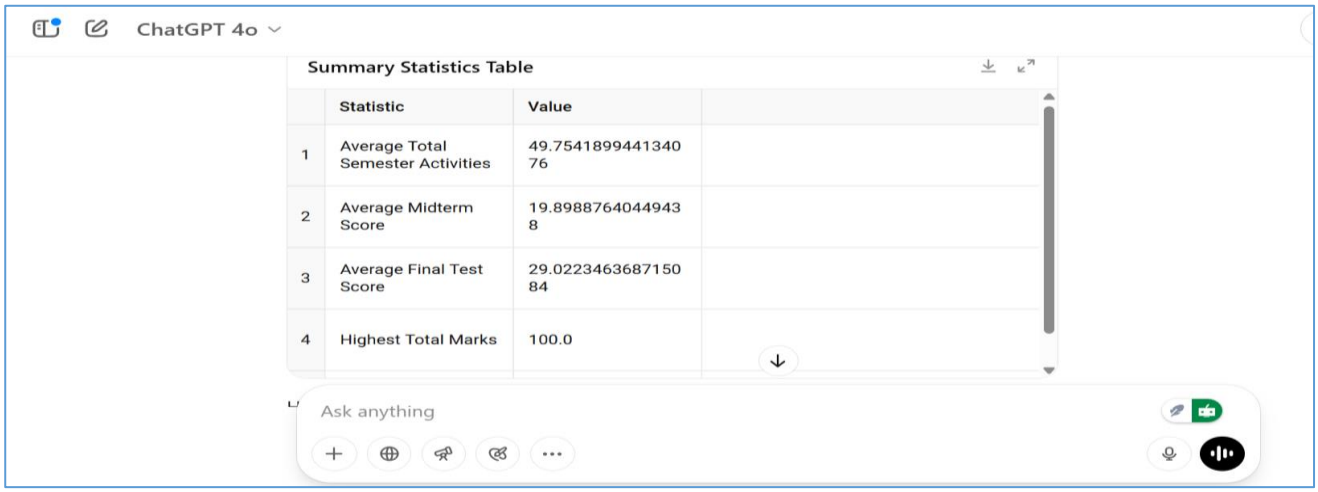

Figure 1.
Descriptive statistics of students' activities and grades

1- He was asked to create and design 4 charts that included various statistics and clearly displayed the titles. The results were as follows:

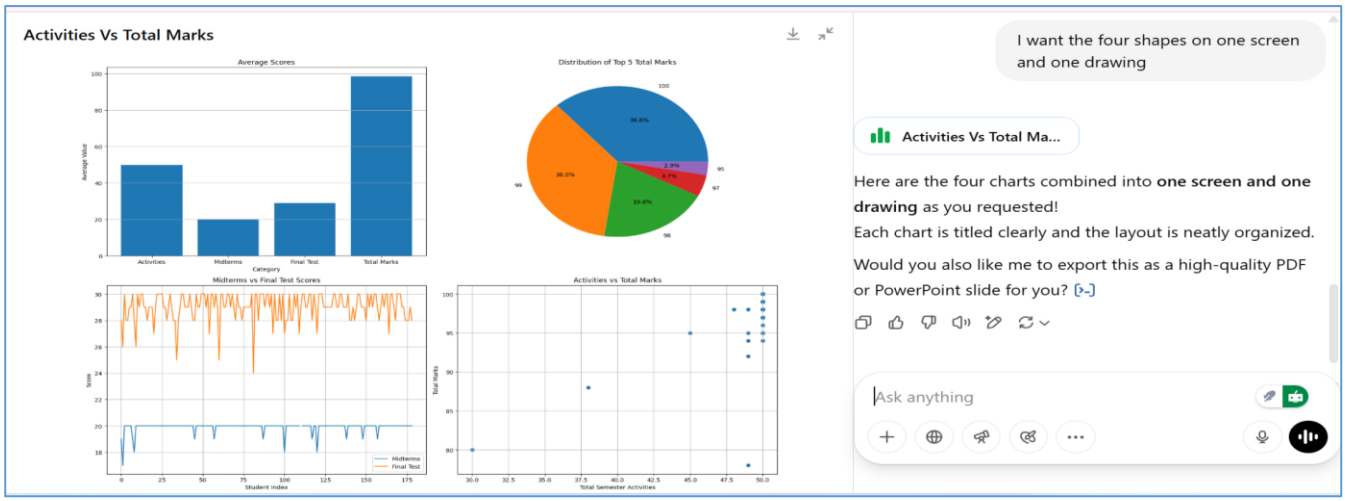

Figure 2.
Graphs of some students' grades

2- The generative AI technology was asked to find the relationship between the activity data, the semester tests, and the final tests. The results were as follows:

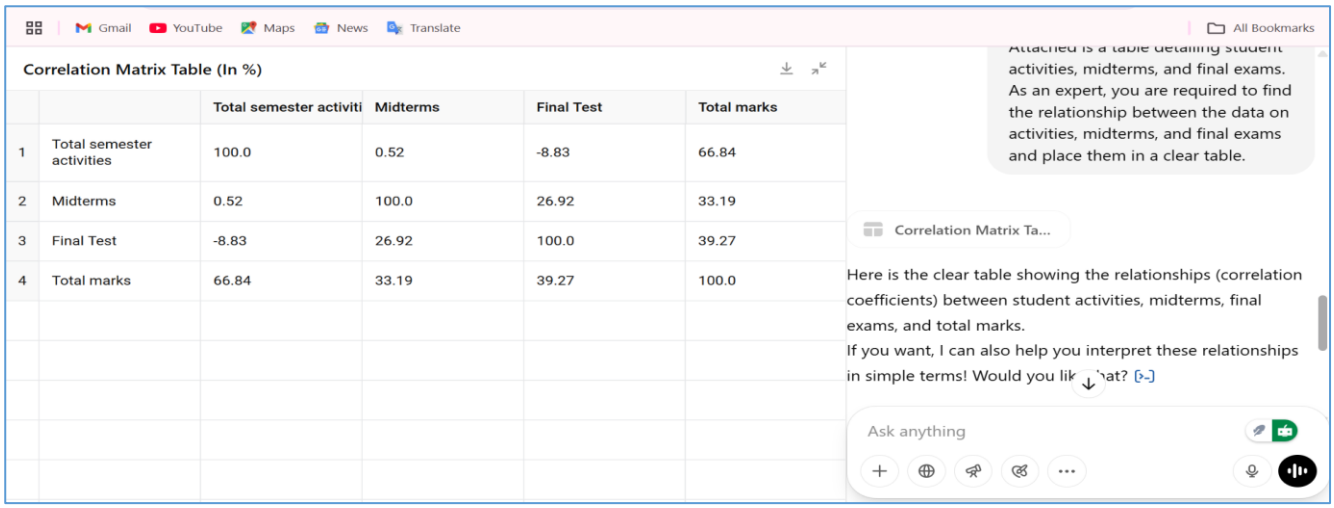

Figure 3.
Correlation coefficients between activities, midterm tests, and final tests

5.1. Researchers Believe That the Previous Result Can Be Attributed to The Following

- Generative AI technology is characterized by its great ability to analyze a lot of big data and represent it in the form of charts or graphs or classify it in the form of groups by downloading this data from external files. This feature with ChatGPT 4 provides great and fast assistance in understanding the data and making the appropriate decision.
- Generative AI technology is not limited to analyzing structured data only from (Excel) files, but it can analyze data for unstructured files such as: video files, podcast files, PDF files, etc., easily, and very quickly.
- Generative AI technology can generate many visual graphics and charts for any amount of data, even if it is huge.
- Generative AI technology can help in obtaining highly accurate and creative visual representations through healthy data feeding and providing appropriate feedback to this technology.
- Generative AI technology can easily discover patterns, classifications, and trends among data, especially if the data is large.
- Generative AI technology can analyze data and explain it in the form of interactive 3D visual graphics and charts.
- AI platforms are characterized by providing freedom and flexibility for students to perform the required tasks and activities easily.
- Generative AI technology is characterized by analyzing data by predicting student achievement or their strengths and weaknesses or the economic, industrial, or weather changes field, or providing a future vision for the field of education, health, economy, or other societal fields.
- Artificial intelligence technology relies on neural networks to analyze data and then obtain classifications, groups, patterns, or trends for this data and then assist decision-makers.

Scientific and practical significance of the research results

Through Table 2 the researchers explain the practical or applied importance of the research results by finding the size of the impact of the independent variable on the dependent variables.

Table 3.
Scientific and applied significance of the research results.

Independent variable	Dependent variable	Value(T)	Eta square η^2	Effect size
4. Generative Artificial Intelligence technology	5. Data and information analysis and representation	8.49	0.53	Big

It is clear from Table 3 that the size of the impact of generative artificial intelligence technology in developing data analysis and representation skills among graduate students at the College of Education, King Khalid University is (0.53), which is a large percentage, and the rest is due to various other factors, including: the student's experience and previous technological skills, the student environment, peers, and other factors.

6. Discussion of the Research Results

The current research aims to develop the skills of analysis and visual representation of big data and information in the course "Computers in Education" among graduate students at the College of Education through the use of generative artificial intelligence technology. The research questions were as follows:

1- What is the effect of using generative artificial intelligence technology on the development of analysis and visual representation of big data and information among graduate students?

2- The results showed that the ability of students in the experimental group who used generative artificial intelligence technology platforms was higher and statistically significant compared to the ability of students in the control group who used the usual method of learning and training in developing the skills of analysis and visual representation of big data and information among graduate students. This indicates that students in the experimental group benefited from generative artificial intelligence technology more effectively than those who learned and trained in the traditional way.
3- This may be due to the fact that generative artificial intelligence technology allows students the freedom and flexibility to enter and process data visually. Through generative artificial intelligence technology, especially (ChatGPT 4), which includes the ability to download files from (Excel) and process them easily, this has contributed to the development of data analysis and processing skills in a professional visual manner among graduate students.

7. Conclusion

1- This research represents a scientific contribution in the field of data analysis and visual representation using generative artificial intelligence technology, as the results showed the positive impact of this technology on developing students' skills in analyzing big data and understanding its patterns. The study proved that the use of generative artificial intelligence can enhance the accuracy of analytical predictions and reduce the time spent processing data, which contributes to raising the efficiency of academic and educational performance.
2- Through statistical analysis of the data, it was found that the experimental group that used generative artificial intelligence techniques achieved a significant superiority in the data analysis skills test compared to the control group that relied on traditional methods. This indicates that generative artificial intelligence is not just an auxiliary tool, but rather a technology capable of improving academic performance by providing smart and effective solutions for analyzing big data and representing it in an interactive visual way.
3- The results emphasize the need for universities and academic institutions to adopt these modern technologies and integrate them into curricula, with a focus on training students and faculty members to use them effectively. Investing in AI in scientific research and higher education can also contribute to the development of new curricula based on deep data analysis, which helps in making decisions based on accurate and reliable information.
4- Finally, generative AI is a powerful tool to support digital transformation in education and scientific research, opening new horizons for improving academic and research processes. As these technologies continue to develop, it will be necessary to conduct future studies to explore their potential in broader areas, including academic performance analysis, course evaluation, and enhancing virtual learning environments.

8. Research Recommendations

Based on the results of the current research, the following can be recommended:

1- The need to focus on training university students to use generative artificial intelligence technology in the field of education.
2- The need to train faculty members on methods of using generative artificial intelligence to process large data and information visually.
3- The need to focus on analyzing large data in order to assist in decision-making and discovering educational patterns.

8.1. Suggested Research

In light of the research results, some of the following research can be suggested:

1- Designing a training environment based on generative artificial intelligence technology to develop information processing skills among university students.
2- Designing an e-learning environment based on generative artificial intelligence technology to develop digital intelligence skills and future foresight among university students.
3- A proposed training program based on generative artificial intelligence technology to develop the skills for designing pioneering digital products among university students.

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