

Brainstorming Based on ChatGPT in Developing Generative Thinking among Students Considering Bring Your Own Device Policy

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Abstract—Students' lack of generative thinking skills, including fluency, flexibility, hypothesis formation, prediction, and error recognition, negatively impact learning and require research. Therefore, this study aims to find out the effectiveness of brainstorming based on artificial intelligence applications of ChatGPT in developing generative thinking among third-year students specializing in early childhood education, considering Bring Your Own Device (BYOD) Policy in the second semester of the academic year (2023/2024). The researcher relied on the quasi-experimental approach with two groups to identify the effectiveness of the independent variable teaching method (Brainstorming based on ChatGPT) and the dependent variable (Developing generative thinking skills). The study sample consisted of 32 female students who were learning at Jadara University and specializing in early childhood. The results showed that brainstorming based on ChatGPT develops generative thinking skills. Based on the results, the researcher recommends conducting studies that employ technological innovations, Brainstorming, ChatGPT, and Bring Your Own Device Strategy (BYOD) Policy on different academic study populations and different topics, especially the early childhood teacher students' stages and topics.

Keywords—brainstorming, ChatGPT, generative thinking, early childhood, bring your own device

I. INTRODUCTION

Artificial intelligence has played an important role in all matters of life, especially in teaching and learning, which will change traditional classrooms to use a combination of robots and artificial intelligence, and a large percentage of students will benefit from robots that are characterized by continuity and flexibility. Artificial intelligence techniques help improve and enjoy students' learning. And improve their scientific and cognitive ability at the same time [1]. Some believe that artificial intelligence techniques are among the basics of any educational system, and relying on them has become necessary to increase the guarantee and success of these systems [2]. As it is an educational input that stimulates students' interest and support for learning, and the diversity of experiences and skills it contains, contemplation, thinking, and creativity, which achieves growth for them in all directions, works to enrich areas of experience, and engages all of the learner's senses in the process of accelerating learning, and helps to form Interconnected and beneficial relationships are established between everything the student learns when the senses participate in shaping the new experience and linking it to previous experiences [3]. Artificial intelligence refers to a group of new methods and approaches in programming computer systems, which can be used to develop systems that mimic some elements of human

intelligence and allow it to make inferences about facts and laws that are represented in the computer's memory [4]. The modern concept of artificial intelligence means building machines that perform tasks that require a degree of human intelligence when performed by humans. They are also programs that allow the computer to simulate some mental functions and abilities in a specific way [5]. The researcher believes that artificial intelligence is a group of systems and applications that mimic the human being through smart devices in dealing with all the requirements of life, meaning that it deals with humans and machines with each other, in solving everything that they are required to implement with high accuracy and extreme speed.

A. ChatGPT

ChatGPT is one of the artificial intelligence programs that was trained on a very large database containing a lot of information, relying on various cognitive sources, to be able to receive the questions and requests posed to it by the user, then process them and provide reasonable answers written in a way that resembles human language [3]. ChatGPT is on track to set a world record as the fastest-growing and fastest-advancing user program. With its ability to comprehend a wide range of human languages and produce insightful and well-organized responses, ChatGPT stunned the globe with its Artificial Intelligence (AI)-powered capabilities, which were developed by Open AI. It employs deep learning, which mimics how the human brain learns [6]. ChatGPT has established generative (AI) as a well-known subfield of AI and a powerful technology.

This technology, like other artificial intelligence programs, has entered the educational process. ChatGPT is considered the closest - so far - to simulating human language, and it is expected to have a profound impact on the present and future of education [7]. It contributes to performing new educational tasks, such as writing articles, drafting presentations, building lesson plans, and setting learning objectives, which some have considered a new way to support the educational development process [8]. As a free source of knowledge, it saves the time and effort required in searching for information, as well as being a free source available to everyone around the clock. It helps students develop curiosity and knowledge, self-learn, brainstorm, and then come up with new ideas for their homework. It facilitates the process of developing curricula as it provides an inexpensive knowledge explosion. It also helps educational institutions provide their services more efficiently [9]. Qawqaza [10] believes that employing ChatGPT in the educational process

leads to fundamental improvements in cognitive fields and thinking patterns.

AI can both enhance and challenge critical thinking across cognitive, affective, and metacognitive domains; key elements such as melioration, ethical reasoning, collaboration, and reflective thinking were identified as critical for developing deeper engagement with AI-generated content [11].

There are many studies whose results have shown the effectiveness of using ChatGPT in education [3, 12–14].

B. Brainstorming

Brainstorming refers to an electronic educational approach that utilizes various electronic programs and applications. In this method, the instructor presents a particular educational issue or scenario and requests students to electronically propose numerous ideas to solve the problem using the provided applications or programs. Subsequently, the suggested ideas are evaluated, and the most suitable one is selected to address the given problem [15]. Ibrahim [16] emphasizes the utilization of technological advancements to enable the active participation of all students in generating as many ideas as possible on a specific subject. Aldalalah [17] argues that this method aims to engage students and stimulate their interaction to contribute ideas within an electronic setting. Moreover, brainstorming constitutes one of the e-learning strategies, wherein a specific problem or topic is presented and deliberated upon to generate many ideas and select the most optimal one.

Additionally, brainstorming has been proven to increase student achievement and bolster critical thinking skills. Through its various sessions, students can not only propose solutions and discuss different perspectives but also build upon their existing knowledge, allowing for a more meaningful learning experience [18]. Furthermore, brainstorming contributes to enhancing student achievement and establishing an educational atmosphere that emphasizes higher-order thinking skills such as analysis, application, and interpretation of information. This is achieved through a range of sessions where students can propose various solutions, engage in open dialogue, and consider diverse perspectives. As a result, learners gain a deeper understanding of the subject matter by encouraging critical thinking, tapping into prior knowledge, and engaging in meaningful discussions and interactions, thus significantly impacting the learning process [19]. Brainstorming also provides a positive learning environment that reduces the state of fear, anxiety, and tension that accompanies brainstorming sessions, which is often due to evaluation, fear of making a mistake, or putting forward strange ideas [20]. In brainstorming, all opinions and ideas must be accepted and recorded electronically, without criticizing any of the ideas presented to reach convincing solutions to the problem, as brainstorming is the result of a combination of electronic learning and traditional strategies in education, which is brainstorming [21]. Abu Mutlaq [22] and Yuonus [23] both assert that brainstorming can be divided into two distinct approaches. The first is computer-assisted brainstorming, which is based on the use of specialized programs to capture and present ideas to everyone for discussion and selection. The second is online brainstorming, which allows for the

utilization of social media tools and applications to let all participants submit and review ideas. Through online brainstorming, participants can easily share their ideas from any location, increasing motivation and engagement in the process [24]. The results of studies have indicated the role and effectiveness of brainstorming in teaching various subjects, because it saves time and effort as communication takes place via the Internet between individuals, which helps to alleviate the psychological pressures that they may feel during traditional education, in addition to its ability to record conversations electronically and from then recover it at any time and quickly when needed, even if the groups have a large number of participants in finding solutions to the problem [17, 24–26].

C. BYOD Policy

Bring Your Own Device (BYOD) Policy began in the economic field among companies with the spread of tablets and smartphones. Which allows the use of personal devices at work, organizations found that effectiveness and productivity increased due to the use of these devices, so they began to apply this strategy during work, which saved the money necessary to purchase work-specific devices, in addition to the correct use of the devices by users because they belong to them. They also felt comfortable dealing with their devices and controlling them better, which led to the emergence of many theories, laws, and technologies that support this trend [27]. The use of BYOD Policy has moved to the educational field when educational administrations allow teachers and students to bring their devices to classrooms, whether they are smartphones, tablets, or laptops, and benefit from the technical capabilities provided by these devices for educational uses and improving educational processes [28].

BYOD Policy is one of the modern technical trends or policies that allow teachers and students to bring their own devices (smartphones, tablets, mobile devices) and use them in different educational situations. They are also allowed to connect to the Internet and access the databases of the educational institution, it is an effective system in education that must be carefully planned, laws must be enacted that regulate the rules for its use, and its wired or wireless networks must be well protected, after which students and teachers can bring their own devices to use in learning activities [29]. BYOD Policy is considered a private device that complements the educational institution's equipment. It also allows for the possibility of cooperation outside class time, in addition to helping to democratize education, as the educational institution becomes an educational medium that is easy for everyone to access, as it targets administrators, teachers, students, and parents [30]. There are also conditions for benefiting from BYOD Policy in education, including Firstly centralization: educational institutions must work to focus their technological infrastructure to extend the life of their devices, operating systems, and applications that they use to ensure safe use across many devices and accessories of the institution that are owned by teachers and students. Secondly, Browser-Based Accessibility allows general access across different browsing programs and on different devices. Third, Mobility provides remote access capabilities so that anyone from anywhere can use their device based on a browser [31]. In conclusion, we can say that schools today

are more obligated than ever to reconsider the way they integrate and use modern technologies based on the BYOD Policy system, as indicated by many studies [29, 30].

D. Generative Thinking

Generative thinking is the ability to formulate hypotheses to solve problems and predict results considering data and to produce diverse and unusual ideas, relationships, and learning styles. It is also known as the ability to use previous ideas to generate new ideas that are linked to previous ideas and each other [32]. It is a type of thinking that reveals the ability to use available information and process it mentally in a way that enables one to arrive at new ideas, relationships, or solutions to some problems. It includes the skills of fluency, flexibility, developing hypotheses, making predictions considering data, and recognizing fallacies [33]. It is a constructive process through the ability to generate many alternatives, ideas, or information and link them to previous ideas and knowledge [34].

Generative thinking is of great importance through the goals it achieves, the most important of which is increasing motivation for learning, because it enables the student to obtain information and build knowledge on his own by developing the ability to generate information and increasing interest in thinking as a process rather than focusing on its outcomes, in addition to developing the ability to solve problems [35]. Different, because generation skills are essential in various fields of life, not just education, by going beyond traditional solutions and producing new and diverse solutions, which enhances self-confidence through feeling the importance of productive ideas [36].

Jennifer [37] mentions that generative thinking skills fluency means the ability to generate the largest number of ideas. Flexibility: This means the student's ability to adapt. Expansion: This means the student's ability to provide details and explain information related to previous knowledge. Prediction: This means the student's ability to predict certain outcomes from a specific situation. Representation: This means the student's ability to add new meaning to information. Reasoning: This means the student's ability to reduce or solve a specific problem. Establishing hypotheses: This means the student's ability to reach a preliminary conclusion that will be subjected to examination and experimentation. Recognizing errors and fallacies: This skill includes the student's ability to recognize errors and fallacies.

Generative thinking is affected by many factors, including the school environment, as traditional methods that focus on memorization and indoctrination are an obstacle to the process of generating ideas, in addition to the fact that the family environment is considered the basis of mental arousal and helps to develop generative thinking skills [38]. Among the influential factors is also the philosophical and cultural trend that helps to make the student feel confident in expressing his opinions and ideas. Among the factors are also the evaluation methods that measure what the student has learned using observation and group discussion [39]. The process of acquiring skills in generative thinking represents a necessary need for the student's success and the development of society, as it serves as a provision for everything the student needs. So, he can deal effectively with any type of information and variables. The importance of generative

thinking skills is to make the student have an active role in the learning process and cultivate self-confidence, which makes him feel the importance of his role in producing ideas and solutions that help in practicing different types of thinking, such as creative, critical, and reflective thinking, and contribute to making the learner a producer of information instead of Whoever receives it from others [33, 36, 40].

E. Problem Statement

Generative thinking is considered one of the most important and modern types of thinking because of its focus on important educational outcomes. Therefore, some studies focused on developing this type of thinking (Generative thinking) among students by using some teaching strategies and various educational programs. Among these studies is a study [36, 41]. The results focused on developing students' generative thinking skills which reflects on enhancing students' self-learning abilities, developing their ability to produce knowledge, focusing on developing their creative thinking, developing their ability to solve problems, and developing their self-confidence., it is also evident that there is a lack of previous research and studies that focused on developing generative thinking skills in environments [33, 34]. Especially among early childhood teacher students at universities. Based on the above, and despite the great importance of generative thinking that is closely linked to various fields, it turns out that generative thinking skills are not taught correctly, which may lead to a weakness in generative thinking skills among female early childhood students at Jadara University. This weakness may be due to the methods used in teaching female students or the inadequacy of traditional teaching methods in the content of the curriculum. What the world needs are individuals who possess thinking skills, not just knowledge of facts. Hence, a need for a current study, that aims to determine the effectiveness of ChatGPT through brainstorming based on ChatGPT in generative thinking among early childhood teacher students considering the BYOD Policy.

The problem can be presented and addressed by answering the following questions:

- What is the level of generative thinking skills among early childhood teacher students at Jadara University?
- What is the effectiveness of brainstorming based on ChatGPT by relying on ChatGPT in developing the generative thinking skills of childhood teacher students at Jadara University?

F. Study Objectives

This study is aimed at:

- Determine the level of generative thinking skills among early childhood teacher students at Jadara University
- It also aimed to identify the effectiveness of brainstorming based on ChatGPT by relying on ChatGPT in developing the generative thinking skills of childhood teacher students at Jadara University

II. METHODS AND PROCEDURES

A. Study Population and Sample

The study population consisted of all students registered in the early childhood program at the faculty of educational

sciences at Jadara University in the second semester of the academic year (2023/2024), the names of the multi-section courses were identified, and then a random draw was conducted, resulting in the selection of the Computer in Kindergarten Course as a study sample, which is taught through two sections. The two sections were randomly distributed into study groups.

The sample of the study consisted of 32 male students; it was distributed into two groups randomly. the first group. consisted of 17 students, who studied through brainstorming based on ChatGPT, and the second group consisted of 15 students, who studied through blended learning. A pre-test is measured before the beginning of the study. To examine the equality between groups in Table 1, the MANOVA procedure was used. Results have shown that there is no significant difference in the pretest scores between groups. This means that groups of students have the same level of knowledge in generative thinking skills.

Table 1. Equal study groups in generative thinking skills

Variables	Sig
Fluency	0.251
Flexibility	0.435
Expansion	0.657
Prediction	0.878
Representation	0.204
Establishing hypotheses	0.600
Recognizing errors and fallacies	0.718
Overall	0.197

B. Research Design

Since the current study has focused on studying the effectiveness of ChatGPT through brainstorming in generative intelligence among early childhood teacher students considering the BYOD Policy, the researcher used the quasi-experimental method to compare the effectiveness of different teaching modes. The variables that might affect the results of the experiment were controlled by selecting a sample representative of the population. The sample characteristics were similar. The experiment was also applied to the two groups under the same conditions and with the same faculty member.

C. Research Instrument

To identify the students' generative thinking skills at Jadara University, the researcher developed the instrument of generative thinking skills depending on his experience and relevant literature review [31, 33, 34, 38]. The items instrument of generative thinking skills consisted of 37 distributed into 7 domains: fluency consisted of 7 items; flexibility consisted of 6 items, expansion consisted of 5 items, and prediction consisted of 5 items. consisted of 5 items, establishing hypotheses consisted of 5 items, and recognizing errors and fallacies consisted of 4 items.

D. Research Instrument Validity

Validity consists of two different aspects, that is, face and content validity. Face validity and content validity were judged by a panel of experts. The generative thinking instrument was evaluated during the development of the research study. The feedback and comments received from the panel of experts were employed to establish the necessary clarifications, changes, and modifications before and after piloting the study.

E. Correlation Coefficient

To extract the indications of the validity of the generative thinking instrument, the item's correlation coefficients were extracted for the instrument, where the study was applied to an exploratory sample consisting of 15 students who were outside the study sample, as the correlation coefficient here represents the significance of the validity of each item of the instrument and the total score as shown in Table 2.

Table 2. Correlation coefficients between the instrument items and domains and between the instrument items and the overall instrument

Correlation Coefficient		
items	Domains	Instrument
1	0.89	0.90
2	0.71	0.75
3	0.91	0.89
4	0.67	0.76
5	0.83	0.73
6	0.78	0.74
7	0.76	0.64
8	0.87	0.81
9	0.80	0.69
10	0.76	0.71
11	0.91	0.84
12	0.72	0.93
13	0.88	0.84
14	0.65	0.89
15	0.78	0.83
16	0.71	0.85
17	0.91	0.68
18	0.91	0.87
19	0.92	0.91
20	0.85	0.66
21	0.89	0.75
22	0.73	0.89
23	0.87	0.76
24	0.78	0.73
25	0.71	0.74
26	0.91	0.64
27	0.72	0.92
28	0.91	0.85
29	0.60	0.62
30	0.85	0.84
31	0.91	0.64
32	0.92	0.81
33	0.85	0.90
34	0.62	0.75
35	0.84	0.89
36	0.79	0.67
37	0.75	0.83

Table 2 shows the statistical significance and the value of the correlation coefficient for all items in the generative thinking instrument with the domains and with the total score of the overall instrument. The correlation coefficients ranged between the items and the domains 0.64 - 0.93, and the correlation coefficients ranged between the items and the overall score of 0.60 - 0.92, which are acceptable for the study.

F. Research Instrument Reliability

Table 3. Test-Retest reliability for generative thinking instrument

Variables	Sig
Fluency	0.87
Flexibility	0.78
Expansion	0.71
Prediction	0.82
Representation	0.72
Establishing hypotheses	0.84
Recognizing errors and fallacie	0.75
Overall instrument	0.78

The researcher used Test-Retest to check the reliability of

the instrument. The reliability coefficient of this instrument (The Arabic version) was computed by the implementation of Cronbach Alpha as shown in Table 3.

G. Study Variables

- Independent Variables: One independent variable is the electronic teaching method.
Brainstorming Based on ChatGPT
Blended learning.
- Dependent variable:
generative thinking

H. Study Procedures

After defining the objectives and problems of the study, the researchers took the following action:

- Determining the educational content of learning, which is represented in computer-based learning in early childhood. Then, the researchers designed brainstorming based on ChatGPT and blended learning content through the following steps:
- Study and analysis stage: This stage included two main elements: (determining the characteristics of the study sample who were third-year students specializing in early childhood at Jadara University in addition to identifying their educational needs). Design stage: Determine the instructional to be achieved through brainstorming based on ChatGPT and blended learning content, identifying content elements, and choosing appropriate educational media.
- Construction stage: The researchers used programs and applications that serve learning, such as ChatGPT.
- Evaluation stage: The educational content was evaluated in two ways: the formative evaluation for each of the previous stages and the summative evaluation after the completion of the content.
- The use stage: The content was presented to a survey sample of students, the ease of use was noted, and notes were taken to emphasize the work in the best way.
- Study instruments were distributed.
- The Moodle platform was used in addition to Google applications.
- It lasted three weeks in the second semester of the academic year (2023/2024).
- The study instruments were applied again.
- Data was collected and results were obtained.

III. RESULTS AND FINDINGS

The first question: What is the level of generative thinking skills among early childhood teachers' students at Jadara University?

To answer this question, the generative thinking skills of the students were divided into three levels: Low 0–1.66, Medium 1.67–3.33, and High 3.34–5, as shown in Table 4.

Table 4 shows that the students' responses ranged between 3.87 and 2.90, The (fluency) Domain came in first-ranked with a mean of 3.47 and a standard deviation of 1.09, the (Prediction) Domain in second-ranked with a mean of 3.45 and standard deviation of 1.13, the (Representation) Domain in third-ranked with a mean of 3.40 and a standard deviation 1.03, the (Recognizing errors and fallacies) Domain in fourth-ranked with mean 3.38 and a standard deviation 1.05,

the (Flexibility) Domain in fifth-ranked with a mean of 3.37 and a standard deviation 1.08, the (Expansion) Domain in sixth-ranked with a mean of 3.37 and a standard deviation 1.08, Finally the (Expansion) Domain in sixth-ranked with a mean of 3.17 and a standard deviation 1.02. The students responded to the instrument with a mean of 3.36, a standard deviation of 1.08, and a high degree

Table 4. Means and standard deviations of students' responses to the generative thinking instrument

Correlation Coefficient			
	items	Mean	Domains
Fluency	1	3.74	0.86
	2	3.42	1.18
	3	3.13	1.26
	4	3.77	0.88
	5	3.55	1.12
	6	3.39	1.20
	7	3.29	1.13
	<i>Total of Domain</i>	3.47	1.09
Flexibility	8	3.29	0.94
	9	3.81	0.87
	10	3.55	1.12
	11	3.16	1.29
	12	3.16	1.16
	13	3.23	1.09
	<i>Total of Domain</i>	3.37	1.08
Expansion	14	3.29	1.16
	15	3.19	1.05
	16	3.23	1.23
	17	3.13	0.99
	18	3.45	1.15
	<i>Total of Domain</i>	3.24	1.12
Prediction	19	3.19	1.35
	20	3.42	1.23
	21	3.74	0.82
	22	3.65	1.20
	23	3.26	1.06
	<i>Total of Domain</i>	3.45	1.13
Representation	24	3.26	0.89
	25	3.32	1.01
	26	3.87	0.81
	27	3.61	1.20
	28	2.94	1.26
	<i>Total of Domain</i>	3.40	1.03
Establishing Hypothes	29	3.29	1.01
	30	3.42	0.96
	31	2.90	0.87
	32	2.97	1.22
	33	3.29	1.04
	<i>Total of Domain</i>	3.17	1.02
Recognizing errors fallacies	34	3.23	0.80
	35	3.35	1.02
	36	3.52	1.15
	37	3.42	1.26
	<i>Total of Domain</i>	3.38	1.05
<i>Total of Instrument</i>		3.36	1.08

The second question: What is the effectiveness of brainstorming based on ChatGPT by relying on ChatGPT in developing the generative thinking skills of childhood teacher students at Jadara University?

To answer this question, the means and standard deviations were extracted as shown in Table 5.

From Table 5, there is an apparent variation in the means and standard deviations of students' responses to the generative thinking instrument. To identify the significance of the statistical differences between the arithmetic means, MANCOVA was used, as summarized in Table 6.

Table 5. Post-test scores in generative thinking skills of students in various treatment groups

	Method	Mean	Std. D
Fluency	Brainstorming based on ChatGPT	26.3	1.79
	Blended learning	22.3	4.12
	Total	24.2	3.75
Flexibility	Brainstorming based on ChatGPT	22.4	2.44
	Blended learning	18.0	2.64
	Total	20.1	3.36
Expansion	Brainstorming based on ChatGPT	18.9	1.98
	Blended learning	13.8	2.31
	Total	16.2	3.35
Prediction	Brainstorming based on ChatGPT	18.7	2.18
	Blended learning	16.0	2.56
	Total	17.3	2.71
Representation	Brainstorming based on ChatGPT	22.1	1.92
	Blended learning	18.5	2.30
	Total	20.2	2.77
Establishing hypotheses	Brainstorming based on ChatGPT	17.3	1.95
	Blended learning	14.3	2.39
	Total	15.8	2.62
Recognizing errors and fallacies	Brainstorming based on ChatGPT	22.2	3.02
	Blended learning	17.8	3.52
	Total	19.9	3.93
Overall instrument	Brainstorming based on ChatGPT	148.1	7.72
	Blended learning	121.0	7.27
	Total	134.1	15.60

Table 6. MANCOVA of the post-test scores in the generative thinking skills of students in various treatment groups

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Treatment Groups	Fluency	60.989	1	60.989	5.365	0.031
	Flexibility	98.275	1	98.275	13.202	0.002
	Expansion	159.279	1	159.279	41.681	0.000
	Prediction	57.860	1	57.860	11.651	0.003
	Representation	83.737	1	83.737	25.000	0.000
	Establishing hypotheses	80.759	1	80.759	20.756	0.000
	Recognizing errors and fallac	170.632	1	170.632	15.289	0.001
	Overall instrument	4781.730	1	4781.730	108.684	0.000

To know the effect the effectiveness of brainstorming based on ChatGPT on the development of generative thinking skills, the researcher calculated the ETA Square η^2 . The ETA square value is interpreted according to the following distribution: The value of the ETA square (η^2) is interpreted according to the following division: From ($0.01 \leq \eta^2 < 0.06$) the effect size is minimal. From ($0.06 \leq \eta^2 < 0.14$), the effect size is moderate. From ($0.14 \leq \eta^2$), the size of the effect is large.

Table 7. The results of the ETA square (η^2) for the effectiveness of brainstorming based on ChatGPT in developing generative thinking skills

Variables	η^2
Fluency	0.287
Flexibility	0.443
Expansion	0.600
Prediction	0.250
Representation	0.428
Establishing hypotheses	0.328
Recognizing errors and fallacies	0.321
Overall instrument	0.777

The (η^2) results, as shown in Table 7, Brainstorming based on ChatGPT has an impact on developing generative thinking skills among Jadara University students.

IV. DISCUSSION OF THE STUDY RESULT

This study aimed to determine the effectiveness of brainstorming based on ChatGPT in developing generative thinking skills among female early childhood teacher students at Jadara University, based on the BYOD Policy. The results showed that the level of generative thinking was high among students at Jadara University. The results also showed

that there is effectiveness of brainstorming based on ChatGPT in developing generative thinking skills compared to blended learning based on the BYOD Policy. This result is attributed to the fact that the use of personal devices stimulated students' interest in technology, which indicates an awareness of the effectiveness of the use of personal devices in education, as it allowed students to access information and knowledge anywhere and at any time, and to follow special web pages that present various information. Also, the availability of many applications and tools that facilitate the learning process and enable students to interact freely with each other and with the teacher, participate and collaborate, and the ease of dealing with personal devices in the classroom compared to desktop computers. This is in addition to the requirements for working on personal devices that were inexpensive, which is considered an important advantage in this type of learning.

Applying the BYOD Policy allows faculty members and students to bring their devices to the classroom, whether they are smartphones, tablets, or laptops, and to benefit from the technical capabilities it provides for educational uses and improve teaching and learning processes because it contributes significantly to providing a device for each member. University faculty and students. This is in line with modern e-learning adopted by Jordanian universities in terms of good planning and enactment of laws regulating the rules of use, as well as good protection of their wired or wireless networks, which enabled students and faculty members to bring their own devices to use in learning activities. This is consistent with the results of many studies [27, 29, 31] that indicated the effectiveness of employing the BYOD Policy in

education.

This result is also attributed to the fact that brainstorming based on ChatGPT played a major role in students' engagement during learning and enthusiasm when carrying out activities, especially when using their own devices. This contributed to providing an atmosphere of activity and enthusiasm in the classroom environment and thus helped to develop many alternatives or correct ideas for the presented problem. Brainstorming based on the ChatGPT environment also encourages deepening concepts and enriching them with academic content through mental processes when performing tasks and activities, in addition to providing a classroom environment dominated by discussion and the exchange of ideas completely freely while respecting other opinions. This had a positive impact on the students' feeling of safety in writing, defending their ideas, and accepting criticism. Brainstorming sessions also encouraged students to expand their circle of thinking, provide a stimulating psychological environment for learning, deviate from normal ideas, and look at the presented problem from several aspects to reach the best possible results or solutions. Brainstorming based on ChatGPT sessions also encouraged students to expand their range of thinking, provide a stimulating psychological environment for learning, deviate from normal ideas, and look at the presented problem from several aspects to reach the best possible results or solutions.

It also helped the students understand the factors and causes, find relationships between phenomena and problems, and compare and classify information, which enabled the students to build a mental map characterized by the ability to deduce, analyze, and come up with logical explanations for those phenomena and problems. Predicting future changes that may occur in this phenomenon, as the educational environment based on brainstorming based on ChatGPT has led to increased motivation toward exerting more effort and thinking about producing the largest number of innovative ideas and solutions. It also worked to provide a safe classroom environment for them to express their opinions and ideas, provide the freedom to express and reinforce all familiar ideas, and encourage unfamiliar ideas with an emphasis on continuing progress and continuing to think about solutions and new ideas, in a way that makes the student feel self-esteem and enhances her self-confidence. The opportunity to express her ideas, even if they are strange, eliminates barriers that may hinder her abilities, such as shyness and hesitation. It allowed for the creation and diversity of ideas and thus helped to activate mental abilities and develop generative thinking, by providing a classroom environment that stimulates students to learn according to their aptitudes and abilities, enhances their abilities to solve problems and make appropriate decisions about them, raises their level of self-esteem, and develops their levels of generative thinking. Likewise, the steps of brainstorming based on the ChatGPT strategy, which are: identifying the problem, formulating it, and presenting suggestions and solutions, contributed to enabling the students to organize their thoughts, expand their understanding, and expand their imagination in proposing solutions to the problems presented, away from focusing on finding the correct solutions to these problems.

Brainstorming based on ChatGPT also enables students to

be freer from the rules of face-to-face interactions while setting rules such as not criticizing, focusing on quantity, collecting and improving productive ideas, and writing down all ideas, no matter how strange they are. To the ability to think outside the ordinary and produce creative solutions to the problems they face. In addition, the use of open-ended questions and not being restricted to closed, specific-answer questions in brainstorming sessions created an atmosphere of freedom in answering and eased the flow and generation of ideas. It also allowed them to bring in their current and previous knowledge in answering, and this has a role in improving generative thinking skills and developing them. This result agreed with the results of many studies [17, 24–26].

Also, the adoption of brainstorming based on ChatGPT on ChatGPT enabled the students to intensify the number of questions included in the brainstorming based on ChatGPT sessions, which helped them to feel the related problems by bringing these problems closer and linking them to the reality that the students live in in the local environment or by providing regional or global examples. In addition to the availability of a lot of information provided by ChatGPT on how to address problems from their various aspects, such as their concept, causes, and results, and how to limit them in the future, ChatGPT, due to its capabilities related to artificial intelligence, facilitated the brainstorming based on ChatGPT process for female students. By asking the students to answer short questions in quick succession and modifying the questions, this enabled the students to determine a starting point to find solutions to the problems raised, with multiple solutions and information each time you asked questions while following up on the idea and then asking more about anything that interests you, in addition to The ability to start a new chat session if the matter is completely off topic by requesting unconventional or imaginative ideas.

All these capabilities of ChatGPT enabled the students to expand their awareness of the importance of thinking about solutions and suggestions. It also placed them in competitive situations that required the generation of diverse ideas with different dimensions, their movement from one situation to another, and from one activity to another, helped to emerge, this result made them more innovative in their answers and more expansive in their thinking, all of this helped in developing generative thinking skills. This result agreed with the results of many studies [3, 7, 12].

V. CONCLUSION AND RECOMMENDATIONS

The current study aimed to find brainstorming based on ChatGPT in Developing Generative Thinking among Kindergarten Teacher Students Considering the BYOD Policy.

To achieve this aim, an educational environment was designed and taught through two methods (Brainstorming Based on ChatGPT\Blended learning) to determine the effectiveness of teaching methods and the difference between them. The researchers used generative thinking skills instruments in the study. The results showed that there was the effectiveness of brainstorming based on ChatGPT in developing generative thinking skills for students considering the BYOD Policy. Considering the research procedures and the results, the researchers recommended the

following:

- Conducting educational studies aimed at developing generative thinking skills through various electronic methods and techniques based on modern methods for kindergarten teacher students in Jordanian universities
- Activating the BYOD Policy in teaching kindergarten teacher courses in Jordanian universities
- Adopting ChatGPT as a learning tool within Jordanian universities for kindergarten teacher students.
- Focusing on training students and faculty members in universities specializing in kindergarten on brainstorming based on ChatGPT skills.
- Conduct studies that employ technological innovations (brainstorming based on ChatGPT, brainstorming, ChatGPT, BYOD) on different academic study categories in Faculties of Educational Sciences and different subjects.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

The authors have formulated the research methodology, data collection, and analysis contributed to the research, analysis, and presentation of the results. Osamah Aldalalah analyzed the data, wrote the manuscript, and approved the final version. Yousef Eyadat followed up on the proofreading. All authors had approved the final version.

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