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The effectiveness of cloud computing in developing critical thinking skills among early childhood students

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C H R O N I C L E

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A B S T R A C T

The main objective of this research was to find out how well cloud computing works for teaching kids in the early grades to think critically. Participants in the study were a group of early childhood students from schools in the Mafraq Governorate. The duration of the trial was set at one month. Sixty students participated in the study; thirty were randomly assigned to the experimental group and thirty to the control group. Following the intervention, the experimental group performed better than the control group on tests measuring reasoning, interpretation, analysis, and assessment skills. Both in the follow-up assessment and in the time immediately after the intervention, the experimental group and the control group did not vary from one another in terms of critical thinking skill scores.

1. Introduction

Emphasis is placed on teaching and fostering critical thinking during early infancy, which is regarded as one of the most critical periods of an individual's existence. Educational establishments have endeavored to offer curricula that foster the holistic development of a child's sound personality. Therefore, one of the principal objectives throughout the stages of life is the cultivation of critical thinking abilities. It enables the child to contemplate, analyze, and interpret the information presented to him to arrive at the correct conclusion (Njenga et al., 2019). Critical thinking is a crucial form of thinking that fosters independence and moves individuals beyond dependency and self-centeredness by promoting questioning, research, and exploration rather than simply accepting facts at face value. Children adopt the attitudes and ideas of significant persons in their life, and the cognitive approaches of adults impact the lives of children who rely on them (Listiqowati et al., 2022). By nurturing a youngster to have a receptive mindset, he will not rely on luck for his thoughts, but will instead acquire the skill of knowing how and when to inquire. He learns to deduce, apply reasoning, and select appropriate ways of critical thinking (Alharbi, 2021).

Educational scholars in this subject have determined that thinking skills are crucial for fostering critical and effective thinking, which is vital for a child's success in life. It is essential for him to develop fundamental cognitive skills like observation, organization, relationship identification, deduction, and judgment (Tomesko et al., 2022). Training to enhance these skills, starting in kindergarten, is crucial. Modern education focuses on current teaching techniques and tools to adapt to ongoing advances and changes. Since the early 20th century, educators have become interested in critical thinking as a necessary skill in modern society, driven by the vast increase of knowledge. Exciting and swift societal transformation (Ay & Dağhan, 2023). During the transition from the twentieth to the twenty-first century, rapid societal change and new challenges to human skills and potentials began to have a widespread influence on mankind. Several educational disciplines have experienced a

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significant shift in setting educational objectives to address the evolving needs of individuals adapting to this transformation (Listiqowati et al., 2022).

Educational institutions are focused on e-learning as a consequence to facilitate access to educational resources, enable fast and convenient exchange, and offer diverse content and educational experiences. Although e-learning has grown recently, there remains a disparity between traditional classroom education and the use of second-generation technology that emphasizes social interaction (Ismael & Mubariz, 2020). This gap has led to the development of participatory e-learning, enabling teachers and learners to engage, collaborate, and interact during the learning process. Many studies suggest supporting educational practices with digital technology to enhance the educational process and enhance instructors' abilities to create digital material, communicate, and collaborate (AL-Safasfeh & Al-Ajlouni, 2019). Creating a social network between students and teachers in a virtual learning environment with various digital educational resources that can be effectively managed is known as a cloud collaborative environment or cloud computing. This service enables users to get, analyze, and save data on the cloud using a computer or smartphone, without requiring the purchase of software or programs (Al-Adwan, 2023).

Cloud computing is important in education, yet conventional teaching techniques are still predominant, hindering students from developing broad and critical thinking abilities. This is because several issues frequently do not receive adequate coverage owing to the need for collaboration and involvement from learners (Al-Muraikhi, 2023). The researcher deemed it essential to utilize contemporary educational techniques that engage students, stimulate motivation, and encourage learning, such as cloud computing technology and its internet-based applications, particularly due to its affordability. The researcher conducted this study to determine the usefulness of cloud computing in enhancing critical thinking abilities in early childhood pupils.

Research questions:

This study intends to investigate the specified topics in the context of the previous discussion.

1. Are there statistically significant variations in the impact of cloud computing on the development of critical thinking skills in early childhood pupils between the experimental and control groups?
2. Are there significant variations in the efficacy of cloud computing in promoting critical thinking skills among early childhood pupils in the experimental group?
3. Is there a statistically significant difference in scores between post-test and follow-up tests when assessing the impact of cloud computing on the development of critical thinking skills among early childhood students?

2. Literature review

Cloud computing involves using shared resources whose charges are based on their utilization over the Internet. This technology was created to solve the problem of costly technical resources and improve resource management for businesses, especially following the implementation of internet infrastructure in many global locations (Samyan & St Flour, 2021). Laptop computers and cellphones have significantly facilitated communication by enabling Internet connectivity and the interchange of diverse information and files. Virtualization technology improves the efficiency of computer resources and increases their flexibility according to workload and consumption levels. The costs related to owning something, such upkeep and improvements, are covered by an outside organization called the service provider (Tajur, 2022). Educational institutions were driven to use this technology to reduce technical and informational costs, which affect the efficiency of the human labor in fulfilling their responsibilities in these institutions. The institutions' efficiency and effectiveness depend on their administrative performance, which helps them fulfill their objectives (AL-Omari, 2021). Improving administrative performance is now a primary goal. These institutions prioritize optimizing their work processes to maximize efficiency and effectiveness, while minimizing time and expenditures to assure their success and distinctiveness (Al-Muraikhi, 2023).

Cloud computing is an often used and ambiguous word in modern times. It pertains to services, applications, software, hardware, and resources that may be accessible via the Internet and managed by a third-party service provider in their data centers. An individual who expresses dissatisfaction with some parts of this system is often known as a complainer in the pay-per-use model (Ismael & Mubariz, 2020). Many firms often use this approach, which requires payment in order to utilize cloud computing services. Compensation is calculated according to the utilization of processing capabilities, storage space, memory capacity, and the quantity of permitted users, among other variables. Instead of utilizing your computer for network connection and storing applications and files, these resources are kept in data centers called the cloud (ALharahsheh & Al-Dhiabat, 2019). The computer serves as a tool for accessing and connecting with the cloud. This pertains to all computers in a corporation. Instead of immediately deploying the programs they are developing on employees' devices. The apps are implemented on the cloud and function in a standard way (Baldassarre et al., 2018).

The National Institute of Standards and Technology has defined it as a framework that enables convenient and enduring network access, facilitating the rapid provisioning and activation of various computing resources with minimal administrative effort or service provider intervention (Qasem et al., 2019). The cloud model consists of The topic covers five core qualities, three service delivery methods, and four implementation models. It is known as a technology that uses computing capabilities,

computer storage resources, and processing via the Internet, provided as a service by Internet service providers (Komalasari et al., 2020). Cloud computing technology necessitates the existence of the following components:

- User or beneficiary: The recipient of this technology will use their computer or mobile phone connected to the Internet to access and take use of its services (Özdemir et al., 2020).
- Applications: The recipient can use a variety of application packages available in the cloud, including word processing, presentation, spreadsheet, and information sharing services (Alashhab, et al., 2020).
- Platforms: Apple and Google provide this service, delivering extensive servers with great storage capacity and rapid data processing capabilities (Ali et al., 2018).
- Infrastructure: The cloud infrastructure is crucial for providing services and consists of personal computers, the Internet, and storage facilities for data (Ali, 2019).
- Services: Applications provide various features that users may utilize once their device is connected to the Internet. The services provided encompass text editing, email, calendar, chat, and more features (Alonso-Monsalve, et al., 2018).

Cloud computing is characterized by a distinct set of capabilities, including self-service. This pertains to individuals' capacity to autonomously access and employ cloud-based apps based on their own needs. Users can manipulate and save data in the cloud infrastructure using a web browser (Arpaci, 2019). Flexibility is the capacity to switch between service providers without facing major negative repercussions. The concept also includes the capacity to smoothly combine different services, such procuring storage from one source and using software from another, depending on the efficiency and dependability of each service provider (Elhoseny et al., 2018). Flexibility also involves the ability to grow and adjust to upcoming changes by using the latest versions of software and hardware in the cloud. Cloud computing allows users to access its services using a web browser, independent of the operating system, access device, or geographic location in relation to the cloud. Cost reduction: Using computers removes the need to get server space, software, storage devices, and hardware upkeep. The duties are carried out remotely by the service provider over an internet connection utilizing a personal computer, desktop, or mobile phone. Cloud computing services prioritize usability, which is enhanced by modern communication methods through digital devices on the Internet. This enables easy storage and access of data from any place, as well as smooth sharing and cooperation with other users (Juma & Tjahyanto, 2019).

Various companies provide cloud computing services to consumers, with Microsoft, Amazon, and Google being the most prominent. This talk will highlight the prominent services provided by Google that are widely used and available at no cost. Key services provided are email, Google Drive, Google Docs, Google Sites, OneDrive, Google Presentations, Google Forms, Google Calendar, and Google Meet (Njenga et al., 2019). Media students can use a range of services such as academic resources, research applications, and educational tools to further their academic and professional endeavors. Excluding the need for exclusive device usage (mobile, computer), specific physical location, or time restrictions (Aydin, 2021). Cloud computing has attracted considerable attention from professionals in the information sector. This is because it can provide infrastructure, services, and programs over a network, which offers attractive advantages for educational institutions (Al-Muraikhi, 2023). Cloud computing enables the development and use of many sorts of material, including papers, tables, images, presentations, and interactive video displays, by management. Cloud computing has become essential in educational institutions because it allows for the storing of audio files without needing a large amount of storage space (Al-Adwan, 2023). Multiple studies have confirmed that using cloud computing resources in education helps learning and encourages creativity, for individuals and groups. It also helps in addressing educational difficulties (AL-Safasfeh & Al-Ajlouni, 2019). Although there are certain drawbacks to cloud computing, they are largely insignificant compared to the vast potential provided by the cloud environment. Moreover, the cloud upholds strict security standards that are not compromised by tiny faults. This highlights the natural security of the cloud environment (Ismael & Mubariz, 2020).

In the modern era of information technology, there has been a significant increase in revolutionary advancements. Therefore, people are now faced with a wide range of contradictory information, requiring the development of critical thinking abilities. This is essential for distinguishing truth from unfounded claims (Atwa et al., 2022). Developing critical thinking skills is recognized as important and necessary, yet it is difficult. Societal growth depends not just on the creation of new ideas and inventions. It requires regular evaluations using critical analysis to analyze the possible advantages of these concepts and innovations. The review process assesses if adjustments and more progress are needed to promote social progression (Widodo, 2022). John Dewey defines critical thinking as a type of reflective thinking that demands individuals to actively participate and persevere in their cognitive processes. The process entails a thorough scrutiny and assessment of beliefs, together with the evaluation of knowledge claims supported by empirical data, resulting in logical conclusions (Pang, 2022). Critical thinking focuses mostly on evaluating values and analyzing different issues and theories. To fulfill requirements and directions backed by supporting evidence (Syamsidah et al., 2022).

Critical thinking involves a set of sub-skills outlined by Watson and Glaser, including identifying assumptions, interpreting, deducing, drawing conclusions, and evaluating arguments (Listiqowati et al., 2022). Afzali and Izadpanah (2022) define critical thinking as a collection of cognitive skills, including interpretation, analysis, evaluation, inference, explanation, and self-regulation. Critical thinking is seen as a key cognitive function that allows humans to assess and analyze the large volume of information resulting from the fast growth of knowledge and scientific progress. Engaging in critical thinking allows

individuals to distinguish precise and important information, successfully using it to achieve personal and social goals. Evaluating created notions and proposed solutions and subjecting them to logical analysis (Ay & Dağhan, 2023).

Critical thinking is crucial for individuals to tackle rapid changes in modern society and successfully deal with complicated situations that need abstract cognitive skills. The learner gains the ability to construct queries through this cognitive process. When does he ask? When is inference used? (Tomesko et al., 2022). The teacher plays a vital and unique role in nurturing critical thinking and encouraging active and creative thinking in pupils. This is accomplished by intentionally designing demanding learning settings that encourage cognitive involvement and improve the student's ability for creativity, interpretation, analysis, and decision-making. The instructor also has a crucial role in creating a favorable classroom environment that facilitates these cognitive processes (Listiqowati et al., 2022). Encourages participation, personal creativity, free exploration, teamwork, and increased self-confidence. The instructor acts as a facilitator by asking challenging questions that require students to provide evidence or reasoning to support their ideas, hypotheses, and conclusions (Alharbi, 2021).

At the start of life, a person lacks developed mental abilities and talents. The surrounding environment has a crucial influence in developing skills that support and inspire individuals to think and create. Teaching skills to youngsters is increasingly important to enhance their critical thinking abilities. To ensure our children's success in a highly developed and technological society, we must provide them with the essential cognitive abilities to acquire and analyze information in a dynamic environment (Nikolopoulou et al., 2019). In the current era characterized by information abundance and ongoing progress, critical thinking abilities are crucial and indispensable. In the future, the ability to learn, grasp new information, and engage in rational decision-making will be more crucial than possessing specialized expertise. To teach and enhance critical thinking in a kid, one might follow a structured set of activities that stimulate the child's brain to engage in constructive and beneficial behaviors. Ultimately, instructing youngsters in critical thinking strategies will stimulate fundamental cognitive processes. Various sorts of questions necessitate the use of diverse levels and forms of thinking, whether we are aware of it or not. Encouraging children to think critically and creatively enhances self-confidence and promotes experimentation with new ideas and ways without fear of making errors (Romero-Tena et al., 2020). Children must grasp the principles of trial and error, recognizing that making errors is crucial for learning. Adults should exemplify and promote these abilities, urging children to think critically and seek new solutions. There is no hierarchical structure for thinking skills, yet they are interconnected and enhance one another. These talents need to be enhanced, cultivated, and integrated practically (Kahila et al., 2023).

The child develops the skill of critical thinking by discerning between facts, opinions, fallacies, and claims, assessing strong and weak evidence and arguments, categorizing primary and secondary information, understanding logical explanations for events and information, and adjusting thinking to be accurate and avoid being misled by rumors, misinformation, and biased messages (Thiel & Jenssen, 2020). Critical thinking is crucial during childhood since it transforms the acquisition of knowledge into an active process, leading to improved mastery and deeper comprehension. It aids youngsters in developing problem-solving abilities and fosters the capacity to make unbiased and rational decisions, which are crucial for education (Gayatri, 2020). Kahila et al. (2023) emphasized that critical thinking is crucial in education as it allows children to explore subjects deeply, using their experiences and skills in a neutral and logical way. This process enhances individuals' abilities to uncover facts and discern various aspects. This significance pertains to empowering the educated child to become an independent researcher, a contributor to his community, and an asset that contributes to the progress and development of his cognitive and economic community.

3. Previous studies

AL-Safasfeh and Al-Ajlouni (2019) investigated the effects of a cloud computing-focused educational program on eighth-grade students' comprehension of scientific concepts in the area of science. The study included two groups: an experimental group of 30 participants taught using cloud computing and a control group of 30 participants taught by traditional methods. To achieve the study's goal, researchers created an educational program focused on cloud computing and a test to assess the understanding of scientific ideas. The results showed substantial differences in the mean scores of students from the two groups on the scientific concepts test, with the experimental group outperforming the control group.

Al-Jboul and Al-Sharah (2019) detailed how an educational program utilizing cloud computing affected the enhancement of writing abilities in the English language for tenth-grade students. The study involved 40 male and female students from The Jordan University School. Sections of grade ten were randomly assigned to either an experimental group or a control group. The experimental group received eight weeks of teaching utilizing the newly devised curriculum, whereas the control group followed the existing educational program for the same duration. Statistically significant differences were found between the two groups, indicating that the instructional program had a positive impact on writing levels in favor of the experimental group. Additionally, there were significant differences in post-writing skills test results, specifically in linguistic and discursive skills.

Elhadi (2019) studied how cloud computing apps might enhance the critical reading skills of secondary school pupils. The specific critical reading sub-skills focused on were: identifying cause-and-effect relationships, interpreting implicit ideas and information in the text, identifying main ideas, distinguishing between facts and opinions, recognizing the author's bias, differentiating relevant and irrelevant information, understanding the author's purpose, and inferring the antecedent of the sentence. The research involved twenty first-year secondary students from Temai Al-Amdid Secondary School in Dakahleiia

Governorate. They were segregated into two factions: The experimental group received training using cloud computing based on the suggested program. The control group was instructed using conventional methods to develop critical reading abilities. The experimental therapy took place in the second semester of the school year 2017–2018. The study utilized a quasi-experimental methodology with a pre-post design including two groups: an experimental group and a control group, to assess the impact of cloud computing on enhancing the critical reading abilities of first-year secondary school students. The researcher developed and utilized two tools: a pre-post critical reading assessment and a critical reading skills survey. The study found that utilizing cloud computing tools led to enhancements in participants' EFL critical reading abilities and a more positive attitude towards critical reading.

AL-Omari (2021) acknowledged the influence of cloud computing on the enhancement of Google educational applications proficiency and critical thinking skills among students enrolled in the Internet applications in education course at Mutah University. The study sample comprised a cohort of (22) students who were assigned to the experimental group and received instruction through cloud computing. A control group consisting of 22 students was instructed using the conventional technique. The study employed a semi-experimental methodology, wherein data was gathered through the use of note cards and a critical thinking scale. The results demonstrated statistically significant disparities in the student's performance on the observation card, favoring the experimental group. There were no significant statistical disparities observed between the two groups in terms of their scores on the critical thinking measure. Therefore, the study suggests incorporating cloud computing into university education due to its capacity to enhance proficiency in utilizing Internet applications.

4. Methodology

This study employed an experimental design to assess the impact of changes in one or more independent variables on a dependent variable. The effects were assessed and recorded as necessary. The researcher assessed critical thinking skills in young pupils using both conventional approaches and a cloud computing tool. Two cohorts participated in the study: one was instructed in the use of a cloud computing application, while the other received traditional instruction.

4.1 Population and sample

The study included 1,530 children in the early childhood period from the government sector, based on Ministry of Education statistics from 2023. A sample of 60 children, aged 7-8 years, in the early childhood stage in Mafraq city was randomly selected. The children were separated into two groups: an experimental sample consisting of 30 boys and girls, and a control sample also consisting of 30 boys and girls. The consent and approval of the participants was obtained before conducting the study.

4.2 Research instrument

Employing two distinct instruments of research facilitated the accomplishment of the study's goals, as outlined below:

1. A tailored instructional plan was created for a cloud computing curriculum: The initiative aims to improve critical thinking abilities among young children enrolled in schools in Mafraq. The current study is expected to be completed by the academic year 2023-2024. After a comprehensive evaluation of the experiment's main goals and relevant material, the researcher developed an initial list of 32 behavioral objectives. The framework comprises numerous components: usage, comprehension, recollection, evaluation, synthesis, and assessment. A team of professionals and experts verified the precision and comprehensiveness of the data. The particular aims were modified in response to feedback, however the overall number of goals remained constant at 32. One group utilized a cloud-based technological platform to aid the experimental group in preparing courses, while the other group employed traditional techniques. The instructional method panel was provided with many instances for analysis. The task was assigned to evaluate their compliance with the predetermined behavioral goals and the current subject. The final version was created after revising several parts again based on comments from professionals. 32 unique instructional programs were introduced, each employing two methodologies for both groups. Among the 32 apps, half utilized a cloud computing-based electronic platform while the remaining half employed a conventional manner.
2. Develop an instrument for evaluation to improve critical thinking abilities among early childhood students: The study aims to assess the influence of the experimental items on juvenile critical thinking ability. Critical thinking skills encompass reasoning, interpretation, analysis, and assessment abilities. The test questions are carefully designed to communicate the intended purpose and assess practical skills based on the criteria set by current academic research. Most exam portions had multiple-choice questions delivered using a cloud computing-based electronic platform. The item selection approach was based on a specific subscale designed to enhance critical thinking abilities. Every question in the set consists of an opening statement and four possible responses. Students must select an appropriate response. There are a total of 32 components in the test.

4.3 Instrument validity and reliability

Two methods were used to evaluate the instrument's accuracy:

1. The instrument assessment needs a group of 10 arbitrators to set an 80% approval standard.
2. 13 students were part of the sample used to determine discriminant validity. With the observed F values of 4.60, 4.85, 5.00, and 5.30, we evaluated the statistical significance of the discriminant validity of the coefficients.

Cronbach's alpha was used to evaluate the internal consistency of the instrument. The instrument had a good overall dependability score of 0.84. The reliability coefficients for each criterion range from 0.83 to 0.861.

4.4 Data analysis

The mean and standard deviation of the pre-and post-test scores were determined after completing data collection. We utilized Eta Square to assess the impact of cloud computing educational programs on the enhancement of critical thinking abilities in young kids. Statistical methods such as Wilcoxon's test and the Z-value were used to analyze and explain the differences between two similar samples.

5. Results and Discussion

Table 1 showed that critical thinking skills were comparable between early childhood pupils in the control and experimental groups before implementing a cloud computing program.

Table 1
Initial Assessment

Dimensions	Groups	N	M/R	S/R	U	Z	P
Reasoning skill	Experimental	30	16.20	486.00	30.00	12.60	0.180
	Control	30	17.40	522.00			
Interpretation skill	Experimental	30	15.70	471.00	27.00	11.10	0.160
	Control	30	15.60	468.00			
Analysis skill	Experimental	30	14.20	426.00	22.00	9.90	0.110
	Control	30	14.40	432.00			
Assessment skill	Experimental	30	14.00	420.00	21.00	9.80	0.105
	Control	30	14.30	429.00			
Total	Experimental	30	15.00	450.00	25.00	10.90	0.140
	Control	30	15.40	462.00			

According to Table 1, the two groups of students did not differ significantly in their mean score results on the pre-test of critical thinking skills; in fact, their scores were rather similar across all categories.

Table 2
Post-test

Dimensions	Group	N	M/R	S/R	U	Z	P
Reasoning skill	Experimental	30	25.40	762.00	273.00	0.530	0.000
	Control	30	20.50	615.00			
Interpretation skill	Experimental	30	25.10	753.00	265.00	0.560	0.000
	Control	30	20.00	600.00			
Analysis skill	Experimental	30	24.70	741.00	253.00	0.600	0.000
	Control	30	19.00	570.00			
Assessment skill	Experimental	30	23.80	714.00	220.00	0.750	0.000
	Control	30	18.90	567.00			
Total	Experimental	30	24.80	744.00	255.00	0.580	0.000
	Control	30	19.60	588.00			

The results of the post-test for the experimental group are shown in Table 2. The experimental group significantly outscored the control group on measures of critical thinking, which include reasoning, interpretation, analysis, and assessment. The experimental group of pupils clearly demonstrates a high level of competence in applied critical thinking.

The researcher attributed this outcome to the manner in which these technologies were implemented, including multimedia, iPads, projectors, interactive educational games, and activities that engage all of the students' senses. The techniques effectively empowered the students to autonomously learn skills by exposing them to various situations through targeted tactics. The students acquired a multitude of skills using engaging methods, enabling them to learn in a relaxed, unrestricted, and adaptable manner. The student bears the responsibility for the manner in which the activity is carried out, which has a direct impact on their engagement in the learning process. Al-Omari (2021) did a study that shows how cloud computing improves competency in Google educational applications and enhances critical thinking abilities. Students are offered a versatile learning environment that allows them to choose when and where they study, work at their own pace, and have control over the sequence, speed, and progress of the subject. The researcher ascribes this phenomenon to the utilization of interactive elements in educational activities and games. These components have heightened children's enthusiasm and motivation to learn knowledge, improve their skills, and engage with their peers. This has resulted in a dynamic, friendly, and collaborative atmosphere among the students.

The researcher credits the students' heightened motivation to study to the effectiveness of the methods used in the educational material. These strategies offer appropriate tasks for students, moving away from mere narration and indoctrination. They help to overcome educational challenges by incorporating aural signals and promoting precise answers. Providing the learner with several opportunities to practice the work, identify errors, and rectify them, therefore enhancing their academic performance. This aligns with the demands of the digital era and caters to the current generation's inclination for uninterrupted engagement with electronic devices, infusing enthusiasm and enjoyment into the educational experience. The outcome is also connected to the arrangement of critical thinking skills material. This congruence arises from the appropriateness of these skills for kids, since they are already acquainted with the fundamental ideas, in line with their abilities, and pertinent to their environment. Moreover, the skills are imparted to students in distinct, interconnected segments that encompass a range of components. Engaging in diverse and stimulating activities that offer ongoing feedback enhances students' ability to retain knowledge, motivating them to persist in learning and actively engage. This conclusion aligns with the outcomes of prior investigations carried out by AL-Safasfeh and Al-Ajlouni (2019), Al-Jboul and Al-Sharah (2019), Elhadi (2019), and AL-Omari (2021). To address the second question, are there significant variations in the efficacy of cloud computing in promoting critical thinking skills among early childhood pupils in the experimental group? The results are displayed in the table below.

Table 3
Pre and Post-test

Dimensions	Pre/Po	N	M/R	S/R	Z	P
Reasoning skill	Negative Rank	5	4.00	20	43.00	0.000
	Positive Rank	25	12.00	300.00		
	Ties	0				
	Total	30				
Interpretation skill	Negative Rank	5	4.00	20	42.80	0.000
	Positive Rank	25	12.00	300.00		
	Ties	0				
	Total	30				
Analysis skill	Negative Rank	5	4.00	20	42.50	0.000
	Positive Rank	25	12.00	300.00		
	Ties	0				
	Total	30				
Assessment skill	Negative Rank	5	4.00	20	42.60	0.000
	Positive Rank	25	12.00	300.00		
	Ties	0				
	Total	30				
Total	Negative Rank	5	4.00	20	42.70	0.000
	Positive Rank	25	12.00	300.00		
	Ties	0				
	Total	30				

The mean scores of the experimental groups in several critical thinking skills, such as reasoning, interpretation, analysis, and assessment, exhibited considerable disparities among them. Table 3 displays significant variability in the outcome of the final assessment. Following the examination, pupils in the experimental group showed superior proficiency in critical thinking skills.

The researcher credits the outcome to the implementation of a student-centered approach that incorporates many approaches and utilizes both material and moral reinforcement tactics to actively engage students in activities. The researcher selects strategies that are customized to the particular aptitude they wish to cultivate in students, rather than employing a range of instructional methods to enhance the acquisition of skills. Employing strategies such as discussion, think-sharing, brainstorming, and the hot chair can assist individuals in improving their conversational etiquette, cultivating respect for others, and capitalizing on the varied learning possibilities offered by both group and individual learning. Self-directed learning fosters autonomy and cultivates competencies in collaboration, engagement in collective endeavors, and posing perceptive inquiries. The objective is to deliberately engage cognitive processes when presenting a skill in order to enhance awareness and focus, therefore guaranteeing that the skill remains consistently in the speaker's mind. Adapting various approaches and activities to align with the concept and abilities effectively engages youngsters in the learning process, hence enhancing their programming skills and aiding them in attaining academic objectives. The utilization of digital technology, such as multimedia, iPads, projectors, interactive educational games, and activities, enhances the acquisition of many educational skills and concepts. Integrating them into school curriculum and activities enhances the educational process and achieves the intended objectives. It caters to different educational levels and customizes educational programs and activities to suit the specific abilities of learners. Furthermore, these technologies improve focus, deliberate regulation, and response abilities through interactions with peers and participation in group activities within a pleasurable setting. This conclusion aligns with previous research conducted by AL-Safasfeh and Al-Ajlouni (2019), Al-Jboul and Al-Sharah (2019), Elhadi (2019), and Al-Omari (2021).

The last question is about whether there is a statistically significant difference between the scores on the post-test and the follow-up tests when looking at how well a cloud computing program for teaching early childhood students critical thinking skills works. Ensuring a timely response to the present question is essential for delivering a meaningful answer. The results are presented in the table.

Table 4
Post and Follow-up

Dimensions	Po/ Foll	N	M/R	S/R	Z	P
Reasoning skill	Negative Rank	25	12.30	307.50	10.10	0.100
	Positive Rank	0	0.00	0.00		
	Ties	5				
	Total	30				
Interpretation skill	Negative Rank	25	12.30	307.50	9.80	0.140
	Positive Rank	0	0.00	0.00		
	Ties	5				
	Total	30				
Analysis skill	Negative Rank	25	12.30	307.50	9.70	0.125
	Positive Rank	0	0.00	0.00		
	Ties	5				
	Total	30				
Assessment skill	Negative Rank	25	12.30	307.50	10.00	0.110
	Positive Rank	0	0.00	0.00		
	Ties	5				
	Total	30				
Total	Negative Rank	25	12.30	307.50	9.50	0.165
	Positive Rank	0	0.00	0.00		
	Ties	5				
	Total	30				

There was no statistically significant change in the mean scores of the experimental group between the post-test and follow-up assessments, as shown in Table 4. Research showed that the program's efficacy did not decrease once the intervention ended; rather, it remained stable throughout the post-intervention period.

The results provide credence to the theory that early childhood students may be making use of cloud computing program designed to foster analytical thinking. Hence, there was no obvious decrease in the previously reported results for the people in issue. By making it easier to relate new information to what users already know, cloud-based programs also encourage lifelong learning. Students are less likely to experience abrupt or early departure if they are provided with opportunities to practice and enhance their reasoning, interpretation, analysis, and assessment skills in various curriculum-defined scenarios.

6. Conclusion

The results of this study lend support to the idea that using cloud computing software might help early childhood students develop their critical thinking abilities. A student's ability to learn critical thinking abilities and develop abstract mental models using cloud computing is a significant component. This enhances their performance on examinations that examine all aspects of critical thinking. This is in line with what is required in the digital world and satisfies the present generation's preference for constant screen time, which brings energy and fun to the classroom. The organization of content of critical thinking abilities is also related to the result. Since children have a foundational understanding of the concepts, these skills are age-appropriate, suitable for their abilities, and relevant to their surroundings, thus there is a natural fit. In addition, students learn the skills in separate but related parts that cover a lot of ground. Students are more likely to remember information and remain motivated to study when they participate in a variety of engaging activities that provide continuous feedback.

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Ethical approval

The Ethical Committee of the King Khalid University, Saudi Arabia approved this study on 15-12-2023 (Ref. No. RGP.2 / 192 /45)

Data availability

All data related to this article is available upon request.

Competing interests:

The authors declare no competing interests.

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