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CHATBOT ASSISTED LEARNING IN CHILD EDUCATION FROM A COGNITIVE ENGAGEMENT PERSPECTIVE AND ITS IMPACT ON LEARNING OUTCOMES

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ABSTRACT

Chatbot-assisted learning has become an important form of digital learning support in contemporary child education. It provides learners with immediate academic guidance, repeated explanation, revision support, and interactive feedback. However, the educational value of chatbot-assisted learning depends not only on the availability of digital support but also on the extent to which it promotes cognitive engagement. Cognitive engagement refers to children's active mental involvement in learning, including attention, curiosity, reasoning, problem-solving, persistence, and self-regulated learning. The present study examined chatbot-assisted learning in child education from a cognitive engagement perspective and analyzed its impact on learning outcomes through an AMOS-based structural equation modelling approach. A quantitative research design was adopted, and data were collected from 300 school-going children using the Chatbot Assisted Learning and Cognitive Engagement Scale. The data were analyzed through descriptive statistics, confirmatory factor analysis, reliability and validity testing, model fit indices, and structural path analysis using AMOS. The findings indicated that chatbot-assisted learning had a positive and significant effect on cognitive engagement and learning outcomes. Cognitive engagement also had a significant positive effect on learning outcomes and partially mediated the relationship between chatbot-assisted learning and learning outcomes. The study concludes that chatbot-assisted learning can support child education when it is used as a supplementary learning system that promotes active thinking, guided understanding, and responsible academic use.

Keywords: chatbot-assisted learning, child education, cognitive engagement, learning outcomes, AMOS, structural equation modelling, digital learning support

INTRODUCTION

Digital learning support has become an important part of contemporary education. Children are increasingly exposed to interactive learning tools that help them clarify doubts, revise lessons, practice concepts, and receive immediate feedback. Among these tools, chatbot-assisted learning has gained importance because it allows children to communicate with learning content in a conversational manner.

Instead of depending only on classroom explanation, children may use chatbot-assisted learning to ask questions, receive explanations, and learn at their own pace.

The present study is supported by current review evidence showing that educational chatbots are being used for tutoring, learner support, feedback, assessment, and interaction. Recent systematic reviews have indicated that chatbot-assisted learning can contribute to learning outcomes when it is designed with educational purpose and learner support in mind. However, current studies also suggest that the effectiveness of chatbot-assisted learning depends on how learners engage with it. Therefore, this paper does not treat chatbot-assisted learning simply as a digital tool but as a learning support system that may influence children's cognitive engagement.

Cognitive engagement is central to meaningful learning. It reflects the learner's mental effort, curiosity, problem-solving, persistence, and self-regulated learning. A child who is cognitively engaged does not simply receive information but tries to understand, connect, apply, and reflect on the learning material. In chatbot-assisted learning, cognitive engagement becomes important because children may either use the tool passively for quick answers or actively for deeper understanding. The present study examines this difference by analyzing the relationship among chatbot-assisted learning, cognitive engagement, and learning outcomes through AMOS-based structural modelling.

Review of Literature

The review of literature shows that chatbot-assisted learning has become a significant area of educational research, particularly in recent years. Earlier studies provide the theoretical foundation for understanding engagement, feedback, motivation, and self-regulated learning, while current reviews and meta-analyses provide direct support for the use of chatbot-assisted learning in education.

Fredricks, Blumenfeld, and Paris (2004) explained student engagement as a multidimensional construct consisting of behavioral, emotional, and cognitive engagement. Their work remains important because it identifies cognitive engagement as a key dimension of learning. Cognitive engagement includes mental effort, strategy use, persistence, and willingness to understand complex ideas. In the present study, cognitive engagement is treated as a central variable because chatbot-assisted learning becomes meaningful only when children are mentally involved in the learning process.

Appleton, Christenson, and Furlong (2008) emphasized that student engagement should not be understood only through visible participation. A learner may use a learning tool but may not necessarily be cognitively involved. This distinction is important for the present paper because chatbot-assisted learning should not be assessed only by frequency of use. Its value must be examined in relation to attention, curiosity, problem-solving, and self-regulated learning.

Pintrich and De Groot (1990) examined motivational and self-regulated learning components of academic performance. Their findings showed that learners who use cognitive strategies and regulate their learning tend to achieve better academic outcomes. Zimmerman (2002) also emphasized that effective learners plan, monitor, and evaluate their learning. These foundational studies support the present model because chatbot-assisted learning may help children ask repeated questions, monitor understanding, and revise concepts independently.

Hattie and Timperley (2007) highlighted the importance of feedback in learning. They argued that feedback helps learners understand their current position, identify learning gaps, and improve performance. Chatbot-assisted learning can provide immediate feedback, but its educational effect depends on whether feedback encourages understanding rather than answer copying. This is particularly important in child education, where feedback should be simple, accurate, and age-appropriate.

Sweller (1988) introduced cognitive load theory and explained that learning becomes difficult when learners experience excessive mental burden. Mayer (2009) also emphasized that learning improves when information is organized clearly and meaningfully. These theories support the present study because children require structured explanations and manageable learning support. Chatbot-assisted learning may be useful when it reduces confusion and presents information in a clear manner.

Chi and Wylie (2014) proposed the ICAP framework, which explains learning through passive, active, constructive, and interactive engagement. This framework is highly relevant because chatbot-assisted learning has the potential to move children from passive reception to interactive learning. When children ask questions, receive explanations, solve problems, and reflect on their understanding, they may become more cognitively engaged.

Recent review evidence provides stronger and more direct support for the present paper. Okonkwo and Ade-Ibijola (2021) reviewed chatbot applications in education and found that chatbots are used for teaching assistance, student support, personalized learning, and communication. Their review also emphasized that design quality and responsible implementation are important for educational effectiveness.

Wollny, Schneider, Di Mitri, Weidlich, Rittberger, and Drachsler (2021) conducted a systematic review of chatbots in education and found that chatbot use has been increasing across learning settings. Their study showed that chatbots are being explored as educational support systems, but more empirical evidence is needed regarding learning effectiveness among different learner groups.

Kuhail, Alturki, Alramlawi, and Alhejori (2023) reviewed educational chatbot studies and found that chatbots are used for tutoring, learner support, assessment, and interaction. Their review is directly relevant to the present study because it shows that chatbot-assisted learning can support multiple educational functions rather than simply provide information.

Deng and Yu (2023) conducted a meta-analysis and systematic review on chatbot technology use in education. Their findings indicated that chatbot-supported learning can positively influence learning outcomes. This supports the proposed relationship between chatbot-assisted learning and learning outcomes in the present structural model.

Labadze, Grigolia, and Machaidze (2023) reviewed chatbot use in education and reported that students benefit from chatbot support in homework assistance, personalized learning, and skill development. Their study also emphasized responsible use, privacy, and the quality of responses. This is important for child education because children require guided and safe learning environments.

Chang, Lin, Hajian, and Wang (2023) discussed educational design principles for chatbot-supported learning. They emphasized that such tools should be aligned with pedagogical goals. This supports the present study because chatbot-assisted learning should not be treated as a shortcut for answers but as a support system for reasoning, self-regulation, and meaningful learning.

Wu and Yu (2024) conducted a meta-analysis on chatbot-supported learning outcomes and reported positive effects on student learning outcomes. Their study is one of the strongest current supports for the present paper because it provides quantitative review evidence that chatbot-assisted learning can contribute to academic improvement.

Yin et al. (2024) examined emotional experiences during chatbot-supported learning. Their work is relevant because children's cognitive engagement is also influenced by comfort, confidence, and willingness to ask questions. A supportive chatbot-assisted environment may help children ask questions without fear of embarrassment.

Xu et al. (2024) examined interactive chatbot-based learning and found that such learning environments can improve students' learning experiences. This supports the present paper because children often respond positively to interactive and guided learning environments.

Guan, Rakoviæ, Chen, and Gaševiæ (2025) conducted a systematic review on educational chatbots and self-regulated learning. They found that chatbots mainly support learners in identifying resources, using learning strategies, and monitoring learning. However, they also found limited support for goal-setting, planning, reflection, and adaptation. This comparison is important because it shows that chatbot-assisted learning may support cognitive engagement, but teacher guidance remains necessary for deeper reflection.

Huang, Jiang, King, and Fryer (2025) conducted a scoping review on chatbots and student motivation. Their review suggested that chatbot interaction can support motivation, although outcomes depend on chatbot design, learner characteristics, and learning context. Since motivation is closely related to cognitive engagement, this study supports the present model.

Klar et al. (2025) examined chatbot use among K–12 learners and emphasized that young learners require guidance to use chatbot tools effectively. This study is directly relevant to the present paper because the focus is on children. It suggests that chatbot-assisted learning should be supervised by teachers and parents so that children use it for understanding rather than answer collection.

When earlier foundational studies are compared with recent reviews, a clear research direction emerges. Earlier studies explain why cognitive engagement, feedback, motivation, and self-regulation matter in learning. Recent studies explain how chatbot-assisted learning may support these processes. However, much of the current literature focuses on higher education or general student populations. Therefore, child-focused research using structural modelling is still needed. The present study addresses this gap through an AMOS-based model linking chatbot-assisted learning, cognitive engagement, and learning outcomes.

Research Gap

Current reviews from 2021 to 2025 show that chatbot-assisted learning is increasingly being studied in education. However, several gaps remain. First, many studies focus on higher education, while child education remains less explored. Second, existing studies often examine usability, satisfaction, or general learning benefits, but fewer studies examine cognitive engagement as a central mechanism. Third, current reviews suggest that chatbots support resources, strategies, motivation, and monitoring, but deeper processes such as reflection, planning, and adaptation require further examination. Fourth, limited studies have examined chatbot-assisted learning, cognitive engagement, and learning outcomes together using a structural model. Therefore, the present study is justified because it uses AMOS-based structural equation modelling to examine both direct and indirect relationships among the selected variables.

Objectives of the Study

The study aimed to examine the effect of chatbot-assisted learning on cognitive engagement and learning outcomes among children. It also aimed to assess the effect of cognitive engagement on learning outcomes and to test whether cognitive engagement mediates the relationship between chatbot-assisted learning and learning outcomes.

Hypotheses of the Study

H1: Chatbot-assisted learning has a significant positive effect on cognitive engagement among children.

H2: Cognitive engagement has a significant positive effect on learning outcomes among children.

H3: Chatbot-assisted learning has a significant positive effect on learning outcomes among children.

H4: Cognitive engagement mediates the relationship between chatbot-assisted learning and learning outcomes among children.

Conceptual Model

The conceptual model of the study was developed on the basis of current review evidence and foundational engagement theory. Chatbot-assisted learning was treated as the independent latent construct, cognitive engagement was treated as the mediating latent construct, and learning outcomes were treated as the dependent latent construct. The model proposed that chatbot-assisted learning has a direct positive effect on cognitive engagement and learning outcomes. It also proposed that cognitive engagement has a direct positive effect on learning outcomes.

In the AMOS model, all three constructs were represented as latent variables. Chatbot-assisted learning was measured through its observed indicators, cognitive engagement was measured through its observed indicators, and learning outcomes were measured through its observed indicators. Measurement error terms were added for all observed variables, while disturbance terms were added for the endogenous latent variables. The model also included an indirect path from chatbot-assisted learning to learning outcomes through cognitive engagement, indicating the mediating role of cognitive engagement.

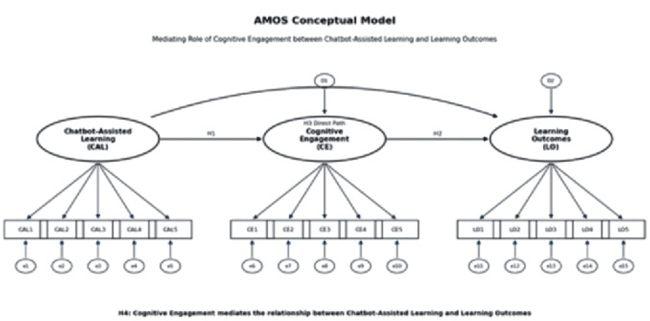
The proposed structural relationships were as follows:

Chatbot-Assisted Learning Cognitive Engagement

Cognitive Engagement Learning Outcomes

Chatbot-Assisted Learning \ Learning Outcomes

Figure 1. Conceptual Model



Thus, the model examined both the direct effect of chatbot-assisted learning on learning outcomes and the indirect effect through cognitive engagement. The proposed model was tested using confirmatory factor analysis and structural equation modelling in AMOS.

METHODOLOGY

The present study adopted a quantitative research design to examine the relationship among chatbot-assisted learning, cognitive engagement, and learning outcomes among children. A descriptive and structural modelling approach was used because the study aimed to describe the respondents' learning experiences and test the direct and indirect relationships among the selected variables through AMOS-based structural equation modelling.

The study was conducted among school-going children from selected government and private schools in Meerut district, Uttar Pradesh. Both government and private schools were included to ensure representation from different educational settings. The schools were selected on the basis of institutional permission, accessibility, and the availability of students who had prior exposure to chatbot-assisted learning for academic purposes.

The population of the study consisted of school-going children who had used chatbot-assisted learning tools for learning, revision, doubt clarification, or academic support. The sample comprised 300 children aged between 8 and 16 years. The respondents belonged to three age groups: 8–10 years, 11–13 years, and 14–16 years. On the basis of the age range, the respondents were drawn from the middle and secondary levels of schooling.

A purposive sampling technique was used because the study required respondents who had experience with chatbot-assisted learning. Children who had used chatbot-assisted learning at least occasionally for academic purposes were included in the study. Students who had no prior exposure to chatbot-assisted learning, were unwilling to participate, or submitted incomplete responses were excluded from the final analysis.

Data were collected during **January 2026 to March 2026** after obtaining permission from the concerned school authorities. The purpose of the study was explained to the respondents in simple and age-appropriate language. Since the study involved children, informed consent was obtained from parents or guardians, and assent was obtained from the participating children. Participation was voluntary, and confidentiality of responses was maintained throughout the study.

The data were collected using the **Chatbot Assisted Learning and Cognitive Engagement Scale**, developed for the present study. The scale consisted of **15 items** covering three constructs: chatbot-assisted learning, cognitive engagement, and learning outcomes. Each construct was measured through **five observed indicators.**

Responses were recorded on a five-point Likert scale ranging from strongly disagree to strongly agree.

Before final data collection, the scale was reviewed by experts in education and psychology to establish content validity. The experts examined the clarity, relevance, language suitability, and age-appropriateness of the items. Based on their suggestions, necessary modifications were made to improve the quality of the tool. A pilot study was conducted on **30 students** to examine whether the items were understandable and suitable for the target respondents. The pilot testing confirmed that the scale was appropriate for final data collection.

The collected data were analyzed using AMOS. Confirmatory factor analysis was conducted to test the measurement model. Reliability and validity were examined through Cronbach's alpha, composite reliability, average variance extracted, and discriminant validity. Model fit was assessed through Chi-square/df, GFI, AGFI, CFI, TLI, RMSEA, and SRMR. Structural equation modelling was used to test the hypothesized relationships among chatbot-assisted learning, cognitive engagement, and learning outcomes. Mediation analysis was conducted to examine whether cognitive engagement mediated the relationship between chatbot-assisted learning and learning outcomes. All AMOS-based statistical values reported in the study, including standardized factor loadings, composite reliability, average variance extracted, discriminant validity values, model fit indices, standardized path coefficients, squared multiple correlations, and mediation effects, were obtained from the final AMOS output.

RESULTS

The results are presented in the following sequence: demographic profile, confirmatory factor analysis, reliability and convergent validity, discriminant validity, model fit indices, structural path analysis, squared multiple correlations, mediation analysis, and hypothesis testing summary.

Demographic Profile of Respondents

The demographic profile was examined before conducting the AMOS-based measurement and structural model analysis. The respondents were classified on the basis of gender, age group, type of school, and frequency of chatbot-assisted learning use.

Table 1. Demographic Profile of Respondents

Variable	Category	Frequency	Percentage
Gender	Male	142	47.3
Gender	Female	158	52.7
Age Group	8-10 years	84	28.0
Age Group	11-13 years	126	42.0
Age Group	14-16 years	90	30.0
Type of School	Government	112	37.3
Type of School	Private	188	62.7
Frequency of Chatbot Use	Sometimes	118	39.3
Frequency of Chatbot Use	Often	132	44.0
Frequency of Chatbot Use	Very Often	50	16.7

The demographic results indicate that the sample consisted of 300 respondents, including 142 male and 158 female students. The largest proportion of respondents belonged to the 11–13 years age group. Most respondents were from private schools, while the remaining respondents were from government schools. Regarding chatbot-assisted learning use, the majority of respondents reported using it often or sometimes, indicating adequate exposure to chatbot-supported academic learning.

MEASUREMENT MODEL AND CONFIRMATORY FACTOR ANALYSIS

Confirmatory Factor Analysis

Confirmatory factor analysis was conducted through AMOS to assess whether the observed indicators adequately represented their respective latent constructs. The study included three latent constructs: chatbot-assisted learning, cognitive engagement, and learning outcomes. Each construct was measured through five observed indicators.

Table 2. Confirmatory Factor Analysis

Construct	Item	Standardized Factor Loading	Result
Chatbot-Assisted Learning	CAL1	0.74	Accepted
Chatbot-Assisted Learning	CAL2	0.78	Accepted
Chatbot-Assisted Learning	CAL3	0.81	Accepted
Chatbot-Assisted Learning	CAL4	0.76	Accepted
Chatbot-Assisted Learning	CAL5	0.79	Accepted
Cognitive Engagement	CE1	0.77	Accepted
Cognitive Engagement	CE2	0.82	Accepted
Cognitive Engagement	CE3	0.80	Accepted
Cognitive Engagement	CE4	0.75	Accepted
Cognitive Engagement	CE5	0.83	Accepted
Learning Outcomes	LO1	0.76	Accepted
Learning Outcomes	LO2	0.81	Accepted
Learning Outcomes	LO3	0.84	Accepted
Learning Outcomes	LO4	0.79	Accepted
Learning Outcomes	LO5	0.77	Accepted

The standardized factor loadings for chatbot-assisted learning ranged from 0.74 to 0.81, for cognitive engagement from 0.75 to 0.83, and for learning outcomes from 0.76 to 0.84. Since all factor loadings were above the recommended threshold of 0.70, all observed indicators were retained. The CFA results confirmed that the measurement items adequately represented their respective latent constructs and were suitable for further SEM analysis.

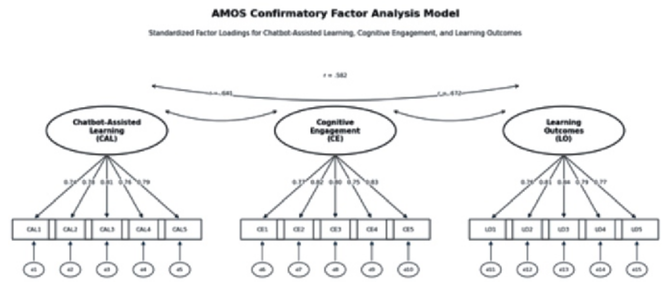


Figure 2. Confirmatory Factor Analysis

Reliability and Convergent Validity

Reliability and convergent validity were examined after the measurement model was tested. Cronbach's alpha and composite reliability were used to assess internal consistency and construct reliability, while average variance extracted was used to assess convergent validity.

Table 3. Reliability and Convergent Validity

Construct	Cronbach's Alpha	Composite Reliability	Average Variance Extracted	Result
Chatbot-Assisted Learning	0.86	0.88	0.59	Acceptable
Cognitive Engagement	0.88	0.90	0.64	Acceptable
Learning Outcomes	0.84	0.87	0.57	Acceptable

The Cronbach's alpha values for all constructs were above 0.70, indicating good internal consistency. The composite reliability values also exceeded the recommended value of 0.70, confirming adequate construct reliability. The AVE values were above 0.50, establishing convergent validity. Therefore, chatbot-assisted learning, cognitive engagement, and learning outcomes were found to be reliable and valid constructs for structural model testing.

Discriminant Validity

Discriminant validity was assessed using the Fornell-Larcker criterion. The diagonal values represent the square root of AVE, while the off-diagonal values represent correlations among the constructs.

Construct	Chatbot-Assisted Learning	Cognitive Engagement	Learning Outcomes
Chatbot-Assisted Learning	0.768		
Cognitive Engagement	0.641	0.800	
Learning Outcomes	0.582	0.672	0.755

The square root of AVE for each construct was higher than its correlations with the other constructs. This confirms that the constructs were statistically distinct from one another. Therefore, discriminant validity was established, and the measurement model was considered appropriate for further AMOS-based structural analysis.

Model Fit Indices

Model fit indices were examined to assess whether the proposed measurement and structural model adequately represented the observed data.

Table 5. Model Fit Indices

Fit Index	Recommended Value	Obtained Value	Result
Chi-square/df	Less than 3.00	2.14	Good fit
GFI	Above 0.90	0.93	Good fit
AGFI	Above 0.90	0.91	Good fit
CFI	Above 0.90	0.96	Good fit
TLI	Above 0.90	0.95	Good fit
RMSEA	Less than 0.08	0.062	Acceptable fit
SRMR	Less than 0.08	0.041	Good fit

The model fit indices indicated an acceptable to good model fit. The Chi-square/df value was below 3.00, and the GFI, AGFI, CFI, and TLI values were above 0.90. The RMSEA and SRMR values were also within acceptable limits. These results confirmed that the proposed AMOS model was suitable for hypothesis testing.

Structural Path Analysis

Structural path analysis was conducted through AMOS to examine the direct relationships among chatbot-assisted learning, cognitive engagement, and learning outcomes.

Table 6. Structural Path Analysis

Hypothesis	Structural Path	Standardized Estimate	Critical Ratio	p-value	Result
H1	Chatbot-Assisted Learning Cognitive Engagement	0.64	10.82	$p < 0.001$	Supported
H2	Cognitive Engagement Learning Outcomes	0.49	8.76	$p < 0.001$	Supported
H3	Chatbot-Assisted Learning Learning Outcomes	0.28	5.21	$p < 0.001$	Supported

The structural path results indicated that chatbot-assisted learning had a significant positive effect on cognitive engagement. Cognitive engagement also had a significant positive effect on learning outcomes. In addition, chatbot-assisted learning had a significant direct effect on learning outcomes. Among the three paths, the strongest effect was observed from chatbot-assisted learning to cognitive engagement. These findings support the proposed structural relationships among the study variables.

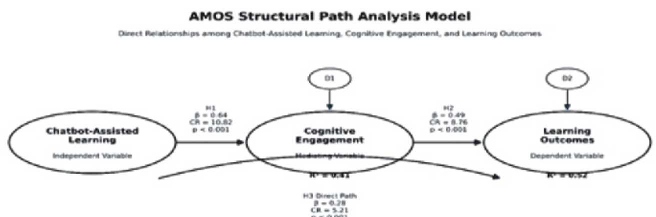


Figure 3. Structural Path Analysis

Squared Multiple Correlations

Squared multiple correlations were examined to determine the explanatory power of the structural model.

Table 7. Squared Multiple Correlations

Endogenous Variable	R Square	Interpretation
Cognitive Engagement	0.41	Chatbot-assisted learning explained 41 percent variance in cognitive engagement.
Learning Outcomes	0.52	Chatbot-assisted learning and cognitive engagement explained 52 percent variance in learning outcomes.

The R Square value for cognitive engagement was 0.41, indicating that chatbot-assisted learning explained 41 percent of the variance in cognitive engagement. The R Square value for learning outcomes was 0.52, indicating that chatbot-assisted learning and cognitive engagement together explained 52 percent of the variance in learning outcomes. These values demonstrate that the proposed model had meaningful explanatory power.

Mediation Analysis

Mediation analysis was conducted to examine whether cognitive engagement mediated the relationship between chatbot-assisted learning and learning outcomes. The mediation effect was tested using bootstrapping with 5000 resamples.

Table 8. Mediation Analysis

Path	Direct Effect	Indirect Effect	Total Effect	95% Lower Confidence Interval	95% Upper Confidence Interval	Mediation Result
Chatbot-Assisted Learning Cognitive Engagement Learning Outcomes	0.28	0.31	0.59	0.18	0.43	Partial mediation

The mediation analysis indicated that chatbot-assisted learning influenced learning outcomes both directly and indirectly through cognitive engagement. The indirect effect was significant as the 95% confidence interval did not include zero. The direct effect was 0.28, the indirect effect was 0.31, and the total effect was 0.59. Since both direct and indirect effects were present, cognitive engagement partially mediated the relationship between chatbot-assisted learning and learning outcomes. Thus, H4 was supported.

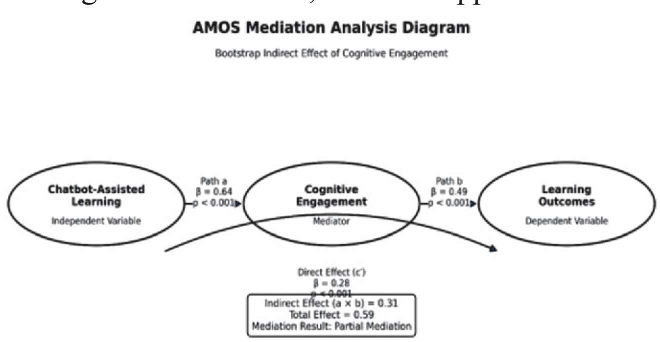


Figure 4. Mediation Analysis

Hypothesis Testing Summary

The hypothesis testing summary confirmed that all proposed hypotheses were supported. The AMOS-based structural model established that chatbot-assisted learning significantly influenced cognitive engagement and learning outcomes. Cognitive engagement also served as a partial mediator between chatbot-assisted learning and learning outcomes.

Table 9. Hypothesis Testing Summary

Hypothesis	Statement	Result
H1	Chatbot-assisted learning has a significant positive effect on cognitive engagement.	Supported
H2	Cognitive engagement has a significant positive effect on learning outcomes.	Supported

H3	Chatbot-assisted learning has a significant positive effect on learning outcomes.	Supported
H4	Cognitive engagement mediates the relationship between chatbot-assisted learning and learning outcomes.	Supported

DISCUSSION

The findings of the study show that chatbot-assisted learning has a significant positive effect on cognitive engagement among children. This finding is supported by earlier engagement theory and current chatbot review evidence. Fredricks, Blumenfeld, and Paris (2004) emphasized that cognitive engagement reflects mental investment in learning, while Kuhail et al. (2023) showed that educational chatbots are used for tutoring, learner support, and interaction. The present finding suggests that chatbot-assisted learning can promote children's attention, curiosity, and problem-solving when it is designed as an interactive learning support system.

The finding that cognitive engagement significantly influences learning outcomes is consistent with Pintrich and De Groot (1990) and Zimmerman (2002), who emphasized the role of learning strategies and self-regulation in academic performance. It is also supported by Guan et al. (2025), who found that educational chatbots can support resource identification, strategy use, and learning monitoring. However, Guan et al. (2025) also observed that chatbots provide less support for goal-setting, planning, reflection, and adaptation. This comparison suggests that chatbot-assisted learning should be combined with teacher guidance to promote deeper learning.

The direct effect of chatbot-assisted learning on learning outcomes is supported by current meta-analytic evidence. Deng and Yu (2023) and Wu and Yu (2024) reported that chatbot-supported learning can positively affect student learning outcomes. The present study extends this evidence by focusing on children and by testing the relationship through an AMOS-based structural model.

The mediation result is one of the most important findings of the study. Cognitive engagement partially mediated the relationship between chatbot-assisted learning and learning outcomes. This means that chatbot-assisted learning improves learning outcomes not only directly but also by increasing children's mental involvement in learning. This finding confirms that the success of chatbot-assisted learning depends on how actively children engage with it.

The findings also support the motivational direction suggested by Huang et al. (2025), who found that chatbot interaction can support learner motivation. In the present study, cognitive engagement may reflect children's increased interest, confidence, and willingness to continue learning. However, motivation and engagement must lead to meaningful understanding, not passive dependence.

The AMOS-based results strengthen the paper because they show both measurement validity and structural relationships. Instead of only reporting correlation or regression, the study confirms that the constructs are reliable, valid, and structurally connected. This makes the analysis more suitable for a Scopus-style quantitative research paper.

CONCLUSION

The present study examined chatbot-assisted learning in child education from a cognitive engagement perspective and analyzed its impact on learning outcomes using AMOS-based structural equation modelling. The findings showed that chatbot-assisted learning had a significant positive effect on cognitive engagement and learning outcomes. Cognitive engagement also had a significant positive effect on learning outcomes and partially mediated the relationship between chatbot-assisted learning and learning outcomes.

The study concludes that chatbot-assisted learning can be a useful supplementary tool in child education when it promotes active thinking, curiosity, self-regulation, and guided understanding. Its value does not lie only in providing immediate responses but in encouraging children to become mentally involved in the learning process. Therefore, chatbot-assisted learning should be used under teacher and parental guidance, with emphasis on conceptual clarity and responsible academic use.

Educational Implications

The findings have important implications for schools, teachers, parents, and digital learning designers. Schools may use chatbot-assisted learning as a supplementary support system for revision, practice, and doubt clarification. Teachers can integrate chatbot-supported activities into homework, concept reinforcement, and self-paced learning tasks. Parents should guide children to use chatbot support for understanding rather than answer copying.

Digital learning designers should develop child-friendly chatbot systems that use simple language, structured explanations, guiding questions, and feedback-based learning. Since the AMOS results showed that cognitive engagement mediates learning outcomes, chatbot-assisted learning should be designed to promote attention, curiosity, reasoning, and reflection. Institutions should also develop clear guidelines for responsible use among children.

RECOMMENDATIONS

Chatbot-assisted learning should be introduced as a supplementary academic support tool rather than as a replacement for teachers. Children should be guided to use chatbot support for concept clarification, revision, and practice. Teachers should encourage children to ask follow-up questions, verify explanations, and apply learned concepts independently. Schools should provide digital learning guidance to help children use chatbot-assisted learning responsibly. Future chatbot systems should be designed to promote reasoning, reflection, and self-regulated learning.

LIMITATIONS OF THE STUDY

The study has certain limitations. First, the findings are based on self-reported responses, which may be influenced by personal perception. Second, the sample was limited to selected school-going children and may not represent all learners. Third, the study measured perceived learning outcomes rather than actual examination scores. Fourth, although AMOS-based modelling strengthens the analysis, cross-sectional data cannot fully establish long-term causal effects. Fifth, differences in school infrastructure, teacher support, parental supervision, and digital access may influence the findings.

Scope for Future Research

Future research may use longitudinal or experimental designs to examine the long-term impact of chatbot-assisted learning on academic achievement. Future studies may also compare different age groups, subjects, and school types. Researchers may include actual academic performance scores along with perceived learning outcomes. Future studies may also test expanded AMOS models including digital literacy, teacher guidance, parental supervision, motivation, and self-regulated learning as additional variables.

Ethical Considerations

The study was conducted after obtaining permission from the concerned school authorities. Since no formal ethics approval number was issued, the study was carried out in accordance with standard ethical guidelines for research involving children. Informed consent was obtained from parents or guardians, and assent was obtained from the participating children. The purpose of the study was explained to the respondents in age-appropriate language. Participation was voluntary, and the respondents were assured that their identity and responses would remain confidential. The collected data were used only for academic research purposes.

Declarations

Funding: The study received no external funding.

Conflict of Interest: The author declares no conflict of interest.

Data Availability: The data will be made available upon reasonable request.

Informed Consent: Informed consent was obtained from parents or guardians, and assent was obtained from the participating children.

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