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Revolutionizing Early Childhood Education with AI: Leveraging ChatGPT to Empower and Support Parents

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Abstract:
Early childhood education is a critical period for cognitive, emotional, social, and physical development, yet many parents face challenges in effectively supporting children's learning due to limited time or resources. AI-based platforms offer personalized solutions that can transform family engagement in early education. This article presents an innovative system grounded in social constructivism theory, which emphasizes learning through interaction and collaboration. A pedagogical model was developed to meet the specific needs of children and their families, with a focus on personalized learning and engagement. The model integrates AI tools to facilitate adaptive, interactive communication, enriching the learning experience wherethe system architecture ensures smooth integration of technological components to support seamless and effective educational interactions.To assess the impact of this model, a mixed-methods study was conducted with parents of primary school children, comparing their involvement in their children's learning before and after using ChatGPT as a support tool. The results demonstrated significant improvements in parental engagement, confidence, and perceived effectiveness in assisting their children's education. Parents reported reduced stress and increased understanding of their children's learning needs. This approach highlights the promise of AI to offer innovative solutions that support early childhood learning during the crucial developmental years.

Keywords*:* Artificial intelligence; Early childhood education; Parental involvement; Social constructivism; Chat GPT Prompts.

1. INTRODUCTION

Early childhood education (ECE) is widely recognized as a crucial phase of human development, laying the foundation for the acquisition of cognitive, socio-emotional, and language skills that persist throughout life. Numerous studies highlight the significant impact of parental involvement during this stage, showing that active engagement in learning activities greatly enhances children's development across various domains. Whether through shared reading, cognitive stimulation, or emotional support, the role of parents is essential in fostering executive functions, memory, problem-solving abilities, as well as self-regulation and social skills(Uzbekistan State World Languages University Faculty Of Second English Language: Foreign Languages And Literature Bachelor's Degree Student, Uzbekistan and Shavkatovna 2023). However, despite its importance, many parents face challenges in

effectively supporting their children's learning due to time constraints, a lack of resources, or uncertainty about appropriate teaching approaches.

The evolution of educational technologies, particularly the integration of artificial intelligence (AI), offers a promising solution to these challenges by providing interactive, personalized, and scalable tools that optimize family engagement in the education of young children(Pardamean et al. 2022). Recent advances in AI, especially in machine learning and natural language processing, have resulted in the creation of advanced platforms that can tailor educational experiences to meet the unique needs of each learner. AI-powered systems have demonstrated their ability to generate personalized content, adjust learning activities in real time, and provide detailed feedback on a child's progress. These tools can be particularly beneficial in early childhood education by enhancing both the learning process and parental involvement(Teresa et al. 2023). For instance, AI platforms can offer interactive, playful scenarios that stimulate curiosity and critical thinking, while providing parents with personalized advice and resources to better support their children's developmental milestones.By bridging the gap between traditional education and technological innovation, AI has the potential to enhance early learning environments, ensuring that children receive the necessary support to thrive(Murtaza et al. 2022).But, to fully understand the potential of AI, it is essential to ground its use in solid theoretical foundations, specifically through the selection of an appropriate learning theory and pedagogical model.

In this article, we propose a rigorous model for integrating AI tools, particularly ChatGPT, into early childhood education. Grounded in social constructivism and principles of personalization, this model aims to optimize educational interactions and strengthen parental involvement. By leveraging AI's ability to adapt content and monitor progress, we argue that a balanced approach—combining human support with technological innovation—can significantly improve educational outcomes and provide a comprehensive framework that creating dynamic, effective, and engaging learning environments for children

2. MOTIVATION AND RESEARCH QUESTIONS

Early childhood education is a crucial phase in children's development, laying the foundation for their lifelong learning. However, many parents face challenges in effectively supporting their young children's learning during this important stage. In response to this need, this study explores the potential of ChatGPT -based online learning platforms, examining key questions such as:*How can these platforms adapt to each child's unique needs to personalize learning*? *How can the accessibility and flexibility offered facilitate the integration of educational activities into the family routine*? *How can the educational support provided help parents better understand their child's development*? *What is the impact of ChatGPT 's interactive format on children's engagement and motivation*? *How can parents monitor their children's progress*? *And to what extent can these online platforms increase accessibility and equity in early learning opportunities*?

3. RELATED WORKS

Recent research highlights the major impact of parental involvement on the development of young children, whether on the cognitive, socio-emotional or language levels(Cosso, Von Suchodoletz, and Yoshikawa 2022). Parental participation in stimulating learning activities, such as shared reading, promotes the development of executive functions, memory and problem-solving competences. On the socio-emotional level, parental involvement is crucial for the development of self-regulation, empathy, and relational skills. Affectionate gestures and emotional support contribute to a positive self-image and better emotion management in children(Polat and Bayındır 2022).Language development also benefits from rich verbal interactions between parents and children, such as reading aloud and stimulating conversations. These verbal exchanges promote the acquisition of language and

communication skills(Wang and Afri 2023).Furthermore, parents play a crucial role in consolidating academic achievements by extending this learning at home. This ensures continuity in the child's overall development and reinforces the skills already acquired.

Research therefore demonstrates that active parental involvement is essential for the development of skills necessary for children's academic success and personal development. By being actively involved, parents increase students' motivation and interest in learning, creating a supportive environment conducive to academic success. However, with the rapid evolution of technologies, it is becoming equally important to integrate artificial intelligence tools into education. These technologies enable the personalization of learning, meeting the specific needs of each student and offering innovative solutions to improve the efficiency and quality of teaching. Thus, a balance between parental engagement and the adoption of AI tools could positively transform children's educational experience(Muhmad Asri et al. 2023).

Artificial intelligence (AI) is attracting increasing interest in educational systems, opening up prospects for improving learning, including in early childhood. Advances in machine learning and natural language processing enable the development of sophisticated AI solutions, tailored to specific educational needs. These technologies personalize learning, optimize teaching practices, and support learners and teachers(Sunitha, Vijitha, and Gunavardhan 2023). AI platforms, such as chatbots, offer personalized educational content and activities tailored to young children, facilitating more engaging learning. In addition, these systems provide detailed monitoring of children's progress, helping to identify areas requiring additional support. AI can also automate administrative tasks, freeing up time for educators. Although its integration in early childhood is in its early stages, AI could transform education by enabling increased personalization and precise progress monitoring. Models such as ChatGPT offer tailored educational content and can act as virtual tutors, supporting students and parents in the learning process(Adiguzel, Kaya, and Cansu 2023).

In early childhood education, language models open up interesting possibilities by generating interactive content adapted to children's development, thus stimulating their engagement in learning. These tools also collect data on children's progress, allowing educators to better target their interventions(Mageira et al. 2022). In addition, these platforms provide parents with personalized advice on educational practices and activities adapted to their child's development. These tools encourage parental engagement, helping parents understand key developmental milestones in their children and actively support them in their early learning. When parents are better equipped, they create a stimulating learning environment at home, reinforcing the skills acquired at school. By bridging the gap between parental knowledge and children's needs, these technologies transform families' involvement in early learning.

Although there are numerous benefits, it's essential to acknowledge that the use of AI in education also brings up ethical concerns, particularly regarding the protection of children's data. Parents should be vigilant about the security and privacy of their children's information when using these tools.Moreover, although AI offers many possibilities, it cannot replace human interaction in the learning process(Dushyant Nimavat, K. K. Bajaj 2023). The role of parents and teachers remains crucial to guide, motivate, and emotionally support children in their educational journey. By using these technologies in a thoughtful and balanced way, parents can create a rich and engaging learning environment that complements traditional school instruction. AI in education is not intended to replace traditional methods, but rather to enhance them, giving children the best chance of success in their educational journey(Gonzalez-DeHass et al. 2022).

To fully understand the potential impact of artificial intelligence on education, it is essential to situate these technologies within the framework of learning theories. Indeed, AI

does not simply offer practical tools; it is part of a broader dynamic of reflection on how children learn and on the teaching methods that best promote their development. Exploring learning theories allows us to better understand how AI tools can be integrated harmoniously and effectively into education, reinforcing existing approaches while opening up new perspectives for supporting students in their educational journey.

Effective integration of AI tools into children's education by parents requires a strong theoretical foundation rooted in established learning theories. Behaviourism, developed by B.F. Skinner, emphasizes observable behaviours and responses to stimuli, making it suitable for AI systems offering virtual rewards and feedback(Clark 2018), though it has been criticized for neglecting cognitive processes.Cognitivism, as proposed by Jean Piaget, focuses on internal mental processes and could guide AI tools in promoting problem-solving and cognitive strategy development [14].Constructivism, advanced by Lev Vygotsky, highlights learners constructing knowledge through experiences, suggesting that AI could create personalized, interactive environment(Fosnot 1996). Connectivism, as developed by George Siemens, views learning as connecting specialized information nodes, which is highly relevant in the digital age (Kathleen Dunaway 2011). Experiential learning, formulated by David Kolb(Morris 2020), emphasizes direct experiences in AI-enhanced simulations, and Gardner's theory of multiple intelligences advocates for AI systems that cater to varied strengths and learning preferences.

Various educational models also benefit from AI integration. Personalized learning, supported by Benjamin Bloom, aligns with AI's ability to adapt content based on real-time performance. Project-based learning, following John Dewey's principles, involves learners in meaningful projects(Maida 2011), where AI could manage resources and tasks. Game-based learning, promoted by James Paul Gee, uses game mechanics to enhance engagement, and AI can create adaptive gaming experiences(Anon 2019b). Finally, the flipped classroom model, popularized by Jonathan Bergmann and Aaron Sams, can leverage AI to deliver personalized content for at-home learning and facilitate interactions during class time(Li and Peng 2022). Together, these theories and models provide a comprehensive framework for the successful integration of AI in education.

Choosing an appropriate learning theory and pedagogical model is crucial for effective integration of AI in children's education. A solid theoretical foundation enhances learning effectiveness and allows for adapting to individual needs. The right framework supports holistic development, ensuring AI contributes not just to knowledge acquisition but to overall growth. Additionally, well-chosen theory can foster engagement and motivation in learners and provide a basis for evaluating and improving AI tools(Feng and Law 2021). A blended approach, drawing on multiple theories, could be especially beneficial in creating dynamic, effective learning environments.

In the following, we explore existing works on the application of AI techniques in online learning environments. A comparative study of current systems and approaches is carried out, followed by a detailed synthesis.

Table 1. AI-based systems in online learning for Parental Support

System / Study	Reference	Personalization	Accessibility	Parent-Teacher Interaction	Educational Results
ALEKS	(Anon 1920)	AI algorithms to adapt learning paths	Parent-friendly interface	Limited but informative	Effective results in mathematics and science
Knewton	(Nosenko 2020)	Predictive analytics for	Flexible and diverse	Powerful analytical tools	Significant improvements

		personalization	interface		in various disciplines
DreamBox Learning	(Farahani and Ghasmi 2024)	Real-time adaptation of mathematics lessons	Fun and interactive interface for children	Focused on young children, little direct interaction	Effective for primary level mathematics
Smart Sparrow	(Kaw et al. 2019)	Personalization by adaptation of the paths	Accessible and flexible	Tools for educators and parents	Visible improvements in student engagement
ClassDojo	(Barahona Mora 2020)	Behavior-based personalization	Fun and engaging interface for children	Direct communication tools for parents and teachers	Positive impact on engagement and classroom management
Kidaptive	(Anon 2019a)	Personalization from behavior and data	friendly and intuitive interface	Facilitated interaction with parents	Significant improvements in cognitive skills
Century Tech	(Algabri, Hayder Kareem, K. Kharade, and R. Kamat n.d.)	AI to personalize learning paths	Easy to access and use interface	Detailed reports and tools for parents	Positive results on engagement and knowledge retention
Duolingo	(Loewen et al. 2019)	Chatbot to Personalize Language Learning	User-friendly interface with gamification	Interaction via chatbots and notifications	Proven effectiveness in language learning
Replika	(Xie and Pentina 2022)	Chatbot for Personalization of Interactions	Accessible and interactive via an application	Chat interaction and advice	Used for social engagement and emotional support
Watson Tutor	(Afzal et al. 2019)	AI to personalize lessons and tutorials	Integration with various educational platforms	Chat interaction with instant feedback	Positive results on understanding and retention of knowledge

AI-powered online learning systems offer benefits and challenges in education, especially for early childhood. Platforms like ALEKS adapt educational content to improve learning effectiveness, but their complexity can limit accessibility for parents.Adaptive systems, such as Knewton and DreamBox Learning, personalize educational pathways in real time, making learning easier for young children,they help track student progress, but require training to use

effectively.Platforms like Smart Sparrow and ClassDojo offer solutions ranging from personalizing learning paths to student engagement and parent-teacher communication. Kidaptive and Century Tech use AI to tailor learning paths. Educational chatbots, such as those from Duolingo and Replika, improve student interaction and engagement.In the following section, we explore how parents can leverage AI tools to enhance their children's education by introducing a system that utilizes generative chatbots like ChatGPT. Thissystem offers a unique opportunity to create personalized and interactive learning environments, catering to each child's individual needs and learning pace.

4. PROPOSED SYSTEM

The primary objective of this initiative is to develop an innovative system for early childhood education by coherently integrating theoretical, pedagogical, and technological elements. The first step involves identifying a learning theory that aligns with the unique developmental needs of young children, thereby providing a solid scientific foundation for the proposed approach. Subsequently, we propose a pedagogical model that guides the design and implementation of the system, with a focus on personalized learning and actively engaging children in the learning process. This model is underpinned by a robust system architecture, ensuring the seamless integration of various technological components. At the core of this system is the utilization of ChatGPT prompts, enabling adaptive, interactive exchanges with children. Furthermore, we strive to leverage the full potential of artificial intelligence tools to enhance the learning experience, offering innovative, accessible solutions for families while ensuring a high standard of education during the critical early years of life.

4.1. Theoretical Foundations

Choosing an appropriate learning theory is crucial for designing an adaptive early childhood education system, as it provides a conceptual framework guiding instructional activities, content structuring, and assessment methods. A well-chosen theory ensures that teaching strategies align with children's cognitive, social, and emotional development while promoting lasting learning. In the context of increasing technological integration, including artificial intelligence, selecting the right theory is essential to create enriching and pedagogically relevant interactions that cater to each child's developmental needs and learning style.

In this work, we have chosen the Social Constructivism theory, which is particularly suitable for our purpose. This theory emphasizes that children construct knowledge through social interactions with peers, teachers, and their environment. By applying this framework, we focus on how collaborative learning and real-world experiences shape a child's understanding, making it an ideal approach for enhancing parental support in primary education. It is also well-suited for digital environments, where AI can simulate social interactions and adapt activities to individual needs, contributing not only to knowledge acquisition but also to the development of social and emotional skills essential for young children's success. In the context of an AI-based learning environment, social constructivism can be applied in several ways:

1. Virtual social interaction: AI can simulate social interactions through conversational agents or virtual characters, allowing children to learn through dialogue and exchange.
2. Adaptive scaffolding: AI can provide adaptive support (scaffolding) that adjusts in real time to the child's level, helping them progress through their "zone of proximal development."
3. Contextual learning: AI systems can create learning scenarios based on real-life situations, helping children connect abstract concepts to their everyday experience.
4. Virtual collaboration: AI-powered learning platforms can facilitate peer-to-peer collaboration, even remotely, encouraging social learning.

Social constructivism aligns well with our modebecause it recognizes the collaborative nature of learning and the role of social interactions in knowledge construction. By leveraging ChatGPT to facilitate interactions between parents, children, and teachers, our approach fosters active engagement, shared understanding, and collaborative problem-solving to support children's learning and development. Table 2 presents a comparison of various learning theories based on the criteria and properties of children's learning when using artificial intelligence tools. This comparison highlights the distinct advantages of social constructivism in this context, which is why we have opted to choose the social constructivism theory for our approach.

Table 2. Comparative analysis of learning theories and children's learning characteristics in the context of ai tools

Criteria/ Properties	**Behaviourism**	**Cognitivism**	**Constructivism**	**Connectivism**	**Social Constructivism**
Interaction with the environment	Low, stimuli/response	Moderate, information processing	Strong, experimentation	Strong, information network	Very strong, social interactions
Personalization of Learning	Limited, based on reinforcements	Moderate, cognitive adaptation	Strong, individual construction	Strong, customization through connections	Very strong, personalized by the social context
Collaborative and Social Learning	Weak, individual-cantered	Moderate, sometimes collaborative	Moderate, individual-cantered	Strong, networked learning	Very strong, collective learning
Adaptation to Individual Needs	Low, standardization	Moderate, cognitive adaptation	Strong, self-regulating	Strong, depends on connections and networks	Very strong, social and cultural adaptation
Role of Interactivity and Engagement	Low, automatic responses	Moderate, cognitive engagement	Strong, active engagement	Strong, network engagement	Very strong, social and interactive engagement
Development of Social Skills	Weak, untargeted	Moderate, indirectly	Moderate, self-determination	Strong, inter-connectivity	Very strong, essential to the theory
Adapting to the Use of AI Tools	Limited, automated response	Moderate, cognitive support	Strong, simulation of experiences	Strong, AI-enhanced network learning	Very strong, AI-simulated social interactions
Active Learning and Exploration	Weak, pre-programmed responses	Moderate, internal processing	Strong, active exploration	Strong, network-driven exploration	Very strong, collective exploration
Effectiveness for Early Childhood Education	Weak, lack of nuance	Moderate, sometimes abstract	Strong, active engagement of children	Moderate, depends on child's connections	Very strong, better balance between social,

with AI				and maturity	cognitive and emotional

- **Behaviourism**: Behaviourism focuses on behavioural responses to stimuli, with little emphasis on interaction or personalization. It is therefore less suited to the use of AI tools that require more nuanced and adaptive interaction.
- **Cognitivism**: Cognitivism emphasizes internal mental processes, which can be useful, but is often too abstract for young children, and less focused on the social aspect essential for primary education.
- **Constructivism**: Constructivism encourages learning through active experience and self-regulation, making it a strong approach for educating children with AI. However, it may lack an explicit social dimension, which is essential at this age.
- **Connectivism**: Connectivism, adapted to the digital age, relies on learning through information networks. While it is relevant to the use of technologies, it may be too complex for young children who require more direct and socially enriched interactions.
- **Social Constructivism**: Social constructivism, on the other hand, offers a comprehensive framework that integrates social interactions as an integral part of learning. With AI tools, it allows for the simulation of interactive and social environments, making learning more engaging and personalized, while developing crucial social and emotional skills.

4.2. The pedagogical model

Providing an appropriate pedagogical model is crucial to ensure the effectiveness of an early childhood education system. Such a model must balance the cognitive, social and emotional dimensions of child development, ensuring that methods and content are adapted to the specific needs of young children. By integrating proven principles of pedagogy, a stimulating learning environment is fostered that encourages the development of essential skills while fostering children's sense of curiosity. This model must be flexible and adaptable to the different needs of children while remaining aligned with long-term educational goals. In the context of an early childhood education system, we proposed a rigorous model based on the principles of social constructivism, active learning and personalization to optimize educational interactions via technologies such as ChatGPT; this pedagogical model offers:

- **Active and Constructivist Learning**: Inspired by social constructivism, the model encourages active learning where children construct their knowledge through direct and interactive experiences. ChatGPT offers playful scenarios to explore and solve problems, fostering curiosity and critical thinking.
- **Learning Personalization**: The model adapts to the specific rhythms and interests of each child, adjusting the educational content in real time. For example, a child interested in animals will see lessons tailored to their preferences, stimulating engagement and adjusting the complexity according to their skills.
- **Social Interaction and Collaborative Learning**: Integrating collaborative activities fosters socio-emotional skills. Children interact with each other or with AI avatars in virtual projects, developing cooperation, empathy and communication.
- **Cognitive and Emotional Development Support**: The model offers personalized emotional encouragement and strategies, building confidence and autonomy while cultivating emotional skills essential to children's overall development.
- **Feedback and Progress Monitoring**: The model provides real-time feedback to both children and parents, helping them monitor progress and adjust learning paths accordingly. This feature allows parents to stay actively involved in their child’s development while ensuring that the learning experience remains adaptable to the child’s needs.

- **Multimodal Learning Experiences**: By incorporating visual, auditory, and interactive elements, the model supports different learning styles, ensuring that children engage with the content in ways that best suit their preferences. This multimodal approach enhances comprehension and retention of information.

4.3. System Architecture

The proposed architecture demonstrates how ChatGPT can be integrated into an online education system to provide personalized and interactive support to parents in their children's education. By combining ChatGPT 's text generation capabilities with analysis and recommendation modules, this system offers a comprehensive and effective solution to enrich primary learning and proactively support parents. Fig. 1 presents the proposed architecture of the system.

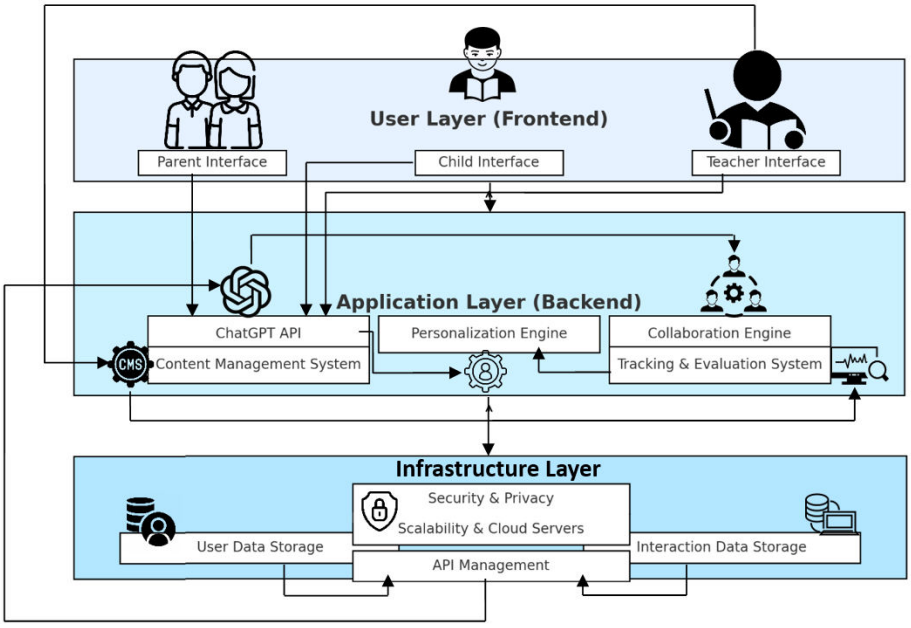

Fig. 1 System Architecture

4.3.1. System modules

In this section, we outline the various components that make up the system. Each module plays a crucial role in ensuring that the learning experience is interactive, personalized, and aligned with the principles of social constructivism. These modules work together to provide an integrated platform that supports both children and parents in the educational process:

1- **The Parent Interface:** Allows parents to monitor and adjust their child's learning via ChatGPT. Through a user-friendly dashboard, they can track their child's activities, customize settings (such as difficulty level or interests), and receive progress notifications. Parents can also interact directly with ChatGPT to ask questions, schedule learning sessions, and adjust the educational approach. Additionally, the interface enables parents to run ChatGPT prompts either proposed by teachers or automatically generated by the system based on the child's learning progress and needs.

2- **The child interface**: is designed to be interactive, playful and developmentally appropriate. Children can interact directly with ChatGPT via text or voice chats, and engage in educational activities such as games and quizzes. The interface personalizes content in real time according to the child's preferences and performance, while offering rewards to encourage motivation. It also ensures safety with content filters and usage limits.

3- **The Teacher Interface:** Allows to monitor, personalize, and optimize student learning through ChatGPT. Through a centralized dashboard, teachers can track student

performance, customize educational content to their needs, adjust the difficulty level, provide suitable prompts and choose specific topics. They can interact directly with ChatGPT for additional activities. The interface also offers monitoring and assessment tools, as well as classroom management features.

4- **Content Management System Module**: the module serves as an essential tool for parents in personalizing their children's education, allowing to adjust lesson difficulty, select engaging topics, and receive performance reports. Advanced features like role management and multilingual content integration enable a tailored learning experience. The personalization engine analyses children's data to adapt activities in real-time, ensuring lessons are engaging and meet individual needs. For instance, it can incorporate a child's interests, like using dinosaur-themed math problems, to make learning more enjoyable and relevant.
5- **Collaboration Engine Module:** Facilitates cooperation between parents, teachers and ChatGPT to optimize children's learning. This interactive system allows information sharing, coordination of educational activities and ensures educational continuity. It integrates real-time messaging, sharing of educational resources, and joint planning of activities. Through collaborative progress monitoring and collective assessments, parents and teachers can adjust educational strategies according to the child's needs, with improvement suggestions proposed by ChatGPT.
6- **Tracking & evaluation module System:**helps track and assess student progress as they interact with AI-powered learning systems. Through an interactive dashboard, teachers and parents can monitor student skills in real-time, evaluate their performance through personalized criteria and adaptive tests, and obtain detailed reports. The module also offers data analysis to identify trends, adapt teaching strategies, and provide personalized feedback.
7- **User data storage module:** is essential for the secure management of user data. It stores profile information, child progress data, and personalization preferences. The module ensures security through data encryption, strict access control, and regular backups. Designed for performance and scalability, it ensures constant data availability and adapts to the increase in the number of users without compromising performance.
8- **Interaction Data Storage module:** manages the storage of data related to interactions between users and the system. It records and organizes conversations, quiz answers, and interactive choices. Interactions are indexed and grouped by session for better analysis. This data is used to personalize future interactions and improve learning analytics.
9- **Security, Privacy, Scalability and Cloud Servers module**:provides security, privacy, scalability, and cloud server management for the system. It encrypts data at rest and in transit, ensures strong authentication, and monitors for intrusions. In terms of privacy, the module complies with regulations like the GDPR (General Data Protection Regulation), minimizes the data collected, and offers anonymization options. Scalability is ensured by adding servers, load balancing and auto- scaling. The module is based on cloud infrastructuresand uses containerization to optimize deployments. It also manages costs by dynamically adjusting resources based on needs.
10- **API Management Module:** provides API management, security, and optimization to facilitate communication between system components and external services. It provides a centralized portal for API access, manages API deployment, and ensures version compatibility. For security, it uses strict access controls, API firewalls, and encrypts all communications. The module monitors usage in real time, analyses performance via dashboards and logs, and implements traffic limiting mechanisms to prevent abuse and prioritize critical services.

4.4. ChatGPT Prompt Commands in the System

In our system, the use of **ChatGPT prompts**is an innovative approach to assist parents in the effective use of the educational platform dedicated to teaching their children. This method is based on the generation of suggestions (or "prompts") that guide parents in various actions, such as personalizing lessons, monitoring their children's progress, or integrating educational content adapted to the specific needs of each child. The central idea is to exploit prompts generated either automatically by the system or manually by education experts with the help of pedagogues. These prompts serve as an intuitive guide for parents, providing them with clear and personalized instructions to use the system's features optimally.Here are some examples of prompts suitable for parents and children in an educational system using ChatGPT:

4.4.1. Prompts for Parents

- Progress Monitoring Prompt: "Your child has completed 70% of this week's math module. To strengthen her mental math skills, we suggest you provide her with some additional exercises. Would you like to recommend activities that are appropriate for her current level?"
- Content Personalization Prompt: “We’ve noticed that your child is particularly interested in dinosaurs. Would you like to incorporate more educational content about dinosaurs into his science lessons?”
- Time Management Prompt: “Your child spent 45 minutes today on learning activities. It is recommended that he take a break. Would you like some suggestions for fun activities that could complement his learning in an enjoyable way?”
- Teaching Strategy Prompt: "Your child seems to be having difficulty with multiplication. We suggest trying a fun approach, such as math card games. Would you like to explain how to use them effectively?"
- Review and Consolidation Prompt: “This is a great time to review what your child has learned this week. Would you like to access a personalized quiz that covers the topics they have recently studied?”

4.4.2. Prompts for Children

- Motivation Prompt: “Great, you managed to finish your reading exercise! How about a little game to learn even more new words?”
- Curiosity Prompt: “You love animals, don’t you? Do you want to learn something fascinating about lions today?”
- Transition Prompt: "That's great that you've been working on your math! Now, let's move on to something different. Are you ready for a little science adventure?"
- Playful Break Prompt: "You did well! How about taking a little break and playing a fun educational game? It's also a great way to learn while having fun!"
- Thought Prompt: “You learned a lot today. What was your favourite part? Do you want to learn more about it?”

In the following, a set of prompts is presented to guide parents through learning different modules:

- **Mathematics:**" Ask ChatGPT for age-appropriate explanations of addition / subtraction / multiplication / division."
- **Reading and Language Arts:**" Ask ChatGPT for tips on improving reading understanding with a 7-year-old kid."
- **Science:**" Ask ChatGPT for explanations of basic scientific concepts like gravity or the water cycle."
- **Social Studies:**" Ask ChatGPT for ideas on teaching a child about historical events like the Algerian Revolution."

- **Critical Thinking and Problem- Solving:**" Ask ChatGPT for strategies to help a child improve their problem-solving abilities."
- **Creativity and Arts:** " Ask ChatGPT for art project ideas to spark creativity in achild."
- **Emotional Intelligence and Well- being:**"Ask ChatGPT for strategies to help a child manages stress or anxiety."

These prompts can serve as starting points for parents to engage with ChatGPT and receive guidance on various aspects of their child's education and development.Depending on the response from ChatGPT, parents can then explore suggested activities, resources, or strategies to support their child's learning journey.Using ChatGPT as an assistant for parents involves crafting specific prompts that guide the AI to provide useful, relevant, and actionable responses.

4.5. AI Tools Usable in an Educational Support Platform

Integrating various AI tools into an educational support platform offers many opportunities to enrich children's learning while providing parents with practical resources and recommendations. These technologies help create an interactive, adaptable, and engaging learning environment, making it easier for parents to be involved in their children's educational journey. To create an educational support platform using AI, several tools can be integrated to enhance learning and help parents teach their children. Table 3 presents some AI tools and associated learning scenarios.

Table 3. Use of AI tools in various learning situations

Tool	Learning Situation	Scenario
AI-Based Recommender Systems	Personalization of the learning path	After analysing the child's performance and interests, the system recommends educational videos, educational games, and books that are tailored to their level and preferences. Parents receive alerts about new recommendations and tips for integrating these resources into their child's learning routines.
Learning Analytics	Tracking academic progress	The dashboard displays the child's progress in different subjects, identifies areas where he/she excels and those requiring special attention. Parents can view weekly reports and receive notifications about goals achieved and areas that need further work.
Augmented Reality (AR) and Virtual Reality (VR)	Immersive and interactive learning	The child uses an augmented reality application to explore for instance the solar system in 3D, allowing an interactive and visual understanding of the planets and their characteristics. Parents can participate by guiding the exploration and asking stimulating questions.
Personalized Video Tutorials	Personalized explanations	After an assessment of the child, the platform generates video tutorials tailored to their specific needs. For example, for a child who has difficulty with geometry, specific videos on basic concepts are created and offered. Parents can watch

		these videos with their children and follow the activities proposed at the end of each tutorial.
IntelligentVoice Assistants	Voice Interactions for Learning	The child asks the voice assistant questions while doing homework. For example, "*How do you conjugate the verb 'to go' in the future tense?*".The voice assistant responds and offers additional examples. Parents can set the assistant up for study time reminders and activity recommendations.
Image Generation (DALL-E)	Creation of educational visual aids	The child learns the life cycle of frogs with images generated for each stage (egg, tadpole, adult frog).
Adaptive Educational Games	Learning through play	The child plays an educational game that automatically adjusts the difficulty level based on their performance. The game offers progressive math challenges, reinforcing skills while remaining engaging.For example, in the jungle, kids might need to calculate the distance to find a hidden treasure, while in the ocean, they could explore marine biology by identifying different sea creatures. Parents receive reports on skills developed and areas requiring intervention.
Spelling Correction (Grammarly/Antidote)	Spelling and grammar correction	The child writes a short story. The tool corrects errors in real time and provides explanations for the corrections.
Speech Synthesis (Text -to-Speech)	Reading texts to improve listening comprehension	The child listens to a text read by a text-to-speech tool to improve their understanding and pronunciation.
Handwriting Recognition (Google Handwriting Input)	Converting handwriting to digital text	The child writes sentences by hand, which are then converted to digital text for spelling review.
Machine Translation (Google Translate)	Learning foreign languages	The child uses a translation tool to understand foreign language texts and learn new words.
Automatic Summary (Summarization)	Synthesis of texts for better understanding	The child summarizes a chapter of his school book using an automatic summary tool to capture the key points.

4.6. Real Application Scenarios

4.6.1. Applying Social Constructivism Theory to Help Parents Teach Their Children Using ChatGPT

Scenario 1: Co-Construction of Knowledge

- **Step 1:**invites the child and two of his or her classmates to connect online to discuss a project on the Algerian Revolution.

- **Step 2:** The parent uses ChatGPT to moderate the discussion by asking questions like "*Why did the Algerian Revolution start*?" or "*What are the long-term impacts of the Algerian Revolution on Africa*?".
- **Step 3:** ChatGPT helps children construct their answers together by offering complementary resources and ideas.
- **Result:** Children develop a deep understanding of the subject through co-construction of knowledge, supported by AI and facilitated by parents.

Scenario 2: Learning by Zones of Proximal Development (ZPD)

- **Step 1:** The parent asks ChatGPT to create a series of math equation problems appropriate to the child's level.
- **Step 2:** ChatGPT offers progressive exercises, starting with guided examples where the child receives a lot of help.
- **Step 3:** The parent watches the child solve initial problems with ChatGPT assistance,then gradually decreases the assistance as the child becomes more proficient.
- **Result:** The child succeeds in solving more complex equations independently after crossing the ZPD, with adapted support thanks to ChatGPT.

Scenario 3: Encouraging Dialogue and Critical Reflection

- **Step 1:** The child discusses the book he or she has read with the parent, and ChatGPT is used to ask open-ended questions such as "*What do you think of the main character's behavior?*" or "*How does this story connect to current events*?"
- **Step 2:** The parent encourages the child to express his or her opinions, while ChatGPT provides alternative arguments or different perspectives to enrich the discussion.
- **Step 3:** After the discussion, ChatGPT helps the child structure his or her essay by summarizing the key points of the discussion and proposing an outline.
- **Result:** The child develops an ability to think critically, defend his ideas, and write a well-structured essay, thanks to a constructive dialogue supported by ChatGPT.

4.6.2. Real application of the pedagogical model

1. Reception of the parent's request:The parent submits a question or request for help, for example: "*How do I do the sum operation?*"
2. Analysis of the request and generation of additional prompts:The system records the parent's initial request and the ChatGPT 's response:
   a. Ask ChatGPT for an explanation of the principle of the sum operation, suitable for a 6-year-old child.
   b. Ask ChatGPT to present this explanation in a clear and fun way.
   c. Ask ChatGPT to provide examples of applying the sum operation.
   d. Ask ChatGPT to suggest progressive exercises on the sum operation.
   e. Ask ChatGPT to present simple math problems involving the sum operation.
3. Response generation by ChatGPT:The system passes all prompts to ChatGPT, thenChatGPT generates a detailed and structured response, covering the different aspects requested.
4. Presentation of the response to the parent:The system compiles the ChatGPT response into a consistent, user-friendly format, them it is presented to the parent, with appropriate formatting.
5. Personalization and monitoring:The system keeps a history of requests and responses provided, this allows it to personalize future responses based on the parent's needs and preferences.Monitoring of the child's progress can be set up, allowing the resources and exercises offered to be adjusted.
6. Based on the exercises and examples provided by ChatGPT, the system can automatically create or suggest relevant Quizlet flashcards or quizzes as presented in Fig. 2. Quizlet can

be used to present simple interactive math problems involving the sum operation, offering the child an engaging way to practice using flashcards, games, or matching exercises. This integration helps reinforce the learning process through interactive, self-paced activities.

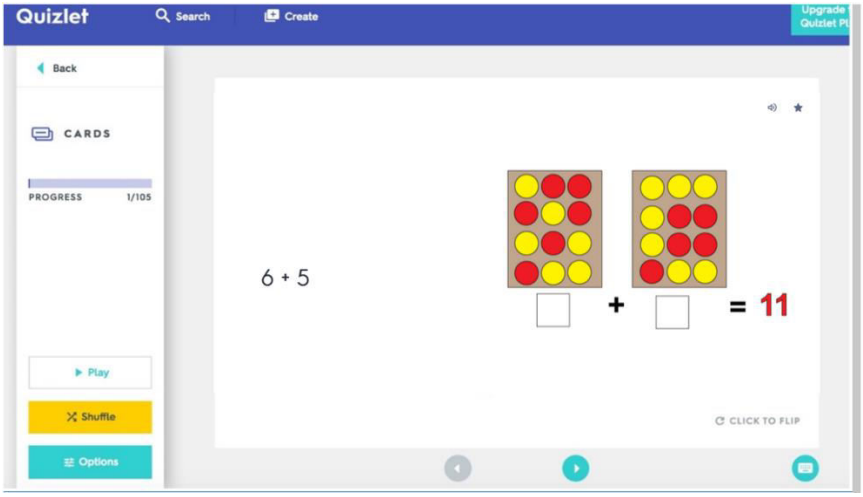

Fig. 2.Example of a flashcard created by Quizlet.

4.7. Implementation of the system

In the following, we present the *LearningTogather* system, an interactive platform designed to support parents in guiding their children. With the help of ChatGPT, parents can access curated educational prompts from teachers and experts or automatically generate customized prompts. Children then engage with personalized learning content, adjusted to their age and learning pace, making education fun and effective. The platform also offers tools for tracking progress and improving parent-child interaction in learning.Here are some key features of the system:

1. **Parent Interface**:

- **Goal**: Help parents guide their children in primary education.
- **Features**:
  - **ChatGPT Prompt Library**: Parents can access pre-designed prompts, either generated automatically or curated by experts and teachers.
  - **Customization for Children**: Based on the child's age, learning pace, and preferences, parents can enter these prompts to receive personalized educational content.
  - **Tracking & Progress Reports**: The system could track progress and give parents an overview of their child's learning journey.
  - **Tips and Resources**: Suggestions for parents on how to use the prompts effectively.

2. **Children's Interface:**

- **Goal**: Deliver engaging, age-appropriate content.
- **Features**:
  - **InteractiveLearning Content**: After a parent submits a prompt, the child receives personalized, interactive content—like quizzes, stories, games, or exercises—designed to match their age and learning speed.
  - **Friendly Design**: Bright, engaging visuals and simple navigation suited for children aged 5–12, with larger fonts, colourful buttons, and character-based guidance.

3. **Teacher/Expert Interface:**

- **Goal**: Allow teachers and pedagogical experts to contribute prompts and content ideas.

- **Features**:
  - **Submit Prompts & Suggestions:** Educators can add curated prompts that target specific learning objectives.
  - **Feedback Mechanism**: Educators can monitor how their prompts perform and get feedback from parents on their effectiveness

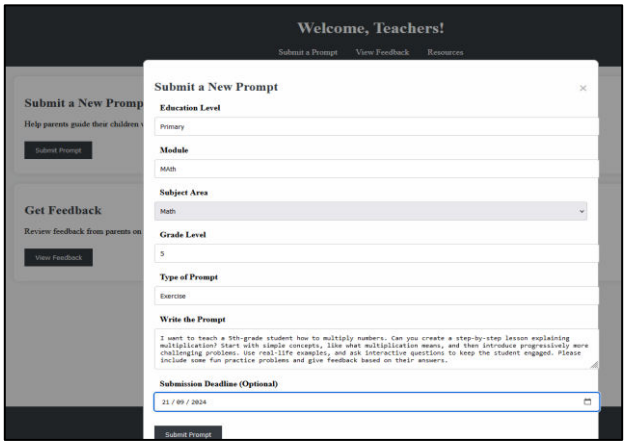

Fig. 3Teacher's interface

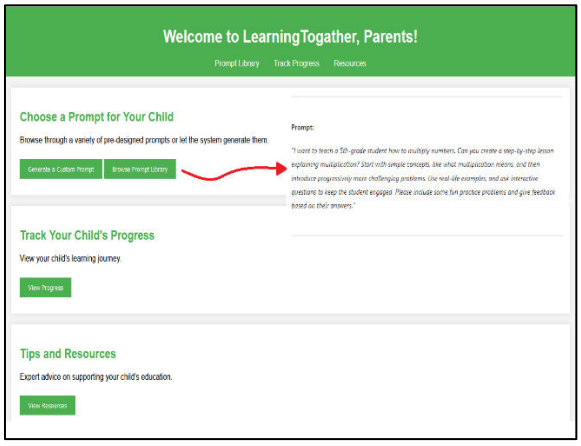

Fig. 4Parent's interface

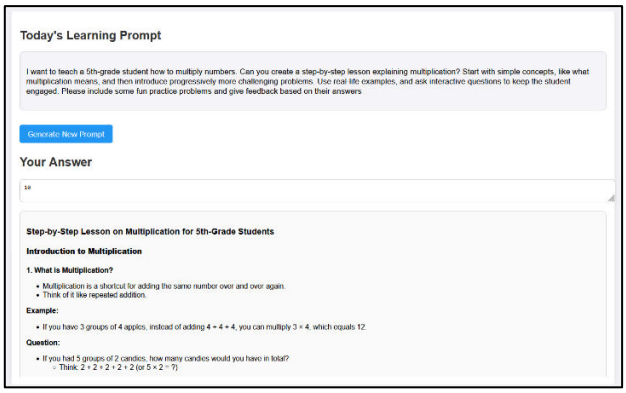

Fig. 5 Student'sinterface

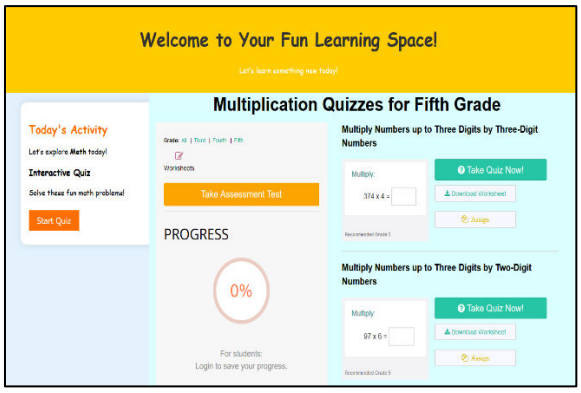

Fig.6 Performance of students in quizzes

5. METHODOLOGY

In recent years, rapid advances in artificial intelligence (AI) have opened up new possibilities in various fields, including education. As parents play a crucial role in their children's educational journey, especially in primary education, there is increasing interest in how AI tools can support and enhance parental involvement in learning processes. This study focuses on the potential of ChatGPT, a large language model developed by OpenAI, to support parents in their children's elementary education.

The research was conducted in the city of Guelma- Algeria to explore how AI tools like ChatGPT could fill educational gaps and support parents in areas where support lessons or supplementary educational services may not be readily available.

5.1. Study design

This study used a mixed-methods approach, combining quantitative and qualitative data to provide a comprehensive understanding of the impact of ChatGPT on parental support in primary education. The research design involved a before-and-after comparison, with data collected at two time points: before parents were trained to use ChatGPT and one month after they had used the tool to support their children's learning.

The study involved 44 parents of children in primary school (grades 1–6). Participants were recruited from local schools, resulting in a diverse sample in terms of education level, number of children, and prior experience with technology in education.

5.1.1. Data collection

Data were collected via Google Form questionnaires at two time points:

1. ChatGPT training (pre-test): In early June 2024, participants completed an initial questionnaire. This survey collected demographic information and baseline data on parents' experiences supporting their children's learning, including their level of confidence, perceived stress, time spent, perceived effectiveness, and understanding of their children's learning needs.
2. ChatGPT use (post-test): In early July 2024, one month after ChatGPT training and subsequent use, participants completed a follow-up questionnaire. This survey included the same measures as the pre-test, allowing for a direct comparison. In addition, it included questions about their experience using ChatGPT and its perceived impact on their ability to support their children's learning.

Both questionnaires included a mix of Likert-scale questions for quantitative analysis and open-ended questions for qualitative information.Training on the use of ChatGPT was provided in a public library in June 2024. The training program was designed to:

1. Introduce parents to the basics of AI and more specifically ChatGPT;
2. Demonstrate how to effectively use ChatGPT for educational support;
3. hands-on practice in using ChatGPT for various educational tasks;
4. Discuss ethical considerations and best practices in using AI for children's education;

After the training, parents were encouraged to use ChatGPT as a support tool to help their children with their schoolwork over the next month.

Fig. 7A mother answering the questionnaire about her child

5.1.2. Data analysis

Quantitative data from the Likert scale questions were analysed using paired-samples t-tests to compare pre- and post-test scores. This allowed for assessment of significant changes in key variables such as parental confidence, stress level, time spent, and perceived efficacy.Qualitative data from open-ended questions were analysed using thematic analysis. This approach identified recurring themes and patterns in parents' experiences and perceptions of using ChatGPT for educational support.

5.1.3. Ethical considerations

Participants gave informed consent and all data were anonymized to protect confidentiality. Parents were informed that their participation was voluntary and that they could withdraw from the study at any time without consequences.This study provides a comprehensive examination of the impact of ChatGPT on parents' ability to support their children's elementary education, providing both statistical evidence of change and rich contextual information about parents' experiences. The one-month period between training and follow-up assessment provides a reasonable time frame for parents to integrate ChatGPT into their educational support routines and observe its effects.

5.2. Qualitative study

For this qualitative analysis, we have used a thematic analysis approach to identify and analyze trends within the data. We focused on open-ended responses and changes in parents' perceptions before and after using ChatGPT.

5.2.1. Data analysis

Table 4 presents an organization of the main themes that emerged from the data analysis. Responses were coded to identify notable recurrences and variations in responses, allowing common patterns to emerge. This structure facilitates an overview of key themes, helping to understand major trends and developments in the data collected.

Table 4. Key themes emerging from the data.

Theme	Description	Representative quotes
Increased confidence	Parents reported feeling more competent and confident in their ability to help their children with their homework after using ChatGPT.	"I now have more confidence in my ability to help." "I feel very comfortable explaining concepts that I previously struggled with."
Stress reduction	Many parents have noticed a significant decrease in their stress levels when helping their children learn after integrating ChatGPT.	"I feel much calmer when I help my children now." "The pressure of not knowing all the answers is gone."
improved understanding of the subject	Parents have found that ChatGPT helps them better understand difficult topics, especially in areas they previously found difficult.	"I can now explain mathematical concepts that I used to avoid." "Foreign language homework is no longer a source of anxiety for me."
Time efficiency	A common theme was the ability to deliver more effective help in less time.	"We do our homework faster now, with better results." "I spend less time looking for answers and more time teaching."
Enhanced learning experience	Parents reported a more positive and productive learning environment at home.	"Learning together has become more enjoyable for both of us." "My child seems more engaged when we use ChatGPT as a tool."
Technology Integration	Many parents said they were surprised at how easily they were able to integrate AI technology into their teaching methods.	"I never thought I would use AI to teach my kids, but it is surprisingly intuitive." "Technology has become a useful partner in our learning process."
Personalized learning support	Parents noted a better ability to adapt their teaching to the	"I can now quickly find different ways to explain things when my child

	specific needs of their child.	doesn't understand." "It's easier to adapt to my child's pace and learning style."

5.2.2. Interpretation of results

Qualitative analysis reveals a transformative effect of ChatGPT on parents' experiences in supporting their children's learning. The tool appears to address many common issues parents face when trying to help their children with their homework, such as lack of confidence, high stress levels, and difficulties in certain subjects.

The increase in self-confidence and reduction in stress levels are particularly noteworthy, as these factors can have a significant impact on the quality of the learning experience. When parents feel more competent and less anxious, they are likely to create a more positive and encouraging learning environment.

Another crucial finding is the improvement in understanding of topics, especially in areas that parents previously found difficult. This suggests that ChatGPT is not just a quick-response tool, but a resource that helps parents deepen their own understanding, enabling them to provide better explanations and support to their children.

The topic of efficiency and time management is particularly relevant in today's fast-paced world. Parents are finding that with ChatGPT they can provide more support in less time, which could lead to a better balance between academic support and other aspects of family life.

The shift in attitudes toward the use of technology in education is also significant. Parents who may have been hesitant to integrate technology into learning appear to have found ChatGPT to be an accessible and beneficial tool. This could pave the way for greater acceptance and integration of AI tools into home learning.

5.3. Quantitative study

The quantitative study involved collecting numerical data to assess the effectiveness of ChatGPT in enhancing parental support for children's primary education. Surveys were administered to the 44 participating parents before training and again one month after they began using the tool. The surveys measured various factors, including parents' confidence in assisting with homework, the frequency of ChatGPT usage, and perceived improvements in their children's learning outcomes. Statistical analyses were conducted to identify significant changes and correlations, providing insights into the overall impact of the intervention on parental engagement and student performance. Based on the findings from the surveys and data analysis, here are the hypotheses formulated to assess the impact of ChatGPT on parental support in primary education:

1. Hypothesis 1 (H_1): Using ChatGPT greatly improves parents' confidence and effectiveness in teaching primary school subjects to their children.
2. Hypothesis 2 (H_2): Using ChatGPT reduces stress levels among parents when helping their children learn.

5.3.1. Method of analysis

To test these hypotheses, we will use a paired-samples t-test to compare pre- and post-measurements for key variables. This is appropriate because we have data from the same participants before and after learning how to use ChatGPT, allowing us to measure change within each individual. Here are the key variables we will analyze:

1. Confidence in teaching ability
2. Stress Levels When Helping Children Learn
3. Understanding the child's learning needs
4. Time spent helping the child learn
5. Effectiveness in supporting child learning

The paired-samples t-test (also called the dependent-samples t-test) is used in this study for several reasons:

1. Before and after design: We have measurements from the same participants at two different time points, before and after learning how to use ChatGPT. This creates naturally matched data.
2. Within-subject comparison: We are interested in change within each individual, rather than differences between groups.
3. Continuous variables: Our variables of interest (trust, stress levels, etc.) are measured on continuous scales.
4. Normal distribution assumption: The paired-samples t-test assumes that the differences between pairs are normally distributed. For large sample sizes (typically $n > 30$), the central limit theorem suggests that this assumption is generally met.
5. Direct measure of change: This test allows us to directly assess whether there is a significant change in our variables of interest after the introduction of ChatGPT.

Note: Trust, stress level, understanding, and effectiveness were measured on a 5-point Likert scale. Time spent was measured in hours per week. Table 5 presents the stages of paired sample t-test calculation for evaluating pre- and post-intervention scores

Table 5. Paired sample t-test calculation

Stage	Description	Formula
1	Calculate the difference (d) between each pair of before and after scores.	d = After score - Before score
2	Calculate the mean difference ($\bar{d}$)	$\bar{d} = \Sigma d / n$, where n is the sample size
3	Calculate the standard deviation of the differences (sd)	$sd = \sqrt{[\Sigma(d - \bar{d})^2 / (n - 1)]}$
4	Calculate the standard error of the mean difference (SE)	$SE = sd / \sqrt{n}$
5	Calculate the t statistic	$t = \bar{d} / SE$
6	Determine the degrees of freedom (df)	df = n - 1
7	Compare the t-statistic to the critical value for the chosen alpha level (usually 0.05) to determine significance	

5.2.1. Detailed results

- Increased Confidence: Before using ChatGPT, many parents expressed feelings of incompetence when helping their children with homework. Comments such as "*Not very confident*" were common. After learning to use ChatGPT, there was a marked change, with parents using phrases such as "*I have a lot of confidence*" and "*Very confident*" to describe their level of confidence. This increase in confidence appears to be particularly pronounced in subjects that parents previously found difficult.
- Stress Reduction: Before using ChatGPT, a significant number of parents reported feeling "*tense*" or "*very nervous*" when trying to help their children learn. After using ChatGPT, many of these same parents reported feeling "*calm*" or even "*very quiet*" during study sessions. This stress reduction appears to contribute to a more positive learning environment at home.
- Better understanding of the subject: Parents often mentioned that they struggled with certain subjects, including math and foreign languages, before using ChatGPT. After incorporating ChatGPT into their teaching toolkit, many parents reported having a better

understanding of these difficult subjects. This better understanding appears to translate into more effective teaching and explaining of complex concepts to their children.

- Time efficiency: The data shows an interesting trend: reduced time spent helping children learn, coupled with reports of increased efficiency. Before using ChatGPT, some parents reported spending 6-10 hours per week helping their children.After using ChatGPT, most parents reported spending 3 to 4 hours and felt more efficient in their support compared to the old method of searching for courses and exercises using traditional search engines.
- Improved learning experience: Many parents noted a change in the description of the effectiveness of their teaching, from "slightly effective" or "moderately effective" before using ChatGPT to "very effective" after. This change was often accompanied by comments suggesting a more enjoyable and productive learning experience for both parent and child.
- Technology Integration: There was a notable shift in attitudes toward the use of technology to support learning. Prior to the introduction of ChatGPT, many parents used technology to support learning only "sometimes" or "rarely." After learning about ChatGPT, the frequency increased to "most of the time" for many parents, with a corresponding increase in their belief in the potential of technology to support learning.
- Personalized learning support: After using ChatGPT, many parents reported a better understanding of their child's learning needs. This improved understanding appears to allow for more personalized and effective support, with parents feeling better equipped to explain concepts in a way that their children can understand.

Table 6 presents the calculation of the main analysis variables. It includes confidence in teaching ability, stress levels, understanding of the child's learning needs, time spent on learning support (in hours per week), and effectiveness of learning support. Each variable is assessed using quantitative methods, such as Likert scales and hourly estimates, allowing a comprehensive assessment of parental support for education.

Table 6. Statistical analysis

Variable	**Before the average**	**After the average**	**Average difference**	**t value**	**p-value**
Confidence in teaching ability	2.34	3.82	1.48	9.76	<0.001
Stress levels	3.68	2.41	-1.27	-8.54	<0.001
Understanding the child's learning needs	2.86	3.73	0.87	7.32	<0.001
Time spent helping child learn (hours/week)	3.45	2.91	-0.54	-3.21	0.002
Effectiveness in supporting child learning	2.59	3.95	1.36	10.12	<0.001

For each of these variables, the calculation process follows the steps outlined in the artifact above. The *t* and *p* values indicate that all changes were statistically significant, with *p* values well below the conventional threshold of 0.05. It is important to note that while these results show statistical significance, practical significance must also be considered. The large *t* values and small *p* values suggest that the observed changes are likely not due to chance, but the mean differences provide insight into the magnitude of these changes in real terms. These results collectively support the hypotheses that using ChatGPT improves parents' confidence and efficacy in teaching their children, while reducing stress levels. The significant changes

in all measured variables suggest that ChatGPT has had a substantial impact on various aspects of parents' experience in supporting their children's learning.

5.2.2. Interpretation of results

The results demonstrate significant positive changes in parents' teaching experiences after learning to use ChatGPT:

1. Confidence in teaching ability: Parents' confidence in their teaching ability increased significantly after learning to use ChatGPT ($t = 9.76$, $p < 0.001$). The mean confidence level increased from 2.34 to 3.82 on a 5-point scale.
2. Stress Levels: Parents reported significantly lower stress levels when helping their children learn after using ChatGPT ($t = -8.54$, $p < 0.001$). The mean stress level decreased from 3.68 to 2.41.
3. Understanding of child's learning needs: Parents' understanding of their child's learning needs improved significantly after using ChatGPT ($t = 7.32$, $p < 0.001$). The mean comprehension score increased from 2.86 to 3.73.
4. Time Spent Helping Child Learn: There was a significant decrease in the amount of time parents spent helping their child learn ($t = -3.21$, $p = 0.002$). The average time spent helping their child learn decreased from 3.45 hours to 2.91 hours per week.
5. Effectiveness in supporting child learning: Parents reported a significant increase in their effectiveness in supporting their child's learning after using ChatGPT ($t = 10.12$, $p < 0.001$). The mean effectiveness score increased from 2.59 to 3.95.

The results of this study strongly support our primary and secondary hypotheses:

Improved Confidence and Efficacy (H_1): The significant increase in parents' confidence in their teaching ability and their perceived efficacy in supporting their child's learning provides strong evidence for our primary hypothesis. After learning how to use ChatGPT, parents felt more capable of helping their children with their studies. This increased confidence could lead to more positive and productive learning experiences for both parents and children.

Stress Level Reduction (H_2): The significant decrease in stress levels when helping children learn supports our secondary hypothesis. This stress reduction could contribute to a more positive home learning environment, potentially improving the quality of parent-child interactions during study time.

Improved understanding of learning needs: Improved parents' understanding of their child's learning needs is a notable outcome. This improved understanding could enable parents to provide more targeted and effective support, tailoring their teaching approach to their child's specific needs.

Efficient use of time: The decrease in time spent helping children learn, coupled with increased efficiency, suggests that ChatGPT may help parents use their time more efficiently. They are able to provide better support in less time, which could be especially beneficial for busy parents.

Overall Impact on Home Learning: The combination of increased confidence, reduced stress, better understanding of learning needs, and improved efficiency paints a picture of significantly improved home learning experiences after introducing ChatGPT as a tool for parents.

5.4. Data Visualization

The most crucial variables that highlight the impact of using ChatGPT on parents' ability to teach their children are:

1. Confidence in Teaching Ability:

The bar graph shows a significant increase in parents' confidence after learning how to use ChatGPT. The average confidence level increased from 2.34 to 3.82 on a 5-point scale, which is a substantial improvement.

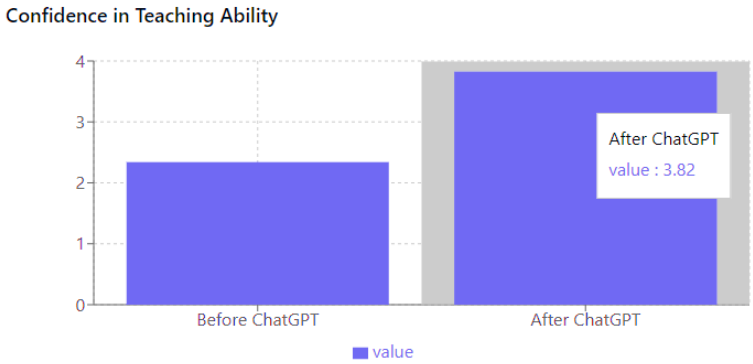

Fig. 8Confidence in teaching Ability

2. Stress Levels When Helping Children with Learning:

This graph illustrates a notable decrease in stress levels after using ChatGPT. The average stress level decreased from 3.68 to 2.41, indicating that parents felt significantly less stressed when helping their children with homework.

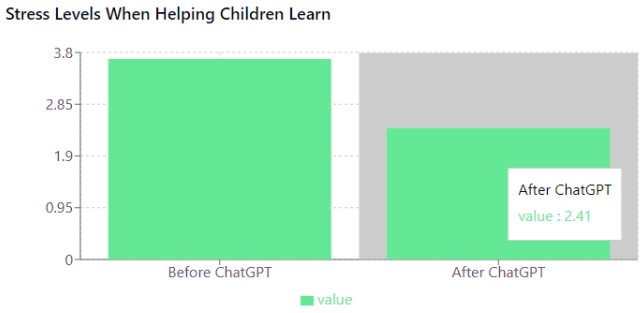

Fig 9. Stress levels when helping children

3. Effectiveness in supporting child learning:

The effectiveness graph shows a marked improvement in parents' perceived effectiveness. The mean score increased from 2.59 to 3.95, suggesting that parents felt significantly more capable of supporting their children's learning after using ChatGPT.

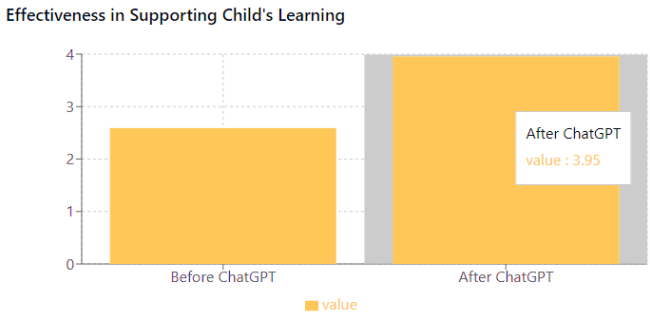

Fig 10. Effectiveness in supporting children

4. Time Spent vs. Effectiveness (Scatterplot):

This scatterplot provides an interesting insight into the relationship between time spent helping children and perceived effectiveness. We can observe that after using ChatGPT:

- Average time spent decreased (shifted left on the x-axis)
- Perceived effectiveness increased (shifted up on the Y-axis). This suggests that parents were able to provide more effective support in less time after learning how to use ChatGPT.

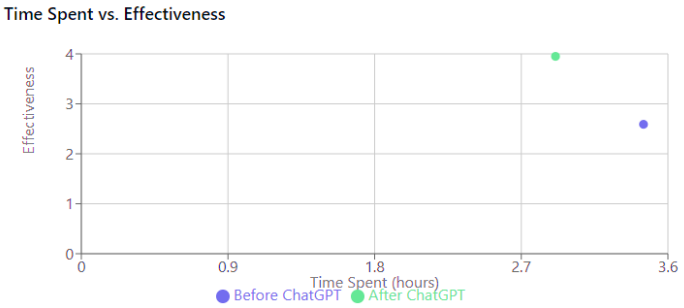

Fig 11. Time spent vs. effectiveness

These visualizations strongly support our hypotheses that using ChatGPT improves parents' confidence and efficacy in teaching their children while reducing stress levels. The consistent positive changes across all key variables suggest that ChatGPT has had a substantial and multifaceted impact on parents' experience in supporting their children's learning.

5.5. Study Limitations, Contributions to the Field and Directions for Future Research

This study relied on self-reported measures, which introduces the potential for bias. To strengthen the validity of these findings, future research could incorporate objective measures of children's academic performance.Additionally, a longer-term study would help determine whether the observed positive effects persist over time.

Despite these limitations, this study provides several valuable contributions to the field of education and educational technology. First, it offers empirical evidence of the potential for AI tools like ChatGPT to support home learning, a crucial area that has gained prominence following global events such as the COVID-19 pandemic. Second, it highlights a new method to enhance parental involvement in education, a well-established factor in children's academic success. Third, by showcasing positive results, the research could promote wider acceptance and adoption of AI tools in educational environments. Additionally, the results indicate that ChatGPT may enhance parents' awareness of their child's learning needs., leading to more effective support and addressing educational gaps. This is particularly valuable for families with limited access to professional tutoring or additional educational resources.

While ChatGPT has the potential to be a powerful tool, it should be viewed as a complement to traditional educational methods and resources rather than a replacement. Future research should explore how to best integrate AI tools like ChatGPT into broader educational strategies to maximize their benefits for both parents and children. This study opens several avenues for future research. Long-term studies could examine the sustained impact on educational outcomes, and further exploration could focus on optimizing the integration of AI tools into education. Research should also explore how these tools can address diverse learning needs across different educational contexts.

6. Conclusion

This article highlights the potential of AI -based tools, in particular ChatGPT, to revolutionize family engagement in early childhood education. By integrating personalized and adaptive

interactions based on the theory of social constructivism, AI platforms can offer precious support to parents, helping them overcome current obstacles such as lack of time and resources. The results of this work highlight the significant positive effects of the use of ChatGPT as a parental support tool, in particular increased confidence, a reduction in stress and better efficiency in supporting children's learning. In addition, the architecture of the system, designed to promote interactive and fluid communication, guarantees a high -quality learning experience, adapted to the specific needs of each family.

It is important to note that although this article demonstrates the potential of AI tools to fill critical gaps in early childhood education, it also emphasizes that these technologies must supplement, and not replace traditional educational methods. The positive effects highlighted in this article, including increased parental involvement and improved learning outcomes for children, underscore the value of incorporating AI into broader educational strategies. As the role of AI in education continues to evolve, future research should explore the best way to balance these tools with existing educational practices in order to ensure effective support for young learners and their families.

AI tools like ChatGPT offer promising and accessible solutions to improve early childhood education by allowing families to be more committed and effective in supporting their children's learning. By responding to immediate educational challenges while taking into account long -term development needs, this innovative approach has the potential to transform the education of young children and to help reduce educational disparities, in particular for those with limited access to traditional resources.

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