Design and Evaluation of SERLI Interactive Games with Deep Learning Integration

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Abstract: This research was motivated by the lack of development of deep learning-based social games as integrated, meaningful, and enjoyable games for children aged 5-6 years. At present, educators routinely employ commercially produced games, which adversely affects the engagement levels of the educational process and can frequently lead to a decline in attentiveness among students. The primary aim was to assess social games founded on deep learning methodologies to promote prosocial behaviors in children aged 5 to 6 years. The conceptualization and evaluation of SERLI Interactive Games that integrate Deep Learning methodologies were conducted utilizing the ADDIE Model, which consists of five discrete stages: analysis, design, development, implementation, and evaluation. The interactive game design was tailored to teachers' needs in using games for prosocial stimulation. The games were designed to emphasize children's developmental characteristics and prosocial skills, as assessed based on evaluations of child development, the number of children, school conditions, and teachers' skills in using technology. The results showed that SERLI Interactive Games with Deep Learning Integration demonstrated a significant increase in prosocial skills ($p < 0.01$) and high user satisfaction. This investigation significantly advances the field of adaptive educational gaming and the implementation of deep learning methodologies within the educational sector.

1 INTRODUCTION

The development and growth of early childhood is one of the most important things to pay attention to, from when the child is in the womb until they are born into the world. Early childhood encompasses the developmental stage of human beings from the moment of birth until the age of eight years. According to (Suryana, 2021), this specific age range represents an exceptionally pivotal phase in the holistic growth and maturation of individuals. Therefore, the provision of appropriate attention and stimulation throughout this formative period is imperative for promoting optimal developmental outcomes in children. This perspective is reinforced by (Windayani et al., 2021), who assert that early childhood is the period when the foundation of a child's personality is formed, which will shape their experiences in the future. Thus, during this period, it

is crucial to monitor every aspect of their growth and development and identify their potential to ensure the achievement of all aspects of their future development.

In the scholarly conversation regarding the various dimensions of early childhood maturation and progression, the sphere of social development surfaces as a critical element that necessitates meticulous examination. According to (Khadijah & Jf, 2021), social development in early childhood is a form of maturity in interacting with people around them through the social relationships they form. This developmental maturity is manifest in the manner in which children comprehend the existence of their peers, engage in communication, and exhibit collaborative conduct across a multitude of contexts. In agreement with (Kaffa et al., 2021), it is added that social development is characterized by a child's ability to socialize, adapt to the social environment,

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and adjust to the norms and values prevailing in their group. Children demonstrating social development typically forge advantageous interpersonal connections with increased facility, possess the ability to conform to societal norms, and display empathy and compassion towards their peers. Furthermore, (Harianja et al., 2023) explain that children's social development is an important and ongoing process in which children learn to understand their identity, form interpersonal relationships, and manage and express their emotions in various social contexts. This protocol encompasses not only the capability for interpersonal interaction but also incorporates an understanding of social norms, empathetic engagement, cooperative endeavors, and the competence to resolve conflicts in a constructive fashion.

According to Vygotsky and Bandura's views, which are known through social learning theory that focuses on cognitive development (Hurlock, 1995), children aged 4–6 years have begun to show progress in social development. The social development of children comprises various significant dimensions, which include: the capacity for self-recognition and self-regulation (self-awareness), comprehension of obligations towards oneself and others, and the exhibition of prosocial behaviors such as sharing, cooperation, and respect for others. Furthermore, children initiate the cultivation of communication competencies, the ability to constructively resolve conflicts, and the capacity for empathy towards the emotions of others. Additionally, children begin to form a social identity as part of a group and learn to manage their emotions healthily in various situations (Harianja et al., 2023).

A pivotal aspect of social advancement that requires deliberate scrutiny relates to prosocial conduct. Prosocial behavior refers to positive actions voluntarily undertaken by an individual to provide assistance to others, whether in the form of physical or psychological support, without any element of coercion (Suparmi & Sumijati, 2021).This behavior not only reflects concern for others but also serves as the foundation for building healthy and harmonious social relationships from an early age. In line with (Saharani et al., 2021), prosocial behavior can be delineated as a classification of actions that enhance interpersonal engagement, cooperation, and selfless support among individuals without the expectation of reciprocal advantages. This conduct exerts a positive impact on social dynamics as it fosters an atmosphere typified by concord and serenity, while concurrently promoting mutual regard and affection among members of the community.

Indicators that reflect social development include: (1) children begin to understand basic rules both within the family environment and when playing; (2) children begin to show compliance with these rules; (3) the emergence of awareness of the rights and interests of others; and (4) children begin to be able to engage in games with peers and gradually expand their social interactions with adults around them (N. Fuadia, 2022). This is evident in children's ability to engage in group activities or interact in peer group contexts through play and games. Moreover, the trajectory of social development in children is characterized by both gradual advancement and individual specificity. Each child demonstrates a unique developmental pace, and their social skills are likely to continue evolving over time, dependent upon the availability of appropriate support and stimulation from their educational environments.

However, observations indicate that the lack of development of deep learning-based social games has limited stimulation of social skills in children aged 5–6 years. Educators persist in employing commercially produced games that do not explicitly aim to cultivate prosocial behaviors such as cooperation, sharing, and empathy. Consequently, children frequently demonstrate diminished engagement in social interactions, a tendency towards conflicts, and difficulties in group adaptation. Moreover, non-contextual games undermine the overall educational experience, resulting in diminished attention spans and low levels of social participation among children. This underscores the pressing need for games that are thoughtfully designed to effectively enhance the optimal social development of children.

With the advancement of technology, digital learning media has begun to be used in early childhood education (PAUD), one of the significant transformations being the use of interactive educational games based on applications as a medium for stimulating children's development. Research by (Firanti et al., 2024) indicates that the use of interactive technology such as tablets, learning apps, and educational games significantly contributes to enhancing young children's social-emotional skills, particularly in aspects such as empathy, emotional regulation, and the ability to resolve social conflicts peacefully. Support for these findings is reinforced by (Elyakim et al., 2024), who state that technology-based learning models can create a conducive learning environment for building social skills, such as cooperation, sharing, and effective communication among children. In the realm of digital collaborative learning, children cultivate the ability to articulate their thoughts, engage in active listening with their

peers, and partake in turn-taking while utilizing devices through the interactive components present in educational games. This highlights the significant capacity of technology not only to enhance educational pursuits but also to improve social skills in a way that is both flexible and pertinent to specific contexts.

In light of the extensive possibilities inherent in technology to facilitate social learning, the advent of interactive educational games has transformed into one of the most prominent pedagogical strategies within the domain of early childhood education. A particularly noteworthy facet that continues to evolve is the utilization of technology-based media, as illustrated by interactive games. Games represent a crucial element of children's experiential learning and play an essential role in their developmental progression. According to (Suryana et al., 2023), interactive games in an educational context offer an enjoyable approach for children by combining the concept of learning through play and serving as an effective learning medium for conveying content while also providing an engaging form of entertainment, thereby enhancing children's motivation and engagement in the learning process. (Fajar & Zega, 2023) argue that interactive games designed with the appropriate approach can provide significant brain stimulation and support early childhood learning more optimally.

Regarding interactive games, a number of previous researchers have studied them for application in children. One study conducted by (Andi Saputri et al., 2024) used innovative interactive learning media to improve six key social-emotional skills in children, namely empathy, emotional regulation, cooperation, communication, conflict resolution, and self-awareness. Meanwhile, (Elyakim et al., 2024) investigated the impact of using educational app-based games on children aged 4–6 years. The results of the investigation suggested that children who were exposed to sufficient time and supervision demonstrated superior advancement in the areas of empathy, emotional understanding, and social conflict resolution skills when compared to their peers who did not engage in interactive gaming experiences.

Consistent with preceding research that elucidates the capacity of interactive media to facilitate the social-emotional growth of children, the investigators in this study intend to devise educational media in the form of technology-driven interactive games as a mechanism for fostering prosocial behaviors during early childhood development. The main difference from previous studies lies in the technological

approach used, namely through the application of an adaptive deep learning system that enables the media to respond to children's behavior in real-time. Therefore, this study aims to examine the "Design and Evaluation of SERLI Interactive Games with Deep Learning Integration."

2 METHOD

This research is a research and development (R&D) study. The development model used is the ADDIE model. This model was chosen because its steps are practical and suitable for the development of the SERLI game based on deep learning for stimulating the social development of children aged 5-6 years. The ADDIE framework is comprised of five distinct phases: analysis, design, development, implementation, and evaluation. The ADDIE development procedure and activities to be carried out at each stage:
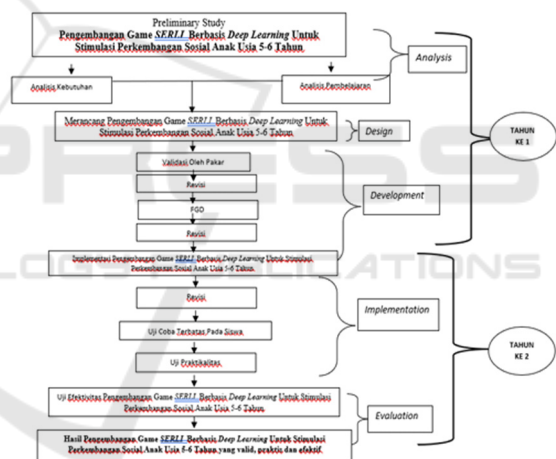

Chart 1: SERLI Game Development Procedure Based on Deep Learning.

The subjects of this study were students in Group B at the UNP Development Kindergarten and the Pertiwi Kindergarten at the Padang Governor's Office. The selection of these early childhood education institutions as the central subjects of the study was based on their congruence with the research aims. The information necessary for this investigation included both quantitative and qualitative aspects, which comprised data from the preliminary study (analytical findings) as well as results from product evaluations. The data from the preliminary study consists of information related to needs assessment, curriculum development, pedagogical strategies, teacher training, and student

achievement outcomes; conversely, the product evaluation data includes analyses of the model's validity, feasibility, and effectiveness.

The instruments to be used in this study consist of (1) interview guidelines; (2) observation guidelines; (3) model validity test sheets and learning tools by experts; (4) model practicality test sheets; and social development measurement scales to test the practicality of the model. The data to be collected are quantitative and qualitative. Data from the validity and practicality tests will be analyzed using the Cohen's Kappa formula, while data on practicality from the implementation aspect will be analyzed using percentage and achievement level techniques. Quantitative data from the effectiveness test will be processed using the t-test statistic. Qualitative data acquired from interviews and observational studies will undergo procedures involving data reduction, data presentation, and the formulation of conclusions. The research product trial will be conducted at the UNP Labor Development Kindergarten, with kindergarten B children as the trial subjects.

3 RESULT AND DISCUSSION

To strengthen the results of the development of SERLI Interactive Games with Deep Learning Integration, researchers also conducted in-depth interviews with several early childhood education (PAUD) teachers to gain a contextual understanding of children's social, motor, and literacy development over the past three years. These interviews aimed to obtain qualitative data to support the effectiveness of the developed media and to explore real-world needs related to technology-based learning for early childhood. The following is a summary of the interview results:

Table 1: Teacher Needs Analysis.

Question	Answer
How has the child's social develop-ment been over the past three years?	Children's social development over the past three years (2022–2025) has shown considerable progress and is in line with their age group, although challenges remain. n the year 2022, subsequent to the COVID-19 pandemic, numerous children encountered social developmental delays attributable to restricted face-to-face interactions and a heightened reliance on electronic devices. These children displayed a proclivity towards fostering enhanced attachment to their caregivers, exhibited a deficiency in self-confidence within unfamiliar environments,
	and encountered challenges in collaborative behaviors including sharing, turn-taking, and conflict resolution. The linguistic constructs employed by these children at times reflected adult vernacular as a result of the omnipresent impact of digital media, notwithstanding their partial grasp of the fundamental significances. As we enter 2023, children are beginning to adapt and recover their social skills through direct interaction at school and group activities such as playing together, collaborative projects, and field trips. Teachers and parents actively provide social interaction exercises such as role-playing and discussions about emotions. By 2024–2025, children's social development becomes more stable: they are more confident in communicating, demonstrate indepen-dence, understand social rules, and are able to share and resolve minor conflicts with guidance. Furthermore, children commenced displaying a sense of ease within expansive social networks, fostering close interpersonal relationships, and demonstrating nascent indications of empathy—evidenced by their solicitude for peers experiencing distress, as exemplified by the observation of a companion in tears. Although some children still struggle to control their emotions or adapt to new environments, overall they are able to socialize well, no longer rely on their parents at school, and actively play and share with their peers.
In what ways has the motor developm ent of your child evolved over the preceding three years?	The motor development of children over the past three years (2022–2025) has generally shown positive progress and is in line with their age stages, both in terms of gross motor skills and fine motor skills. Following the global health crisis in 2022, a substantial number of children exhibited delays in motor development attributable to the constrained physical activity experienced during the period of lockdown. The prospects for children to participate in physical activities such as running, jumping, and engaging in outdoor play have been significantly curtailed, which has subsequently resulted in constraints regarding their gross motor skills, encompassing balance and the coordination of physical movements. Nevertheless, with the reopening of educational institutions and recreational facilities, a significant improvement in motor skills has been documented. Children have initiated active

	participation in a variety of activities, including cycling, ball games, gymnastics, climbing, and jumping, which have facilitated the strengthening of their large muscle groups. Simultaneously, there has been a significant advancement in fine motor development, predominantly due to the heightened involvement in tactile activities within educational environments, such as drawing, cutting, folding, stringing, and writing. Children have started to exhibit improved hand-eye coordination and increased manual dexterity. However, a segment of children continues to experience delays in motor development, potentially influenced by the widespread utilization of digital devices or other factors such as inadequate stimulation, nutritional insufficiencies, or health-related challenges. Although the progress is not homogeneous across the population, the majority of children now exhibit a heightened enthusiasm for engaging in various motor activities orchestrated by educators and demonstrate significant advancements in both their physical capabilities and coordination skills.
How has children's literacy developed over the past three years?	The development of literacy among children aged 4–6 years over the past three years has shown positive progress in line with their age group, although it has been uneven. Children have begun to develop from simply recognizing letters to being able to understand simple texts and write with guidance. This phenomenon has been shaped by a diverse array of engaging pedagogical approaches, including the practice of reading aloud, which facilitates children's ability to narrate stories utilizing their own linguistic expressions. Reading interest is also beginning to grow, especially among children who receive support from home and school and have access to adequate literacy media. Certain children exhibit the capability to identify individuals, inanimate items, and various species, while also adhering to uncomplicated directives. Furthermore, they are commencing to discern letters, numerals, and lexical items with increasing proficiency. However, this development is not yet uniform—there are still children who show slow development, even experiencing speech delays, especially those who are more frequently exposed to gadgets than books. Determinants such as the caliber of cognitive engagement within

	the home environment, the proactive involvement of caregivers, and the availability of enriching educational resources serve as pivotal influences on the literacy achievements of children. Not withstanding, an overarching analysis of the trajectory of children's literacy advancement over the preceding three years indicates a favorable and encouraging progression.
What types of games have educators implemented to enhance the social development of children?	A diverse array of games incorporated into early childhood educational practices during the preceding three years has demonstrated efficacy in facilitating both social and cognitive growth. The games used include traditional games such as hide-and-seek, hopscotch, congklak, snake and ladder, marbles, and jump rope, as well as modern games involving group or team activities, such as ball relay, building towers together, playing ball in a circle, and races. Additionally, role-playing games like "marketplace," "doctor and patient," "family," and becoming a merchant, buyer, teacher, or student are highly popular among children because they provide opportunities for self-expression, communication, taking turns, and understanding social roles in daily life. Activities like playing shop and queuing at the cashier also develop social skills and discipline. Teachers actively create variations of games, including storytelling, drawing, and question-and-answer games that enrich children's imagination and strengthen social interaction. Daily school activities like cleaning the environment together are also turned into collaborative games that instill values of cooperation and responsibility. All variants of these games, encompassing traditional, contemporary, or role-playing formats, confer substantial advantages in the enhancement of children's social competencies, communicative abilities, empathy, and collaborative skills.
What categories of games have educators employed to enhance the motor development of children?	Diverse categories of games and physical endeavors have been persistently employed to facilitate the advancement of gross and fine motor skills in early childhood over the preceding three years. Gross motor activities include games such as jumping rope, jumping over shapes or colors, walking on a balance beam, relay races, playing ball (kicking, throwing, catching), tug-of-war, swimming, hide-and-seek, tag, and obstacle courses that involve crawling, jumping, and walking along a line.

Additionally, endeavors encompassing cognitive intermissions, physical exercises, dance, and music-based movements are pivotal in augmenting children's agility, bodily coordination, and rhythmic locomotion. Simultaneously, fine motor competencies are fostered through activities such as construction with building blocks, engagement with puzzles, manipulation of playdough or modeling clay, clipping and affixing images, threading beads, drawing, coloring, inserting buttons or sticks into openings, and tearing paper. Furthermore, children are provided with the opportunity to engage in role-playing scenarios themed around environments such as marketplaces, healthcare facilities, or educational institutions, which promotes the cultivation of social competencies, empathy, and the integration of manual and cognitive functions. Tasks such as color-sorting of spheres and the transference of water into a receptacle exemplify activities that enhance hand-eye coordination. This synthesis of traditional and modern games has evidenced effectiveness in promoting children's motor development in a comprehensive manner, while concurrently delivering enjoyment and aligning with their playful contexts.

What varieties of games have educators employed to enhance the literacy development of children?	A diverse array of activities and games have been utilized to foster early childhood literacy advancement in a manner that is both engaging and interactive. Initiatives such as read-aloud sessions, digital storytelling, and collaborative storytelling events function as effective instruments for nurturing children's enthusiasm for narratives and linguistic articulation. Morning storytelling sessions, during which children take turns narrating stories and their peers are given the opportunity to ask questions, further facilitate the enhancement of verbal and auditory competencies. Additionally, various educational games such as word guessing, chain messages, picture story boxes, picture word cards, letter and number cards, and picture guessing encourage children to learn vocabulary, initial letter sounds, and word structure in a fun way. Other games like "What's My Name?", matching pictures with their initial letters, and a hidden letter hunt in the classroom reinforce letter recognition and improve children's memory and concentration. Young learners are also encouraged to
	engage with enchanted containers, decipher characters, formulate lexemes, and organize alphabetical or lexical cards, all of which contribute positively to the enhancement of creativity, systematic cognitive abilities, and acquaintance with the alphabet. Physical games such as carrying plastic spoons filled with letters to select matching pictures also train coordination and literacy. All such endeavors—be they conventional or contemporary games, musical compositions, pedagogical videos, or dramatized interactions-thoroughly facilitate the advancement of literacy skills in children from a nascent stage in an innovative and purposeful manner.
Have educators historically conceptualized games aimed at enhancing children's social, motor, and literacy competencies? If affirmative, what categories of games do they encompass and what are their respective titles?	The majority of educators specializing in early childhood development possess proficiency in the formulation and execution of integrated play activities aimed at concurrently enhancing multiple dimensions of child development, including social interaction, motor skills, and literacy competencies. These games are often tailored to weekly themes or learning projects in the classroom. Instances encompass Market Play or Role Play, in which children assume the roles of vendors and consumers utilizing toys, repurposed materials, or self-constructed props. Children learn to read price labels, write shopping lists, and perform simple transactions, which simultaneously stimulate social skills (cooperation, taking turns, politeness), motor skills (writing, carrying bags, holding toy money), and literacy skills (reading text and product labels). Games like Word Market, Smart Mat, or Snake and Ladder searching for letters and numbers are also examples of fun and effective integrated activities. In these educational activities, children have the opportunity to acquire knowledge of letters, words, or numerical concepts, concurrently enhancing their cognitive abilities, motor skills, and social interaction competencies with their peers. Some teachers even combine physical games like relay races moving word cards or simple dramas with literacy and social elements. Although some have never tried it, most teachers report frequently conducting these activities because they are highly beneficial in developing children's various skills comprehensively and enjoyably.

In the event that a game amalgamates technological advancements with traditional gaming formats grounded in deep learning methodologies, do you believe it is imperative to foster social, motor, and literacy advancements? If so, what kind of game is needed?	Games that combine technology with physical and conventional activities are considered highly promising and necessary in stimulating children's social, motor, and literacy development in a comprehensive manner. Various educators have utilized technology such as interactive applications that provide guidance or instructions during learning, as well as digital-based games that encourage children to move and express themselves actively. Examples include picture guessing games, puzzles, sound recognition, and educational games based on deep learning such as "Smart Thematic Puzzle," where children assemble physical puzzles, then scan the results into an application to hear stories and answer interactive questions. These participatory activities facilitate the advancement of literacy skills (through the understanding of narratives and the refinement of storytelling abilities), augment fine motor skills (through the construction of puzzles), and encourage social skills (through cooperative engagement and the sharing of roles). Furthermore, hybrid gaming frameworks that amalgamate tangible tools with adaptive artificial intelligence, in conjunction with augmented reality applications such as nature exploration games, incentivize children to engage in physical movement within real-world contexts while gaining insights into their environment. Activities of this kind are not merely engaging and enjoyable; they also enhance children's cognitive abilities for conceptualization while engaged in play. Most critically, digital games ought to be constructed with a contextual framework that resonates with children's real-world experiences—incorporating physical movement, social engagement, and tactile interactions—thereby ensuring that they do not supplant but, rather, enhance their recreational activities.

This study raises the important issue of stimulating the social development of children aged 5-6 years through SERLI Interactive Games that integrate deep learning technology. The findings of the research indicate that interactive games employing deep learning techniques have a significant impact ($p < 0.01$) on the improvement of prosocial skills in children. The aspects of socio-emotional development that were scrutinized in this study produced encouraging results, especially concerning the enhancement of prosocial behaviors such as cooperation, empathy, and compliance with social norms. This is in line with the view (N. N. Fuadia, 2022) who stated that children's socio-emotional development can be effectively stimulated through specially designed games, where children can learn to interact, share, and show empathy in a fun context. These findings align with (Hafsania, 2021), it has been posited that fostering social and emotional growth in early childhood through play constitutes an exceptionally efficacious approach, as play serves as the inherent medium through which children articulate their emotions and engage with their environment.

The qualitative interviews conducted in this research elucidated noteworthy advancements in the social development of children subsequent to the COVID-19 pandemic. Empirical data indicates that in the year 2022, a significant number of children encountered social delays attributable to restricted face-to-face interactions and a heightened reliance on electronic devices. Early childhood social development is the process of forming social relationships with their environment, but this process often encounters various issues that impact children's social development. This situation reinforces the urgency of developing SERLI Interactive Games as an alternative solution that can bridge the need for technology and stimulate social development.

According to (Rakhmawati, 2022), Efficacious educational games ought to possess the capacity to simultaneously enhance various aspects of child development. These educational games are carefully engineered to operate as pedagogical tools that reinforce educational pursuits, aid instructors in delivering instructional content, and facilitate the comprehensive development of children. SERLI Interactive Games fulfills these criteria by integrating social, motor, and literacy stimulation in a single, adaptive platform. This SERLI research brings innovation by integrating deep learning technology that enables real-time adaptation to children's behavior. These findings align with the view of (Setiawan et al., 2019) who stated that digital educational games can serve as effective learning tools for early childhood by incorporating fun learning concepts. Similar research by (Dewi & Agung, 2021) also shows that interactive multimedia-based educational games can maximize child development, particularly in social aspects through an innovative approach.

The use of the ADDIE model in the development of SERLI games has proven effective in creating adaptive learning media that is tailored to teacher

needs and child characteristics. This is supported by research (Irawati, 2012) which shows that developing educational games using the ADDIE model can improve children's learning abilities through well-integrated games. Furthermore, (Handayani, 2018) it was underscored that meticulously crafted educational games possess the potential to enhance the social development of children, as play constitutes a realm that is intimately familiar to them.

Moreover, the principal advancement of this study is encapsulated in the application of deep learning methodologies, which facilitate the game's capacity to adjust dynamically in response to the behavioral patterns exhibited by children. This differs from previous studies, which generally used static games. The development of a treasure hunt game based on paintings to facilitate the social and emotional development of early childhood children is highly feasible for use in learning, but has not yet integrated adaptive technology like that developed in SERLI.

Overall, this investigation provides a substantial advancement in the formulation of adaptive educational games and the implementation of deep learning methodologies within the realm of early childhood education. The SERLI game is not only statistically proven to be effective but also relevant to the needs of education in the digital age, where technology must be utilized to support children's holistic development while maintaining the natural and enjoyable essence of play.

This research further corroborates earlier conclusions indicating that unsuitable educational play materials can engender novel difficulties for children, thereby rendering social development an essential component. SERLI's interactive games address this issue with designs tailored to the developmental characteristics of 5-6-year-olds and the needs of early childhood education curricula.

4 CONCLUSIONS

This research elucidates that the advancement of SERLI Interactive Games, grounded in deep learning methodologies, exerts a beneficial influence on the enhancement of prosocial competencies in children within the age bracket of 5 to 6 years. Employing the ADDIE instructional design framework, this game was adeptly developed in a manner that is responsive to the requirements of educators, the distinctive attributes of young learners, and the contextual elements pertinent to early childhood pedagogy. The evaluative findings indicate that the deployment of this game significantly augments children's abilities

in collaboration, empathy, and compliance with social norms ($p < 0.01$), while also producing heightened levels of user satisfaction among both educators and learners. Additionally, the game integrates stimulation of children's social, motor, and literacy aspects, addressing post-pandemic learning challenges and overcoming the limitations of conventional games. Therefore, SERLI Interactive Games is an effective and relevant educational innovation to support the development of young children in the digital age.

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