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PADANAN PINTAR: TOWARDS A GAME-BASED APPROACH FOR REGULATING SENSORY AND EMOTIONAL OVERLOAD IN CHILDREN WITH ASD

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ABSTRACT

This research aimed to develop *Padanan Pintar*, an interactive mobile game specifically designed to help children with Autism Spectrum Disorder (ASD) manage sensory and emotional overload, which can often lead to behavioural issues such as tantrums. The development process was structured into three key phases: requirement gathering, which involved creating user personas and defining game requirements; application development, where the game was built using the Adalo mobile application platform; and evaluation, which followed a qualitative approach. In the early stages, interviews and observations provided insights into the sensory and emotional needs of children with ASD, guiding the design of the game. User testing conducted with autistic children demonstrated positive engagement, emotional and behavioural responses. The feedback indicated that *Padanan Pintar* effectively provides a calming influence, reduces sensory overstimulation, and fosters relaxation, making it a promising tool for managing ASD-related challenges. These outcomes highlight the initial finding of potential digital games elements in supporting emotional and sensory regulation for children with ASD.

Keywords: Mobile Game Application, Game Elements, Persona, Game Design, Game Testing, Autism Spectrum Disorder

INTRODUCTION

Children with Autism Spectrum Disorder (ASD) often face significant difficulties with attention, engagement, recognition, and problem-solving, especially during daily routines. These challenges can greatly affect their independence and quality of life. Although research has enhanced our understanding of

ASD and led to the development of evidence-based interventions, effectively addressing these core issues remains a complex task (Dawson & Geschwind, 2016). Children with ASD also struggle to regulate their behaviour and emotions. Parents and caregivers might interpret these behavioural and emotional symptoms, such as meltdowns leading to tantrums or irritability and restlessness, as "bad behaviour," often not realizing they are caused by sensory overload. Children with sensory overload processing can have a negative effect on mood, the ability to perform daily functions and learning (Kong & Moreno, 2018).

Despite advances in understanding the disorder and implementing interventions, managing the behavioural and emotional challenges of ASD continues to be a major hurdle (Hastings et al., 2021). ASD affects social interactions, emotional regulation, and behaviours such as attention problems, anxiety, depression, and aggressive or oppositional behaviour (Ashburner et al., 2010; Pouw et al., 2013), making it essential to address these challenges for the well-being of those affected. These difficulties not only impact the individual but also affect those around them, including friends, parents, and teachers. Children show symptoms such as crying, sulking, and even tantrums, which will continue until the underlying cause is properly addressed.

Recently, multimedia technology has demonstrated the potential to improve educational experiences for children with autism by offering captivating and interactive learning settings (Valencia et al., 2019) (Omar et al., 2020). Research has shown that the use of multimedia therapies can decrease anxiety, enhance concentration, and facilitate relaxation in children with ASD (Frolli et al., 2022), resulting in improved educational achievements and overall welfare. While evidence-based interventions such as Applied Behaviour Analysis (ABA) have demonstrated promising results in improving communication and social abilities in children with ASD (Ayaz et al., 2024) (Fenton, 2024), there remains a gap in the knowledge and utilization of multimedia technology in regulating sensory and emotional overload of these children (Parmar et al., 2021). Motivated by various research that working in this domain, we are very interested in understanding and utilizing this multimedia technology and designing an interactive application that can cater to the emotional regulation of children with autism. Specifically, we are interested in how the gaming environment can be utilized by these children and benefit from it.

This project aims to create an interactive gaming application that helps children with autism meet their emotional control. The following are the objectives of the project; (1) identify elements that control sensory overload and encourage relaxation in gaming experiences for autistic children; (2) develop a game for autistic children that uses elements identified in the first objective; and (3) evaluate the effectiveness of the game application. This interactive game project is called *Padanan Pintar* that specifically developed to include features that aim to achieve the stated objectives. The research will employ various techniques including document analysis (in literature review), interviews with teachers, observation and testing of the game with the target population. The next sections of this article will detail our work in creating an interactive game of *Padanan Pintar*. This article also will also serve as an initial finding for suitable game elements for ASD children in regulating sensory and emotional overload.

PREVIOUS WORK

Research has highlighted the importance of interactive applications in supporting the learning and development of children with autism. Since ASD has no cure, early interventions and tailored educational exercises are crucial for helping children make significant progress. Interactive applications, particularly those integrated with information technology, have been shown to enhance the teaching and learning process for children with ASD by providing personalized support that addresses their unique challenges, such as difficulties in social interaction. Mobile social applications, for instance, have been proposed to

help autistic children develop better social interaction skills by creating engaging, interactive environments tailored to their needs (Azahari et al., 2016). Additionally, mobile technology has been recognized for its potential to provide educational opportunities anytime and anywhere, effectively extending learning beyond the classroom and fostering better participation in social and educational settings (Hussain et al., 2016).

Multimedia elements are also vital in designing educational tools for children with autism. According to an article by Mazurek et al. (2012), the study was conducted to explore the impact of multimedia technology on children with ASD. The subject of discussion was the requirement for efficient instruments to handle the emotional and behavioural difficulties that kids with ASD encounter. According to the study, children with autism could greatly benefit from multimedia interventions that involve calm and visually stimulating environments to lower anxiety and increase focus. These technologies give children a fun, stress-free experience that promotes relaxation and the growth of critical cognitive abilities. The study highlighted the potential of multimedia technology in providing children with ASD with supportive and stimulating experiences that will enhance their general well-being and skill development. Additionally, "Multimedia Learning for Autism," for example, is a specialized e-learning platform that incorporates text, images, sound, and animation to create an engaging learning experience for young children with autism (Ahmad Mahyuddin, 2014). Such multimedia elements are not only entertaining but also help enhance cognitive functions by encouraging children to think, use their imagination, and improve visual perception while having fun. The incorporation of augmented reality (AR) into educational tools further supports this by offering natural and realistic environments that can be tailored to the specific cognitive and sensory needs of autistic children. AR enhances learning by adding extra content that supports multimedia learning, thereby fostering associations between verbal and visual information through multiple sensory and working memory channels (El Shemy et al., 2023).

Games have proven to be particularly effective in engaging children with autism and supporting their cognitive and social development. Digital games offer several advantages, such as performance tracking, easy customization, and strong visual engagement, making them a valuable tool in special education settings. Research indicates that while many parents recognize the benefits of using digital devices and software to support their children's development, there is a need for better training to maximize these tools' effectiveness in enhancing social skills (Troshanska & Nikolovska, 2023). The structured nature of games, combined with their ability to provide instant feedback and rewards, can motivate children with autism to persist in learning activities, thus promoting skill development over time (Atherton & Cross, 2021).

Furthermore, game-based learning has been identified as a powerful strategy to teach both cognitive and social skills to children with autism. The intrinsic reward systems built into most games—such as points, levels, and progress bars—serve as additional incentives that reinforce positive behaviour and encourage continued participation (Atherton & Cross, 2021). This positive reinforcement is particularly beneficial for children with ASD, as it helps maintain engagement and interest, making the learning process more enjoyable and effective. Another key design consideration is the use of muted colours, which can provide a calming sensory experience, helping to reduce stress and anxiety (Shareef & Farivarsadri, 2019). In terms of typography, Garamond has been identified as a preferred font for autistic individuals due to its readability and reduced visual overstimulation (Autism and the Assembly, 2024). These visual elements can contribute to a more comfortable and manageable gaming experience, particularly for children who are prone to sensory overload.

In addition to visual design, audio elements play a crucial role in ensuring the game remains engaging without causing overstimulation. Research indicates that quiet, slow music helps reduce anxiety, while

loud or fast-paced sounds may trigger sensory overload (Larrazabal, 2023). By incorporating these calming auditory cues, the game can promote a soothing atmosphere conducive to focus and relaxation. Moreover, the integration of minimal multimedia elements ensures that the game remains child-focused and avoids unnecessary distractions.

To foster long-term engagement, it is important to include features such as rewards, encouragement, and praise to keep autistic children motivated during gameplay. Allowing repetitions of tasks or levels can also help children build confidence and mastery, as they tend to feel more secure with familiar challenges. Furthermore, incorporating easily recognizable icons into the game interface enhances navigation and usability for children with ASD, who may find visual symbols more intuitive than text-based options (Azahari et al., 2016). When combined, these autism-friendly design features can improve the overall accessibility of the game, promoting sustained user engagement and positive outcomes. Overall, the integration of interactive applications, multimedia elements, and game-based learning approaches in educational tools offers promising strategies for improving the learning experiences and developmental outcomes of children with autism.

METHODOLOGIES

This research was conducted in three phases. The phases followed the objectives of this research as mentioned in the Introduction section. In each phase, there were a few techniques employed that were suitable for the various activities such as collecting data, shaping the requirements, designing and developing the game and finally evaluating it. In the following section, each phase will be explained respectively.

Phase 1: Identify elements in regulating sensory overload and encourage relaxation in gaming experiences for autistic children

In order to carry out these phases, a school in northern region of Malaysia that has class for special needs children was approach. After the school granted the approval, we were working with a teacher that has ten years' experience with children with ASD. Parents' consents were also granted as we promised not to mention their children name and identity. They were also emphasizing that children should not be forced to take part in any activity that they refused as it may affect they mood and behaviour. After these issues were resolved, we started the data collection work by conducting the observation techniques in the class. During the observation, short videos were recorded which showing various children's activities. This recording was an essential component of the observation process. It enables researchers and practitioners to document and review their findings, assuring accuracy and consistency of the data gathered.

Although there were several videos have been taken, only five videos were analysed as they clearly show and allow us to hear the voice. These videos were mostly focused on skill-building exercises that aim to promote cognitive, communication, and social development among these children. There are a few activities that they did during the learning process, but the activities are mostly a mix-and-match puzzle pattern, finding the same image of animals, and other objects. The video also shows teachers helping their students by explaining and demonstrating the daily activities to improve their basic skills such as how to sit on a chair safely, wash their hands properly, tidy up their toys and belongings and many more. Different videos show different approaches taken for the student, depending on their skill level and how long it takes for them to understand and finish certain tasks.

Other than the physical behaviour, the non-physical behaviour also being observed such as the children emotion and feeling (through the children's senses and expression). Through the video, it was shown that the visual and colourful images are very helpful in attracting them to learn. For example, in two of the videos, the teacher used different types of colours which shows high engagement and longer attention span. Different types of colours also affect children as vibrant colours attract their attention whereas soft colour make them calm and happy.

As a result of our observation, we created a persona of ASD children as to have a deep understanding of the end users and their needs (Cooper et al., 2014). This persona has ability in guiding developers and designers to create apps that resonate with specific individuals. The ASD children persona can be viewed in Figure 1.

Figure 1

Persona of ASD Children

Profile Attributes
Name : Aryan
Age: 9 years old
Gender : Male
Nationality : Malaysia

Profile:
Aryan is a nine-year-old boy with autism who attends primary school with additional support from special education. His parents work closely with his teachers and therapists to ensure a supportive environment at home and school. Aryan loves visual cues, particularly colours, patterns, and shapes, and enjoys playing with the same toys repeatedly without getting bored. However, he struggles with verbal communication, which often leads to frustration when he can't express his needs.

Frustrations:

- **Communication**: Aryan has difficulty expressing himself verbally, causing frustration and isolation when his needs aren't understood.
- **Sensory Overload**: He is sensitive to loud noises and bright colours, and overstimulation can overwhelm him, making him seek calm environments.

Goals:

- **Improve Communication**: Aryan's main goal is to improve both verbal and non-verbal communication, helping him better connect with others.
- **Skill Development**: His parents and teachers aim to use engaging activities, like puzzles, to enhance his cognitive, communication, and social skills.

Motivation:

- **Visual Stimulation**: Aryan is highly motivated by visual stimuli, especially calm, muted colours that make learning more comfortable.
- **Sense of Achievement**: Positive reinforcement and celebrating his successes boost his confidence and encourage him to engage in more learning activities.

Other than Persona development, requirements for the mobile game application for the ASD children was also developed in this phase. This requirement states the product features or functions that developers must implement to enable users to accomplish their tasks and achieve the objectives. Our game requirement consists of several elements/features, its description and rationale of selecting the elements. Each elements selected is based on the study from the literature and whichever seems suits to the persona developed earlier. The game requirement was laid out in Table 1.

Table 1

Game Requirements for an Autism-Friendly Matching Game

ID	Requirement	Description	Rationale
F001	Colour Palette	Use muted colours (pastel shades, neutral tones) to create a calm environment. Avoid bright and vibrant colours.	Muted colours provide a calming sensory experience for autistic children, reducing stress and anxiety (Shareef & Farivarsadri, 2019).
F002	Font Style	Use Garamond font. Headings should be in larger characters, and bold text should be used for emphasis instead of italics or underlining.	Garamond is preferred by autistic individuals for readability and reduces visual overstimulation (Autism and the Assembly, 2024).
F003	Matching Game Mechanics	The main feature is a matching game designed to promote relaxation and calming effects.	Relaxation-focused games help reduce anxiety and promote focus in autistic children.
F004	Game Elements and rules	Rewards, encouragement, praising and allow repetitions	These features will help autistic children keep their motivation while playing the game.
F005	Multimedia Integration	Include images, audio, and text. Ensure they are synchronized and not overstimulating.	Multimedia element is kept minimal to make them children-focused.
F006	Audio Design	Use soothing, slow-paced sounds and gentle sound effects.	Quiet, slow music reduces anxiety, while loud or upbeat sounds may overstimulate autistic children (Larrazabal, 2023).
F007	Icon-based Navigation	Replace navigation buttons with easily recognizable icons (e.g., home icons for the main page).	Icons are easier for autistic children to recognize and navigate.

NF001	Accessibility	The UI must be intuitive, consistent, simple, and free from distractions. Include visual cues and feedback to guide users.	Autism-friendly design enhances ease of use (Azahari et al., 2016), and promotes user engagement.
NF002	Performance	The game should run smoothly with no lag.	Fast response times prevent disengagement and frustration.
NF003	Usability	Provide simple, clear instructions and a help section with visual explanations.	Usability ensures children and caregivers can easily navigate and use the application.

To sum up, in this phase we have conducted observation in the special needs class, and as a results ASD children's persona and game requirement specification were produced. These will be the guidelines for the development of *Padanan Pintar* game explained in the next phase.

Phase 2: Develop a game for autistic children that uses elements identified in the first objective

In this phase the game were developed based on the Persona and game requirement from the previous phase. The game development process took approximately two months to produce a high-fidelity prototype. Several iterations of the game concept (storyboard) were created and extensively reviewed with teachers and supervisors then compared against the Persona and Game Requirement developed earlier. The high-fidelity version was built using Adalo software and can be downloaded for use in a mobile environment. In the development there are several aspects that were important such as game play, game challenge and game element.

Game Play

The gameplay is designed to be simple, helping children maintain focus for longer periods. It involves a mix of matching and grouping the correct items based on requests. Additionally, children must choose the appropriate actions to complete daily tasks, promoting problem-solving. This approach is intended to enhance cognitive development while they play.

Game Elements

The story begins with a quest to assist a boy named Aryan in overcoming several challenges he faces in his daily activities, such as matching colours, identifying shapes of everyday objects, and selecting the appropriate actions after completing tasks. There are three different games of *Rona Warna*, *Reka Bentuk* and *Padankan Saya* and each of them retains the same concept of a matching game. In *Rona Warna*, children were asked to *match the colour* of the object, in *Reka Bentuk* children were asked to match correct shapes whereas in *Padankan Saya* children were asked to *choose a suitable object* that was suitable for the given situation. The goal is to enhance the cognitive skills of ASD children and at the same time provide positive user experience.

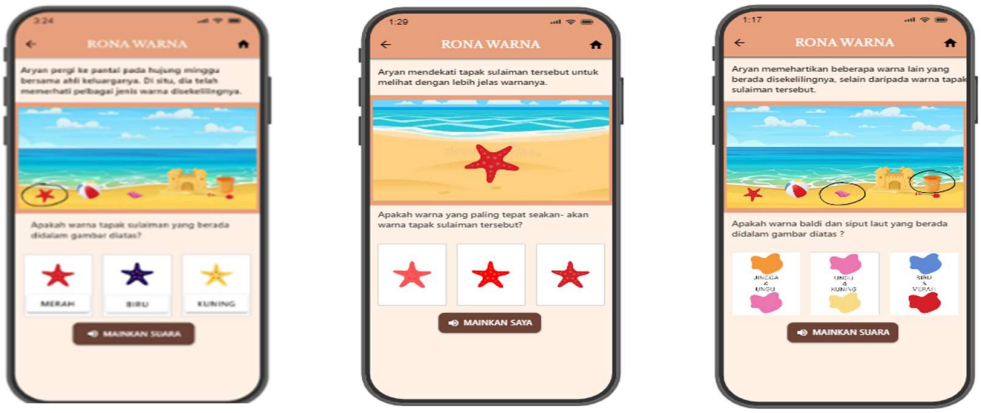
Game Challenge

The game includes minimal challenges spread across three levels for each game type. The challenge we design in three different level of low, medium and high with increasing difficulty as the levels progress as shown in Tabel 2. Upon completing a level, children receive rewards in the form of visual images and audio to encourage motivation. However, they have the option to repeat or stop at any level if they make a mistake or choose not to continue.

Table 2

Game challenge in different level

Low Level	Medium Level	High Level
children were asked to ***choose the same colour*** for the object that they saw by giving them a different colour choice	they need to choose the object colours by giving them a ***range of similar colo***urs to the given object.	Children need to determine ***more than one colour of different object***s asked by the application.

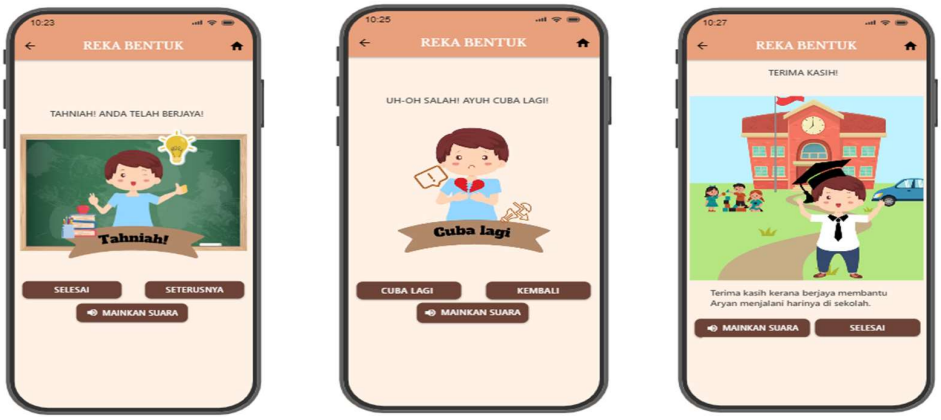


Engagement

These game engagement elements were carefully chosen to reduce the sensory overload and the simple game concept that will make the children easy to play, teaching them while paying with minimal cognitive loads. Engagement elements that attract the children's attention such as a simple story, pastel colour code, audio as narrator and soft background music (can be turned off) and visually appealing interface to the autistic children. The game mechanics is a simple matching game, while the rules of the games allow continuity or stop and repetition at every level (refer to Figure 3).

Figure 3

Interface of Engagement

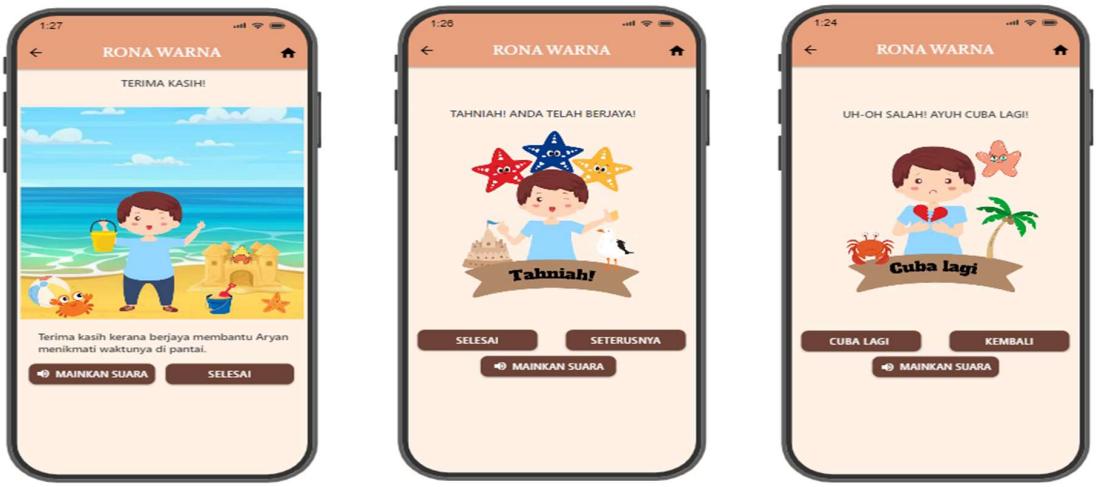


Motivation, Rewards, Praise and Encouragement

Among important aspects in game are rewards, motivation, praise and encouragement that would make the players stay and receive positive experience while playing. Rewards are given to children for completing the quest by helping Aryan in the game (Figure 2 A). Positive reinforcement to motivate them is provided when they make the correct choice (Figure 2 B), while an encouragement page pops up to support them if they make a mistake (Figure 2 C). These aspects were design attentively in order to achieve the research objective as stated earlier.

Figure 2

Interface of Motivation, Rewards, Praise and Encouragement



A B C

Phase 3: Evaluate The Effectiveness of The Game Application.

The last phase was evaluation phase in which we evaluated the application with five students diagnosed with ASD from the same primary school where initial observations were made. We adopted usability evaluation which mentioned that five user was sufficient to get the validated data (Nielsen, 2024). The children who agreed to participate were familiar with the researchers, as they had spent considerable time in the school. During the evaluation, we were observing few criteria that have been discussed in the literature, which is engagement, behaviour, emotion, sensory interaction and lastly the overall impression as they interact with the game. These criteria were chosen in order to understand on how effectively the design of the game able to regulate the ASD children sensory and emotion overload.

The evaluation exercise was conducted using qualitative approach. Firstly, the participants were asked to play the game while being observed. Working with children, particularly those with ASD, during the evaluation presented challenges, as noted by Parmer et al. (2021), yet it is essential for them to be participants. Figure 4 shows the evaluation exercise of *Padanan Pintar* game. Secondly, during the activity a teacher assisted the children, one researcher recorded videos and took photos, while another researcher observed to assess the stated evaluation criteria. Finally, results from the observation will be discussed in the findings sections.

Figure 4

Evaluation Exercise of Padanan Pintar

FINDING AND DISCUSSION

In analysing the evaluation data, we were observing several behavioural criteria such as engagement, behaviour, emotion, sensory interaction and overall impression as stated in the previous section. The students were named with alphabets of A to E and their ages were also noted. The findings were analysed and summarized in Table 3 as follows.

Table 3

Evaluation Phase – Finding

Criteria	Finding
Age and Engagement	While there is overlap, there seems to be a general trend towards higher initial engagement in the older age group (9 years old). Students C, D, and E, aged 9, consistently displayed immediate enthusiasm and engagement.
Usability and Navigation	Most students adapted well to the application. Students A and E excelled in navigation, requiring minimal guidance. Students B, C and D needed initial assistance but improved with practice.
Behavioral and Emotional Responses	All students exhibited positive emotional responses, including happiness, enjoyment, and excitement.
Sensory Interaction	Students responded favourably to both auditory and visual stimuli, with no reports of sensory overload or meltdown during playing the game.
Overall Impression	All students demonstrated positive overall impressions, with varying degrees of engagement and enjoyment. Most students showed particularly high levels of engagement and positive affective responses.

The evaluation of the interactive system revealed several important trends among children with ASD. A significant correlation was observed between age and initial engagement, with older students showing more enthusiasm. Most participants displayed positive emotional responses, indicating the game's

effectiveness in generating interest and engagement. The majority of students adapted well to the game's navigation, accepted the game mechanics and rules, and were motivated to complete the game's quests. However, it is essential to acknowledge the limitations of the study. The small sample size restricts the generalizability of the findings to a broader population. Additionally, the evaluation primarily focused on immediate reactions and user behaviour, providing limited insights into long-term outcomes and overall user satisfaction. Consequently, the results should be interpreted with caution and considered within the context of these constraints.

CONCLUSIONS

The development of the mobile game application *Padanan Pintar* for children with ASD is very important for these particular children as well as their caregivers. The carefully designed multimedia elements and combination with gaming elements that address ASD children's unique sensory and emotional aspects might pave the way to improving the overall quality of life for these children. *Padanan Pintar* should aspire to enhance the development of fundamental abilities and create a sense of calm and relaxation in children with ASD by offering an entertaining and educational gaming experience.

The findings from these activities highlight several key points; (1) Encouraging relaxation - games designed with simple rules and challenges (Atherton & Cross, 2021) along with the opportunity for repetition, can promote a calming effect and help children relax; (2) Reducing Sensory overloads: utilizing pastel colours and soft audio within the games can create a soothing environment, which helps in minimizing sensory overloads and providing a calming experience for children with ASD as reported previously by Omar and Bidin (2015) that the use of suitable colour has a positive impact with ASD children; (3) Boosting Motivation - Incorporating rewards, praise, and encouragement in the game is crucial for motivating children to engage (Atherton & Cross, 2021) and continue participating. Caregivers can use these game apps to support children with ASD in reaching specific developmental goals, managing their emotions, and regulating their behaviour, thereby improving the overall effectiveness of care. Moreover, this approach can be adapted to other games and integrated into various therapeutic tools and learning environments.

In conclusion, the development of the gaming application *Padanan Pintar* is significant for children with ASD and their caregivers. By incorporating carefully designed multimedia and gaming elements that address the unique sensory and emotional needs of children with ASD, *Padanan Pintar* has the potential to improve their overall quality of life. While initial evaluations suggest that the game can effectively promote relaxation, reduce sensory overloads, and boost motivation, further research is necessary to fully understand its impact. Expanding the sample size, extending the duration of gameplay, and broadening the evaluation criteria to include aspects like learning outcomes and user satisfaction will provide a more comprehensive assessment of the game's effectiveness (Atherton & Cross, 2021). This deeper understanding will help identify the strengths and weaknesses of *Padanan Pintar*, guiding future improvements and its potential adaptation for use in other therapeutic and learning environments, ultimately contributing to the development of guidelines for using digital games to regulate sensory and emotional overload in children with ASD. While *Padanan Pintar* offers promising initial results, future research is necessary to deepen our understanding of its effectiveness and guide its evolution as a tool for ASD intervention. This work will lay the foundation for future digital game interventions aimed at supporting sensory and emotional regulation in children with ASD.

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