Serious Game Design Principles for Children with Autism to Facilitate the Development of Emotion Regulation

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***Abstract*—Autism spectrum disorder (ASD) is a deficit-driven neurodevelopmental condition in three areas, which are social interactions, communication, and the presence of restricted interests and repetitive behaviours. Children with autism mainly suffer from emotional disturbance that emerges as meltdowns, tantrums, and aggression, increasing the risk of developing mental health issues. Several studies have assessed the use of serious games in helping children with autism enhance their communication, learning, and social skills. Significantly, these serious games focus on the strengths and weaknesses of the disorder to establish a comfortable and controlled environment that is able to support children with autism. However, there is still a lack of evidence in studies exploring the use of serious games for children with autism to facilitate the development of emotion regulation. The aim of this study is to consolidate and propose a new serious game design principle for children with autism to facilitate the development of emotion regulation. The target age of the children involved in this study ranged between 6 and 12. A review of previous literature on serious game design principles was conducted. More than 70 articles related to serious games for children with autism were analysed using thematic analysis. This study found 16 elements that influenced the designing and developing process of creating a serious game for children with autism. It has been organised and categorised into five attributes (user, game objectives, game elements, game aesthetics, and player experience). Certainly, this study demonstrates the needs and requirements of children with autism when designing serious games.**

***Keywords*—Autism spectrum disorders; serious game; emotion regulation; serious game design principles**

I. Introduction

Autism spectrum disorder (ASD) is one of the world's fastest-growing diseases. It is no longer considered an uncommon disorder in Malaysia but rather a developmental impairment that requires immediate assistance and understanding from all levels of society. Autism is a long-term neurodevelopmental condition distinguished by difficulties in interpersonal communication and social interactions, along with restricted, repetitive behaviour and interests [1-3]. Additionally, autism is referred to as a 'spectrum' disorder due to the wide range of symptoms that individuals experience. Presently, there is no known medical solution for autism, and researchers are still trying to figure out what causes it [4].

It is estimated that there are roughly 12,800 instances of autism in Malaysia, which is equivalent to 1 out of every 600 children [5]. Thus, the number of people diagnosed with ASD requesting services from the National Autism Society of Malaysia (NASOM) has increased by 30% across all age groups in recent years [6]. Besides that, males are more likely to have autism [7, 8] despite the fact that a recent meta-analysis found that the actual male-to-female ratio is closer to 3:1 than the previously reported 4:1; even though this study did not use the DSM-5 criteria [9].

Several studies have revealed that the majority of children with autism experience behavioural challenges, and certain characteristics of autistic children can be concerning to parents. Emotion regulation (ER) deficits were discovered to be a salient predictor of social and behavioural issues in children with autism [10] since they often exhibit excessive emotional reactivity or an emotional deficit compared to children with typical development [11]. Some children with autism who have limited verbal or nonverbal communication often face difficulties expressing themselves when they are frustrated or stressed [12]. As a result, children with autism are more likely to experience emotional disturbances such as meltdowns, tantrums, and aggression, which are risk factors for developing mental health disorders [13]. Besides that, disappointment induced by dysregulated emotions in children with autism may result in increased anxiety, despair, poor anger management, low frustration tolerance, impatience, despair, violence, mood dysregulation, and physical health implications [14, 15].

Conventional methods, such as paper-based and various therapeutic approaches have been suggested to support ER training for children with autism. However, paper-based aids are resource-intensive due to the need to craft the materials and intense instructions for children with autism [10], making them challenging for caregivers, teachers, and parents to utilise. Additionally, Sadka and Antle [16] also stated that the average delay in treatment for various mental health disorders surpasses ten years as a consequence of failure to notice symptoms, a lack of health care literacy, personal or social stigma associated with mental health care, and a lack of access to mental health therapy. Therefore, serious games have been shown to facilitate and support children with autism in acquiring academic, communication, job, and leisure skills [17]. Moreover, serious games bridge the gap between the tremendous demand for evidence-based interventions and the limited availability of professional autism services [18].

Despite the variety of technology-based interventions for children with autism, usability and uptake remain low. It is not surprising that there are few studies on serious game technology that may simulate the daily routine of children with autism to support emotion regulation [14, 19]. In fact, most of the existing studies fall into the social skills subcategory [20] focusing on facial expression [10, 21], or point to some aspects of the serious game, such as behavioural interventions and training methods [22, 23] without discussing in-depth analysis in the literature on serious games to develop emotion regulation [24] or promoting conventional emotion regulation training through serious games [25].

This study aims to better understand the user's needs and requirements to facilitate children with autism with their development of emotion regulation, such as recognising, interpreting, and generalising six basic emotions. The objective of this study is to consolidate and propose new serious game design principles for children with autism, focusing on the development of emotion regulation. Besides that, this study is driven to address the research question, which is: What are the appropriate serious game design principles for children with autism to facilitate their development of emotion regulation in their daily life activities? Significantly, this study focuses on filling the gap in the existing studies on facilitating the development of emotion regulation among children with autism using serious games.

II. Related Works

A. Autism Spectrum Disorder and Emotion Regulation

The term 'emotion' usually refers to a subjective state of being that is referred to as 'feelings' by most people. Emotions are an essential component of cognition and are closely tied to it [26]. Aside from that, emotions are generally thought to be actively felt and deliberate, whereas mood refers to a protracted, less intense affective state unrelated to whatever an individual encounters. Consequently, emotion recognition is considered a crucial skill that underpins more complicated emotional understanding and social abilities [27]. Additionally, emotion regulation is influenced by biology and through interactions with people in the environment [28].

Emotion regulation (ER) is defined as the voluntary management and modulation of emotional reactions through cognitive processes to regulate affective states in order to attain a goal [29]. Furthermore, emotions are also intertwined with an individual's daily life and have an impact on a variety of areas of human functioning, particularly communication and socialisation. As cited by Jinnah, et al. [30], it is mentioned that normally, typical infants begin to employ emotional expressions for social referencing between the ages of eight and ten months. However, children with autism may demonstrate little or no imitation of others' behaviour [1]. As a result, children with autism struggle to communicate, socialise, and maintain relationships with others [31].

Therefore, emotion regulation is a crucial skill that children with autism need in their lives. Certainly, emotion regulation has ended up as one of the critically highlighted issues in numerous areas, including Human Computer Interaction (HCI). In addition, as cited by Sharma, et al. [32], emotion is crucial to understanding motivation in classroom interactions since teachers' instructional and interpersonal responses to children are often influenced by emotions. Thus, early intervention and evaluation of social and emotional skills in children with autism may help explain their observed traits [33].

B. Serious Games for Children with Autism to Facilitate Emotion Regulation

The most straightforward definition of 'video game' is interactive digital entertainment that is played on a computer, game console, or smartphone. It is also more commonly known as an electronic game that requires user interaction through a user interface that generates visual feedback. Furthermore, video games can be employed in a variety of sectors, including in the education field for people with special needs, despite being generalised as a source of entertainment only. Also, special education teachers are increasingly using technology-based interventions such as serious games to provide training to children with autism to enhance their social skills and quality of life [34]. Thereby, it should be noted that games have been employed as an additional tool for teaching and learning since the early nineteenth century.

According to Kokkalia, et al. [35], games in education are common because teachers frequently use games to create a more dynamic and creative learning experience. Besides that, video games and serious games have demonstrated that they can help children develop their cognitive and physical abilities owing to the consistent strategies for activity motivation and the feeling of personal pleasure gained from accomplishments [36]. Moreover, serious games have the ability to generate an emotional connection for people with special needs who are undergoing therapy or rehabilitation. In addition, previous studies claimed that games can be a joyful and pleasurable way for children to improve their skills [37]. Thus, several scholars believe that active exploration and immersion in games are able to enhance constructive, situational, and experienced learning [38].

Moreover, games have shown enormous potential as an intervention for children with ASD due to their ability to integrate attentively designed features with naturally occurring situations (i.e., having fun together) [39]. It is because game-based intervention is able to create a predictable environment to encourage attention and lessen the frustration of children with autism [40, 41]. For instance, a study found that training using virtual reality (VR) game approaches is able to improve the emotional and social skills of children with autism [42]. Additionally, game-based intervention is advantageous because it is predictable, repetitive, and devoid of stressful social demands, which are preferred by children with autism.

For instance, a previous study found that a game called FaceSay has successfully helped children with autism recognise facial expressions and feelings through the assistance of a realistic avatar [43]. Moreover, the visualisation of gaze in video games aids in the development of social attention and emotional abilities in children with autism [44]. Shams, et al. [45] also highlighted how the cosy and appealing aspects of serious games showed their ability to

improve emotion control in children with autism. Therefore, serious games are believed to have the potential to help children with autism improve their social communication skills and enhance their capacity to perceive and express emotions.

C. Designing Serious Games for Children with Autism

Game technology has been evolving with features and functions that defy expectations. Particularly, games have proven to be beneficial in a variety of fields, including the military, healthcare, and education. In fact, serious games have a lot of potential because they can foster relationships in a range of settings and contexts, such as realistic simulation games [46]. To emphasise, the usage of games in education has made learning more engaging and dynamic [47]. Therefore, game technology can be a promising tool for helping children with autism meet their needs by facilitating their therapy and skill development. In fact, games have the ability to capture the attention of children, including children with autism [48].

A large number of studies suggest that games can permanently prepare children physically and cognitively while also increasing their creativity, critical thinking, and sense of possibility. Additionally, studies have shown that ICTS is able to increase the interest and motivation of children with autism and support their social skills and social emotional domain skills development in a safe environment by using virtual environments that can replicate real-world situations [49]. Lee, et al. [50] also concede that animation, sound, and interface in technology-based intervention may reinforce and inspire children with autism.

As a result, a lot of guidelines and design principles have been produced to serve as a guide for designing and developing an appropriate game for a specified group, considering gameplay design, game mechanics, level design, reward systems, and other game aspects. Basically, the components that may be addressed in designing serious games include storylines, targeted skills, level progressions, feedback, and rewards [22, 51-53].

III. Methodology

This section describes the method used in this study. A comprehensive literature review on serious game design principles was conducted to retrieve and gather all the studies related to autistic people. A comprehensive literature analysis on serious game design principles was conducted to acquire and compile all studies that are relevant in facilitating children with autism with their development of emotion regulation. The children are aged between 6 and 12.

There are three stages of filtering and analysis used in the literature review stage. In the first stage, articles were extracted from Google Scholar, Science Direct, ACM Digital Library, IEEE Xplore, Scopus, Research Gate, and Springer Link between 2006 and 2021 using the key search criteria. The primary search keywords were ‘Serious Games for Children with Autism Spectrum Disorder’, ‘Serious Games to promote Emotion Regulation of Children with Autism Spectrum Disorder’, and ‘Designing Serious Game for Children with Autism Spectrum Disorder’. In addition, search terms such as ‘Autism Spectrum Disorder’, ‘serious games’, ‘design principles’ and ‘emotion regulation’ were used to find additional articles. The keywords were gathered from academic journals, textbooks, technical reports, websites, and conference proceedings.

The first 70 articles in the search engine result were studied, and those that seemed relevant in terms of game-based interventions, serious games, and autism spectrum disorders (ASD) were chosen. In the first stage, the studies proposing serious games in the context of children with autism and review articles were accepted. Next, in the second stage, the articles were reduced to 48, which were discovered to be significant for analysis based on the suggested criteria related to the study. Then, these 48 articles were analysed in-depth to investigate the application design and existing guidelines in the third stage. The inclusion and exclusion criteria were described further in Table I. Iteratively, the analysed articles were taken into consideration and revisited, with a focus on serious game design principles for children with autism. In total, 24 articles were selected for critical examination and made it to the result table.

TABLE I. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Studies from 2016 to 2022	Older than 2016
Serious Game, Game-Based Technology.	Any other computer-based intervention or assistive technology.
Focusing on designing games for autism spectrum disorder.	Studies that were not explained in literature or working paper.
Serious games that were tested on enough samples and in-game performance were validated.	Not enough studies and in +-game performance were not validated.

After that, the 24 articles that were chosen were analysed and examined thoroughly, and the design principles were extracted using card sorting and thematic analysis. Prior to the complete system design, the card sorting technique was found to be very effective and an important way of getting the user’s input [54]. In addition, thematic analysis was used to extract the design principles. Thematic analysis is a technique for methodically detecting, organising, and interpreting patterns of meaning in a dataset. Besides, thematic analysis is a more divergent, compatible, and flexible research tool [55]. Thereby, the data were clustered thematically from the literature review.

In the first analysis, as shown in Fig. 1, the data was thematically clustered into five themes: user (green), game objectives (yellow), game aesthetics (pink), game elements (blue), and player experience (purple). Table II further explains the description for each theme.

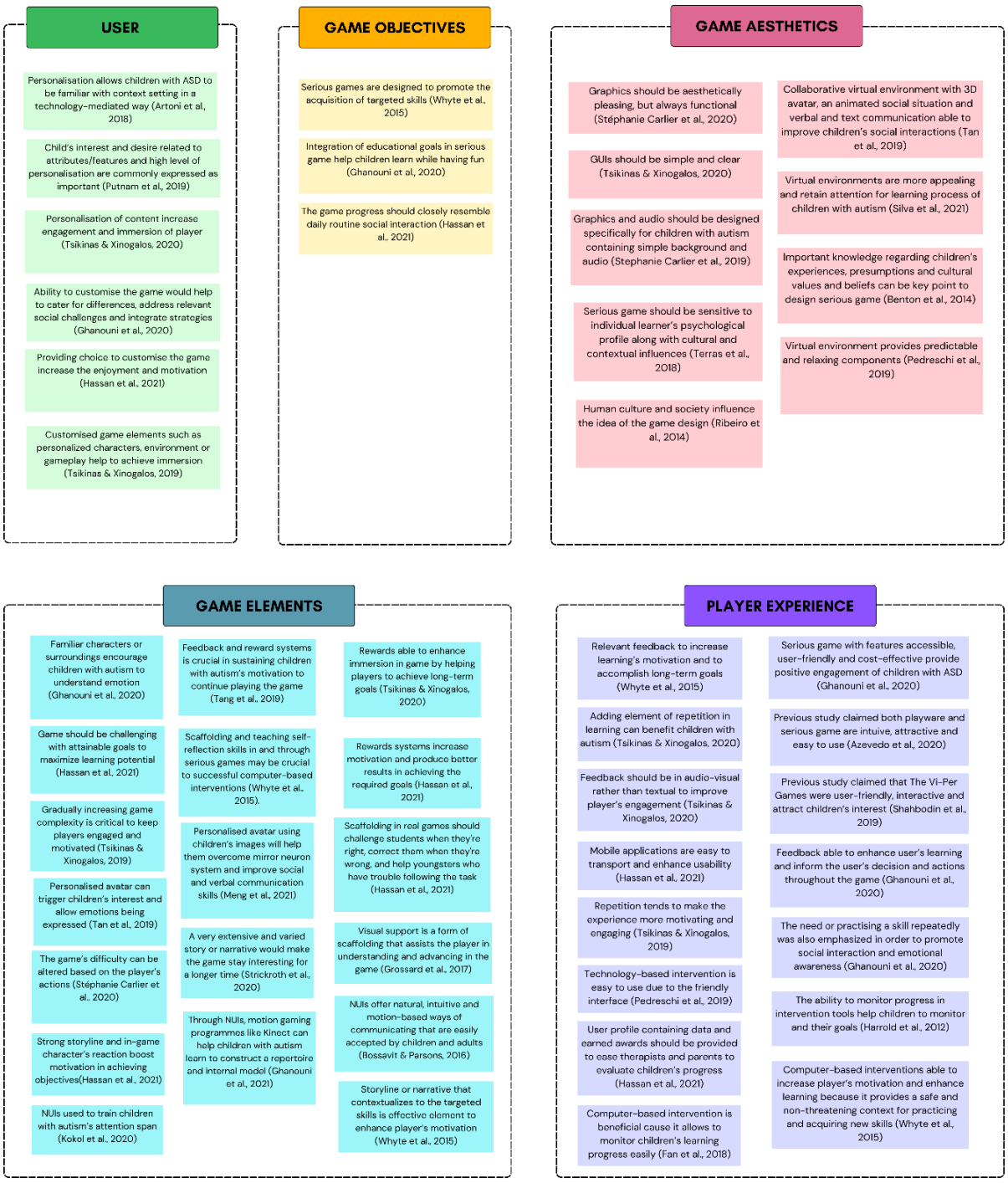

Fig. 1. First analysis: An iterative process in developing themes: user (green), game objectives (yellow), game aesthetics (pink), game elements (blue), and player experience (purple).

TABLE II. DESCRIPTION OF FIVE THEMES

Themes	Description	Colour coded
User	Represents the player profile.	Green
Game Objectives	Something that the player tries to achieve.	Yellow
Game Aesthetics	Sensory phenomena that the player encounters in the game/ Generalisation about art.	Pink
Game Elements	Components that make up the game.	Blue
Player Experience	Represents what the player goes through when playing the game.	Purple

In the second analysis, the themes were thoroughly examined to discover any possibilities for expanded sub-themes. As shown in Fig. 2, the User theme was refined to personalisation and customisation, the Game Objectives theme focused on the Individual Education Plan (IEP) goal of

children with autism, and the Game Aesthetics theme was narrowed to a graphical user interface, context settings, and virtual environment. The user was refined to personalisation and customisation in order to create a profile for children with autism, while the game objectives were refined to the individual education plan (IEP) goal since children with autism have specific IEP goals to achieve. Meanwhile, the game aesthetics theme was refined to include a graphical user interface (GUI), virtual environment, and context settings that are able to ensure the game can provide comfortable environments and resemble the daily life activities of children with autism.

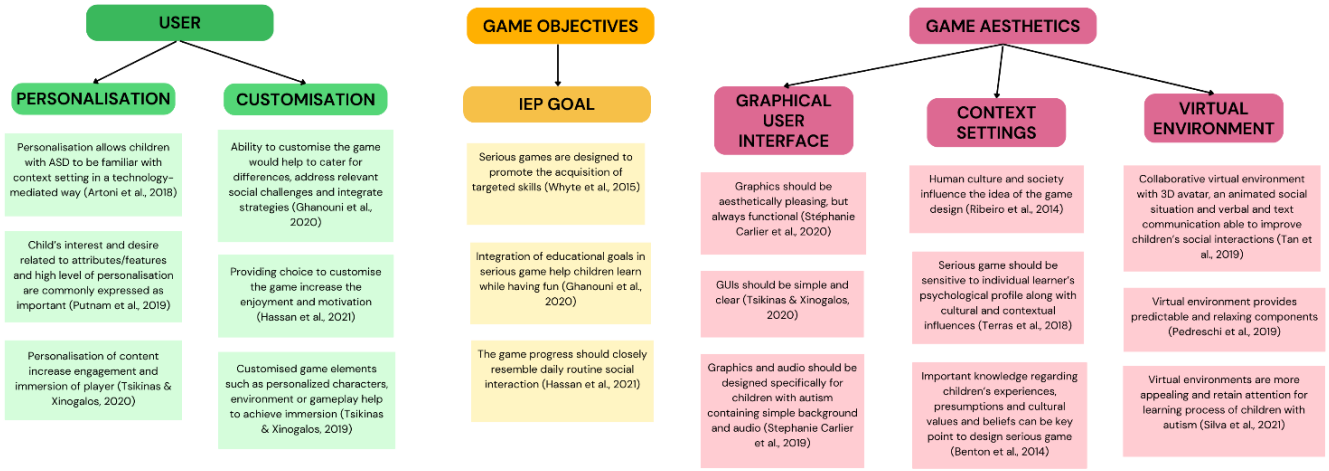

Fig. 2. Sub-themes for user, game objectives and game aesthetics.

Furthermore, in Fig. 3, the Player Experience theme was refined to feedback, repetition, usability, and monitoring in order to provide good responsive feedback and experience for children with autism when they interact with the game. Meanwhile, the Game Elements theme was clustered into level progression, character, interaction, rewards, storyline, and scaffolding, which refer to the components that fulfil the design principles of serious games. Thereby, Table III shows the expanded themes with more sub-themes.

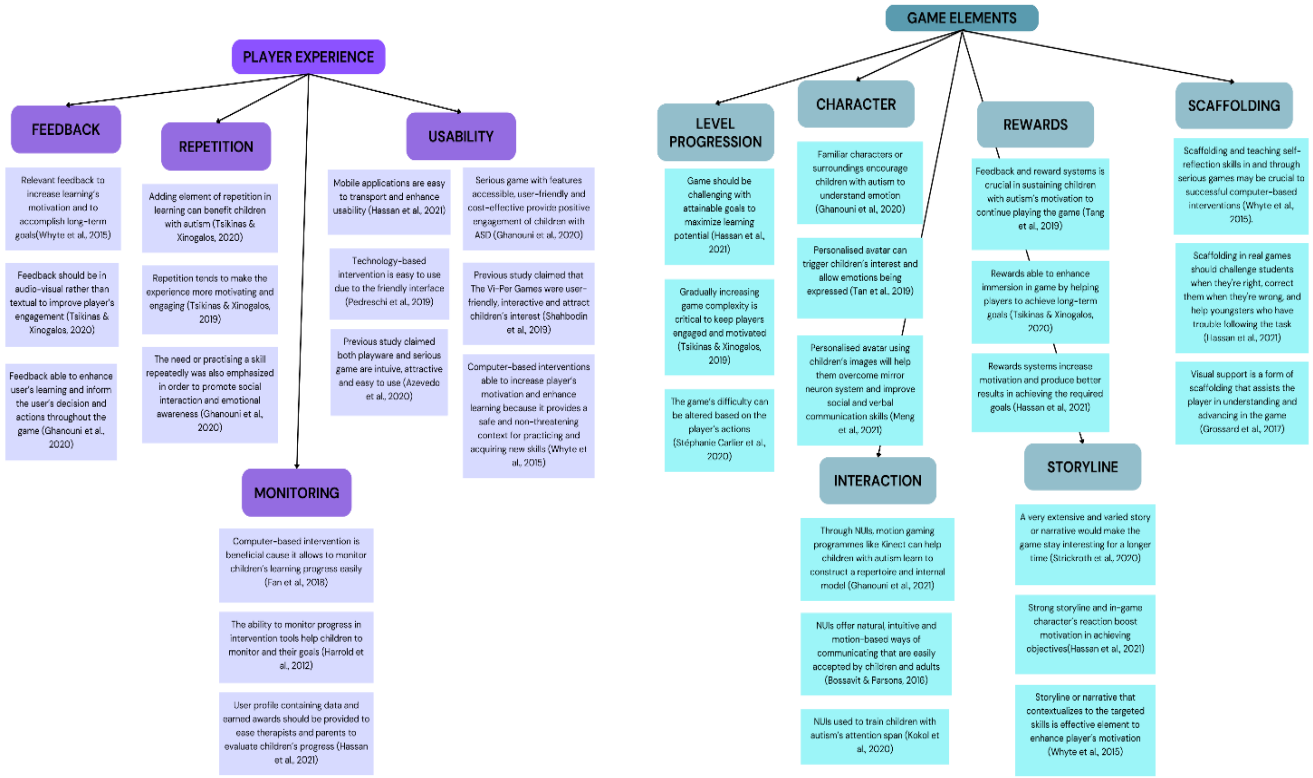

Fig. 3. Sub-themes for player experience and game elements.

TABLE III. RESULT OF SECOND ANALYSIS

Themes	Sub-themes	
User	● Personalisation	● Customisation
Game Objectives	● IEP Goal	
Game Elements	● Level progression ● Character ● Interaction	● Rewards ● Storyline ● Scaffolding
Game Aesthetics	● Graphical user interface (GUI) ● Virtual environment ● Context settings	
Player Experience	● Feedback ● Repetition	● Usability ● Monitoring

IV. RESULTS AND DISCUSSION

Through the comprehensive literature review on serious games for children with autism, Table IV is tabulated and presents the list of design principles for each of the components. There were 16 elements in the sub-themes found in this study, and they are clustered and organised into five attributes: (1) user, (2) game objectives, (3) game elements, (4) game aesthetics, and (5) player experience. This section briefly explains the five attributes of serious game design principles for children with autism.

TABLE IV. SERIOUS GAME DESIGN PRINCIPLES FOR CHILDREN WITH AUTISM

Attributes	Component	References
User	Personalisation	Allow content personalisation according to the needs [56-58].
	Customisation	Allow customising game elements to boost enjoyment and motivation [22, 52, 59].
Game Objectives	Individual education plan (IEP) goal	Specific targeted skills for children with autism to achieve that align with classroom activities [51, 53, 58].
Game Elements	Level progression	The game progression should gradually increase to motivate players [22, 52, 53].
	Character	Familiar and personalised character trigger children's interest [59-61]
	Interaction	Interactions should be natural and intuitive [59, 62, 63].
	Rewards	Player motivators [22, 23, 58].
	Storyline	Immersive, social-based stories and narratives [53, 64, 65].
	Scaffolding	Assist the player without controlling them through playing the game [22, 53, 66].
Game Aesthetics	Graphical user interface (GUI)	Visualisation should be clear, simple, and minimalist [12, 52, 67].
	Virtual environment	Provide immersive, relaxing, and attractive feelings by including animation, verbal, and text communication [61, 68, 69].
	Context settings	Culture and contextual influences should be considered [70-72].
Player Experience	Feedback	Relevant and responsive feedback should be considered to provide good engagement [52, 59, 65].
	Repetition	Repetition is needed to allow players to practise the targeted skills [58, 59, 73].
	Usability	The game should be easy to understand, safe, and child-friendly [53, 59, 68].
	Monitoring	Provide user profile containing data to monitor the progress [10, 22, 74].

A. User

A user is considered a person who uses or operates the video game. In this case, children with autism are considered the users of the serious games. Since children with autism have difficulty processing inputs and social signals, they struggle to recognise emotions in social interactions [75]. Thus, personalisation and customisation are found to enable prioritising the child's needs.

Personalisation is important for children with autism, as parents or teachers can personalise the game according to the child's capabilities. Moreover, personalisation features in the games should be familiar and relate to children's interest and desire to increase their engagement and immersion experiences. According to Artoni, et al. [56], personalisation allows children with autism to become familiar with context in a technology-mediated way. Additionally, personalisation of both technology accessibility [76], content [58, 77], and the child's interest [57] is a critical key point when developing serious games for children with autism to increase engagement and immersion. Hence, game designers must have specific requirements to develop serious games that meet the autistic child's needs, especially focusing on facilitating the development of emotion regulation.

Customisation is also one of the important elements in the user category because games should provide the ability to customise certain game elements to increase enjoyment and motivation as well as cater to the children's needs. According to end-users, such as parents and therapists, customisation should be considered to ensure that children with autism properly provide feedback patterns [21]. Certainly, the ability to customise the game would aid in accommodating diversity, relevant social challenges, and integrating strategies [59]. Moreover, the ability to customise the characters, environment, or gameplay helps to achieve immersion and enhance the perception of uniqueness [22, 52].

It is important to consider personalisation and customisation when designing and developing games for children with autism to allow teachers and parents to personalise and customise the game according to the targeted skills. In fact, personalisation and customisation in games would also give flexibility to children with autism.

B. Game Objectives

Usually, any video game would have specific contents or objectives that would keep the game enjoyable to explore. This study found that serious games should have specific targeted skills and certain goals to be achieved or improved. Hence, a serious game for children with autism should have clear goals based on the individual education program (IEP) goals that teachers and parents want the child to achieve. Significantly, it is a critical component in designing serious games for children with autism because it requires specific content that aligns with the IEP goal, especially in facilitating the development of emotion regulation.

According to Hassan, et al. [22], when designing a serious game, the game content should closely reflect daily life

activities to ensure that children with autism are able to apply the skills in real-life scenarios. Besides, Tang, et al. [65] and Whyte, et al. [53] concede that the game objectives should be clear and must be classified as medium-term or long-term goals to ensure that players display greater intrinsic motivation when playing the game. Moreover, a game should have specific and clear objectives that are aligned with classroom activities or the curriculum [58]. Therefore, game designers should consider to using the IEP goals of children with autism to ensure the learning and training process is engaging and the targeted skills are achievable.

C. Game Elements

Game element is a term that refers to anything that is utilised and included in designing and developing a video game. Moreover, game elements are also known as the components that make up a game, which are called game attributes. Through the analysis, this study highlights six elements that have a good impact on designing serious games for children with autism.

Level progression is a crucial element in delivering the necessary content at every moment, and it reinforces progress for the player through a game's systems and mechanics. Level progression in games should not be too easy to avoid amotivation and frustration for the player. Hassan, et al. [22] emphasised that games should be challenging with attainable goals to maximise learning potential. In fact, the complexity of the game should gradually increase to keep players engaged and motivated [52]. Simply put, serious games cannot be so difficult that players become frustrated or so easy that they never learn new abilities [53].

Aside from that, character is also an important element to be considered when developing serious games for children with autism because characters can retain the child's attention as the game continues [73]. This is because familiar characters or surroundings encourage children with autism to get immersed in the game, especially in understanding the emotion [59]. In fact, Papoutsi, et al. [78] concede that familiar characters also make the user feel more at ease and improve the learning process. For instance, a mobile game application demonstrated that the use of a personalised avatar based on children's own pictures may elicit their emotions when they participate and engage in the activity [61]. Moreover, Meng, et al. [60] emphasised that children with autism can overcome the mirror neuron system and improve social and verbal communications with a personalised avatar. To summarise, character creation is an important element in designing serious games because it helps the player feel more immersed and interested to keep playing the game.

Besides that, interactions in games such as natural user interface (NUIs) enable children with autism who have sensitivity to interacting with technology intervention to benefit because NUIs provide a natural feeling using modalities such as touch, gestures, or voices. In fact, current Human Computer Interaction (HCI) paradigms indicate that interfaces should be natural and intuitive, leveraging motion-based touchless interactions known as NUIs [79]. According to Ghanouni, et al. [80], motion gaming programmes like Kinect are able to facilitate children with autism in learning to create a repertoire of internal models through NUIs. For example, combining RGB cameras, depth detection, and careful user interface design in the Kinect visual sensor would provide better gaming and enjoyment experiences [62]. As a result, this study found that interactions play an important role in catering to the needs of children with autism.

This study also found that rewards provide a meaningful experience for children with autism since they can help motivate them to continue playing the game. Indeed, reward systems may be perceived as either motivators for players or as a means of mitigating disappointment [81]. In fact, Hassan, et al. [22] and Tsikinas and Xinogalos [58] concede that reward systems increase motivation and immersion in achieving medium-term and long-term goals. Additionally, Jouen, et al. [23] emphasised that gaming platforms offer a flexible and customisable manner of rewarding the player for achieving the objective, encapsulating the spirit of reward-based interventions. Eventually, when designing serious games for children with autism, designers should consider rewarding the player and the rewards should bring positivity to avoid frustration and give up.

Moreover, storylines in games are found to have a positive impact on children with autism by enhancing their motivation, attention, and interest in learning because they provide an interactive and immersive experience with a social-based context. Hassan, et al. [22] believe that a strong storyline and in-game characters' reactions are able to boost the player's motivation to achieve the objectives. In addition, a very extensive and varied narrative would keep the game interesting for a longer time [64]. A previous study also emphasised the importance of designing serious games underpinned by a motivating storyline to encourage players to keep playing [53, 65]. Therefore, this study concedes that a strong storyline with a social-based context is able to enhance social skills, foster intrinsic motivation to learn, and encourage them to pay attention.

Scaffolding is one of the strategies used in developmental learning and teaching. This is because scaffolding provides just enough assistance to ensure the children are successful in completing the given tasks on their own. This is why scaffolding can be an important element in designing serious games for children with autism. In fact, the affordances created by movement-driven avatars may have provided the best context for scaffolding engagement in autistic children [82]. Furthermore, Whyte, et al. [53] concede that scaffolding elements in serious games play an important role in successful game-based interventions as they intrinsically enhance the children's motivation to keep playing and learning. Certainly, scaffolding in games is a form of assistance to the player through playing the game by challenging them and correcting them in completing the tasks [22, 66]. Therefore, the game should include scaffolding elements to initiate engagement and interaction between player and game or player and peer, aside from assisting them through the game's progress.

D. Game Aesthetics

The sensory phenomena that players encounter in the games, such as visual, auditory, haptic, or embodied, are referred to as game aesthetics. Game aesthetics are an

expression of the game because the game itself needs precise degrees of interaction to function properly. Annetta [83] mentioned that visualisation is a powerful cognitive approach, and researchers have recognised it as an essential problem-solving strategy.

This study found that in designing serious games for children with autism, it is important to ensure the graphical user interface (GUI) is simple, clear, and minimalist. Subsequently, by improving the GUI design, higher usability and acceptance are able to be achieved [67]. In fact, children with autism may be overwhelmed and abandon the game or be distracted if the GUIs are complex, so the GUIs should be simple, clear, and appropriate [58]. In addition, to make the experience more user-friendly, researchers use basic and clear images with clear font text, huge navigation buttons presented clearly, and simple virtual reality aspects to avoid player distraction [52]. Carlier, et al. [12] concede that graphics and audio should be aesthetically pleasing but always functional. Hence, the GUIs in serious games for children with autism should be displayed clearly, not overlapped, and the use of colour should be minimised.

Immersion and engagement are important to attract the attention of children with autism, increase their attention span, and motivate them to keep playing. Thus, this study found that a virtual environment is able to teach children with autism to adapt to different situations in a safe way due to its feasibility. Additionally, children with autism can enhance their social interactions and comprehension by using collaborative virtual environments that include a 3D expressive avatar, an animated social setting, and verbal and text communication [61]. In fact, virtual environments are considered autistic-friendly because they provide predictable and relaxing feelings [68]. Moreover, virtual environments are appealing and able to retain the attention of children with autism in the learning process [69]. Hence, the simulated real world with 3D representations in a virtual environment is able to elicit interaction, the feeling of immersion, and the imagination of children with autism.

Other than that, context settings, localities, and cultural elements have been found to be considered when designing serious games for children with autism. This is because cultural and contextual settings would influence positive engagement. Ribeiro, et al. [71] concede that human culture and society influence the idea of game design. Besides that, important knowledge regarding children's experiences, presumptions, and cultural values and beliefs can be key points in designing serious games [70]. Additionally, developers should be sensitive to an individual learner's psychological profiles along with cultural and contextual influences when designing games [72]. Thus, the game elements should be integrated with cultural and contextual settings to provide familiarity to children with autism.

E. Player Experience

Serious games will be useless if the user finds them no longer engaging and entertaining, which means that a poor implementation would make it impossible to develop a game with a solid theoretical foundation. Moreover, immersion and exciting feelings in games entail more than just enjoying the game's storyline, graphics, and other game elements. Therefore, in designing a serious game, especially for children with special needs such as autism, player experience should be contemplated.

This study found that feedback is important to provide a response between the player and the game through playing sessions. Indeed, it is also able to increase learning motivation and accomplish long-term goals [53]. Furthermore, feedback is needed in the game to inform the user's decision and action throughout the game, besides enhancing the user's learning [59]. Tang, et al. [65] emphasised that feedback in the game should be natural and provided through visual feedback such as text or animation. Additionally, Abirached, et al. [21] and Tsikinas and Xinogalos [58] concede that feedback in serious games for children with autism should be in an audio-visual format rather than textual to improve the player's motivation and maintain a high level of engagement. For instance, a previous study mentioned that the utilisation of appropriate immediate feedback in a serious game environment can lead to a state of flow or total engagement and immersion [84]. Thus, the feedback provided in the game should be audible or visual to maintain engagement, sustain motivation, and assist the players in game progress and performance.

Repetition, also known as repeatability, is the extent to which a player might want to play the game again after completing it once or more. In designing serious games for children with autism, it is crucial to allow repetition as the game progresses. This is because repetition tends to make the experience more motivating and engaging, which would benefit children with autism in acquiring certain skills [58]. This is supported by Ghanouni, et al. [59], where the value of repeated practice skills was beneficial to foster the development of social interaction and emotion recognition for children with autism. Repetition features in serious games for children are considered important because they can determine the player's mastery level and also make it possible to anticipate the following task [73]. Thus, repetition is a must because children with autism might want to repeat the game even though they accomplished it, possibly due to huge interest.

Besides that, usability is found to be another element that should be highlighted when designing serious games for children with autism to ensure the game is user-friendly, easy to use, and safe for the children. Technology-based intervention, such as mobile applications, web applications, or serious games, is easy to use due to the friendly interface that consists of interactive features that are able to attract children's interest [22, 68]. Importantly, serious games with accessible features, user-friendly, and cost-effective bring positive engagement from children with autism [59]. In addition, it is also able to increase the player's motivation and enhance the learning process as it provides a safe and non-threatening context to practice and acquire new skills [53]. In fact, the rise of toddler-friendly touch screens has had a positive effect on educational approaches for autism [85]. Then, developers should consider the usability of serious games when designing for children with autism.

Additionally, monitoring features have been found to be a crucial element in designing serious games for children with

autism because they provide accessibility, not only for the children but also for their parents, teachers, and therapists. It allows them to monitor the developmental progress of children with autism. Fan, et al. [10] mentioned that computer-based intervention is beneficial for parents and teachers because it can allow easy monitoring of the children's learning progress. This is why developers should consider having user profiles containing data and earned awards in the game to ease the teachers, therapists, and parents evaluation of the children's progress [22]. Moreover, the ability to monitor progress using intervention tools would help teachers and parents facilitate and support the child in developing their skills [74]. Thereby, monitoring progress is important in designing serious games for children with autism to allow teachers and parents to evaluate the developmental progress of the children's skills.

V. CONCLUSION

In conclusion, serious games show promising outcomes in many approaches to facilitating and supporting children with autism by enhancing a range of abilities. Significantly, serious games have shown to be quite beneficial in facilitating autistic people in enhancing their social and emotional domains, such as emotion regulation. This is because the player's emotions can be awakened to attain the game goals, accept challenges, follow game rules, engage with the game world, respond to feedback, or comprehend the game narrative.

Therefore, this study highlights the serious game design principles that should be included when designing a serious game for children with autism to develop their skills, especially emotion regulation skills. This study shows a significant presence of more appropriate design principles for developing serious games for children with autism by deeply understanding their needs and requirements. Therefore, a summary of the serious game design principles is presented in Table V.

TABLE V. A SUMMARY OF SERIOUS GAME DESIGN PRINCIPLES FOR CHILDREN WITH AUTISM

Design Principles	Recommendations
User ● Personalisation ● Customisation	The game should be able to be customised and personalised according to the abilities of children with autism.
Game Objectives • Individual education plan (IEP) goal	The game should have specific targeted skills that are aligned with each child's IEP goal or classroom activity.
Game Elements ● Level progression ● Character ● Interactions ● Rewards ● Storyline ● Scaffolding	The game elements should make the children feel connected to the game and increase their motivation to keep playing the game.
Game Aesthetics ● Graphical user interface (GUI) ● Virtual environment ● Context settings	The game aesthetics should be simple and minimalist, especially for children with autism, to avoid distraction.
Player Experience ● Feedback ● Repetition ● Usability ● Monitoring	The game should be responsive to player engagement and immediately respond to the player's interaction.

Besides that, the proposed serious game design principles that have been elicited from the existing study would undergo a validation process by experts, including special education teachers, academicians, and serious game experts who are experienced in developing serious games for special needs. A focus group discussion will be conducted to validate the proposed serious game design principles that have been identified in this study as suitable for designing serious games for children with autism. The feedback and suggestions from teachers and experts will be used to strengthen the serious game design principles for children with autism.

On the other hand, it is anticipated that these findings will serve as a guide for future researchers and future game developers who are interested in developing serious games for children with autism to facilitate their development skills, especially in supporting the development of emotion regulation. Following that, after the validation process in the focus group discussion, a prototype will be developed and tested with children with autism to identify the engagement and effect on their skill development.

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