Pioneering a New Era in Mental Health Treatment: A Framework for Virtual Reality Serious Game Design

By Timothy John Pattiasina

WORD COUNT	6861	TIME SUBMITTED	08-APR-2025 11:31AM
		PAPER ID	115574062

2024 International Conference on Information Technology Systems and Innovation (ICITSI)
Bandung, December 12, 2024

Pioneering a New Era in Mental Health Treatment: A Framework for Virtual Reality Serious Game Design

Timothy John Pattiasina
Department of Electrical Engineering and Informatics,
Universitas Negeri Malang
Malang, Indonesia
timothy.john.2305349@students.um.ac.id

Harits Ar Rosyid
Department of Electrical Engineering and Informatics,
Universitas Negeri Malang
Malang, Indonesia
harits.ar.ft@um.ac.id

Anik Nur Handayani
Department of Electrical Engineering and Informatics,
Universitas Negeri Malang
Malang, Indonesia
aniknur.ft@um.ac.id

Hartarto Junaedi
Department of Business Information System,
Institut Sains dan Teknologi Terpadu Surabaya
Surabaya, Indonesia
aikawa.@stts.edu

Edwin Meinardi Trianto
Department of Informatics Management,
Institut Informatika Indonesia Surabaya
Surabaya, Indonesia
edwin@ikado.ac.id

David Saputra Octadianto Soedargo
Department of Informatics,
Institut Informatika Indonesia Surabaya
Surabaya, Indonesia
david@ikado.ac.id

***Abstract*— Virtual Reality Serious Games (VRSG) present an innovative approach for treating Social Anxiety Disorder (SAD), offering users safe, simulated environments to practice social interactions. This study pioneers a VRSG framework grounded in Social Learning Theory (SLT), which emphasizes learning through observation and behavioral modeling. By integrating SLT's key components—attention, retention, reproduction, and reinforcement—the VRSG fosters an effective therapeutic environment that encourages users to observe, remember, and reproduce social behaviors, ultimately aiming to reduce social anxiety and enhance social efficacy. The VRSG design aligns with Bloom's Revised Taxonomy, structuring behavior change objectives to match participants' learning needs and promoting interaction and cognitive engagement according to Bandura's mediational processes. Early evaluations suggest that our VRSG design facilitates confidence-building and anxiety reduction, opening new avenues for intervention in SAD treatment. Future work will involve empirical validation of these guidelines, further VRSG refinement based on user feedback, and the development of a prototype tailored for therapists. This prototype, co-designed with mental health professionals, will enhance the real-world utility of VRSG in therapeutic settings, expanding its application to SAD and potentially other psychological disorders.**

Keywords*— *virtual reality, serious games, social anxiety disorder, social learning theory, bloom's revised taxonomy

I. INTRODUCTION

The intersection of advanced technologies such as Artificial Intelligence (AI) and Virtual Reality (VR) with psychotherapeutic approaches has fostered innovative interventions within mental health care, resulting in hybrid treatment modalities that hold the potential for enhanced therapeutic outcomes [1]. Among these technologies, Virtual Reality Serious Games (VRSGs) have gained recognition as a promising alternative for addressing various mental health challenges, particularly Social Anxiety Disorder (SAD). Unlike previous applications of VR for therapy, our study proposes a VRSG framework specifically designed around Social Learning Theory (SLT) principles to target SAD. This approach underscores the role of observational learning in encouraging prosocial behaviors and improving therapeutic efficacy for SAD, a condition that involves intense anxiety in social interactions [2].

VRSG leverages the immersive and interactive qualities of VR to create a safe, controlled environment for individuals to confront and manage their social fears [3]. Recent advancements, including high-resolution head-mounted displays (HMDs), room-scale tracking, and haptic feedback, have significantly enhanced VR's therapeutic potential [4]. However, challenges remain in achieving optimal engagement and therapeutic effectiveness, particularly in tailoring VRSG experiences to meet specific therapeutic needs. Our approach addresses these issues by focusing on SLT-based observational learning as a core framework for the VRSG, with customizable elements to meet diverse therapeutic preferences.

SAD is a pervasive condition marked by a profound fear of social situations and potential scrutiny, significantly affecting individuals' daily functioning and quality of life [5]. Traditional therapies like Cognitive Behavioral Therapy (CBT) have shown efficacy in SAD treatment, yet they often lack real-world exposure opportunities, limiting the scope of practice and confidence-building for patients [6]. By facilitating immersive social scenarios that mimic real-life interactions, VRSG provides controlled, progressive exposure, which has been underutilized in previous SAD interventions [7].

Albert Bandura's SLT emphasizes observational learning, imitation, and modeling as mechanisms for acquiring new behaviors, suggesting that individuals learn not only by direct practice but also through observing and internalizing others' actions and emotional responses [8]. SLT's core processes—attention, retention, reproduction, and motivation—are essential for behavioral acquisition and

2024 International Conference on Information Technology Systems and Innovation (ICITSI) | 979-8-3315-1147-0/24/$31.00 ©2024 IEEE | DOI: 10.1109/ICITSI65188.2024.10929457

change [9], offering a structured approach that aligns well with therapeutic goals in VR settings [10]. Our VRSG framework leverages SLT to create structured, immersive therapeutic experiences that encourage skill acquisition through observational learning, filling gaps observed in prior VR interventions for SAD [11] - [13].

To enhance engagement and align with learning objectives, Bloom's Revised Taxonomy [14] is employed to structure behavior change goals and guide the design of the VR environment [15]. This framework includes a thorough assessment of the target population's needs, with SLT-aligned objectives specifically tailored to enhance active participation, skill-building, and social efficacy. Social elements embedded within the VR environment facilitate collaboration and interaction, which are critical for fostering self-efficacy and social competence in individuals with SAD [16]. Furthermore, Bandura's mediational processes inform the design guidelines, enhancing the cognitive aspects of therapy to make it engaging, memorable, and effective [17]. By combining VR's immersive qualities with SLT's behavioral change principles, this study introduces a distinct therapeutic approach for SAD that aims to promote lasting behavioral change.

Unlike prior research, which focused mainly on exposure without structured observational learning, this framework introduces an SLT-based VRSG model that promotes progressive behavior change for SAD, complementing traditional therapy. Preliminary evidence suggests that VR interventions, particularly VR exposure therapy, show promise in addressing social anxiety, with studies indicating higher scores on the Liebowitz Social Anxiety Scale (LSAS) compared to traditional CBT [18]. Key features of this approach, such as dynamic role-playing, real-time feedback, and social context integration, enhance therapeutic progress. The following sections explore the theoretical foundations, design recommendations, and potential therapeutic implications of this VR-based SLT approach for SAD.

II. Game Mechanics and Cognitive Framework

Serious games are games that integrate educational content with an interactive game format to fulfil two aims: promoting the transfer of learning and ensuring engagement and entertainment [19]. The challenge is to balance these goals, and in the case of serious games this is achieved by leveraging qualitative game-based mechanics [20] that are designed to encourage learning while maintaining participant engagement [21]. While there are many known opportunities for Serious Games in education; how to design these games so that they serve their dual purpose is still under discussion.

1. Facility the transfer of learning into practical and useful educational tools.
2. Making the experience fun and engaging to be considered games.

When developing Serious Games for mental health treatment, it's crucial to strike a balance between educational content and entertainment [22]. The challenge is ensuring that neither aspect overshadows the other. If the game feels too much like therapy, it can become repetitive and unengaging, losing its ability to keep players interested [23]. On the other hand, if it's too focused on entertainment, it may captivate players but miss its therapeutic goals, ultimately failing to deliver the intended mental health benefits.

This balance is closely related to the basic elements of the game, known as game mechanics. Game mechanics refer to the core practices, strategies, and rules that define player interaction [24]. They determine how players engage with the game environment, face challenges, and make progress. Well-designed game mechanics not only need to capture fun but also seamlessly incorporate mental health objectives and facilitate therapeutic outcomes. Achieving this requires careful design, with therapeutic goals embedded in the technology, resulting in an engaging and effective immersive experience for mental health treatment.

From a scientific perspective, theories of mood and motivation should be incorporated into the design of game technology for mental health treatment [25]. According to cognitive load theory [26], the medical content of a game should be presented in a way that does not overwhelm players' mental resources, allowing them to efficiently manage and retain treatments Similarly for self-determination theory emphasizes the importance of autonomy, skill, and interconnectedness for sustaining player motivation and engagement [27]. Thus, game mechanics must be designed so that players develop a sense of control, opportunities to discover coping skills, and social relations within the game.

Research shows that effective serious games for mental health balance intrinsic and extrinsic motivations [28]. Intrinsic factors, such as the satisfaction of learning and improvement, keep players engaged [29], while extrinsic factors, like rewards and feedback, enhance therapeutic outcomes [30]. Aligning game features with these motivators ensures that serious games are both engaging and beneficial for mental health treatment.

The Revised Bloom's Taxonomy categorizes cognitive skills into six levels [31], like the original taxonomy but with notable changes. In the revised version, the sixth level (evaluation) is moved to the fifth position, and the naming of levels has been changed from nouns to verbs, reflecting a more dynamic understanding of learning processes [32].

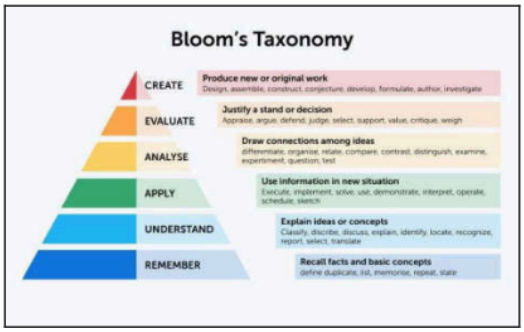

Fig. 1. The Revised Bloom's Taxonomy Model [33]

To improve the efficacy of serious game therapy for mental illness, it is useful to harmonize game mechanics with this revised classification, and to ensure that therapeutic interventions are structured to promote mindfulness development has taken place through these six stages:

a. Remember: Game mechanics should include features that help players remember coping mechanisms and therapeutic strategies. This can be done through repeated exposure and in-game learning, ensuring that the players retain the important information.

b. Understand: The game should include information that requires players to explain concepts or demonstrate understanding in their own words. For example, the game allows players to explain coping mechanisms to a virtual character to ensure they understand how to use them.

c. Apply: The mechanic should encourage players to use learned skills in different scenarios. For example, a game might simulate social situations in which players must use coping strategies to manage anxiety.

d. Analyse: Players should be encouraged to break down information and understand the relationships between different elements. For example, a game might challenge players to analyze the triggers for their social anxiety and develop strategies to deal with it.

e. Evaluate: The game should include mechanics that require players to make decisions based on values and standards. For example, players can be asked to evaluate the effectiveness of different coping strategies in different situations and choose the best one.

f. Create: Finally, game mechanics should foster creativity by encouraging players to develop new strategies or modify existing ones. This may involve developing their own coping mechanisms or creating situations in which new skills appear to be applicable.

The Revised Bloom's Taxonomy provides a detailed and comprehensive framework for categorizing learning by dividing it into two key dimensions: types of knowledge and cognitive processes [34]. Additionally, this work establishes a foundational design framework to guide future research in this area.

III. Social Learning Theory and Bloom's Taxonomy for Effective Design

Social Learning Theory (SLT), developed by Albert Bandura, emphasizes the importance of observing, modeling, and imitating the actions, attitudes, and emotional responses of others [35]. SLT suggests that learning takes place in a social context in and can only be by observation or direct instruction, regardless of embodiment or direct reinforcement [36]. Bandura have identified four key components for learning to occur:

1. Attention: To learn, individuals must pay attention to the model. Attention is influenced by the observer's traits (e.g., sensory capacity, arousal, past reinforcement) and the model's traits (e.g., attractiveness, competence, similarity).
2. Retention: This involves remembering what the model represented. Psychosomatic rehearsal and cognitive processing of learned objects can influence retention.
3. Reproduction: This is the ability to reproduce or mimic observed behavior. This involves the transformation of symbolic images into appropriate actions, which requires the necessary physical and cognitive abilities of the viewer.
4. Reinforcement: This refers to the consequences of performing a behavior, which can influence the likelihood that the behavior will be repeated. Reinforcement can be external, substitute, or self-generated.

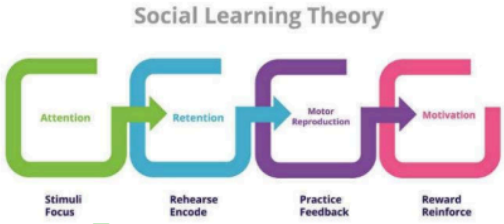

Fig. 2. Albert Bandura's Social Learning Theory [37]

Combining Social Learning Theory with Bloom's Revised Taxonomy creates a robust framework for crafting impactful educational experiences, including serious games aimed at mental health treatment. This approach is especially useful for tackling social anxiety disorder (SAD) using Virtual Reality Serious Games (VRSG). The design framework in Figure 3 shows the integration mentioned.

Fig. 3. VRSG Framework for SAD Using SLT and Bloom's Taxonomy

The following explanation offers an in-depth analysis of the framework's components, highlighting how SLT principles are systematically aligned with Bloom's cognitive levels to effectively target SAD.

A. Attention and Remember

In line with Bloom's first cognitive level, Remember, the SLT component of Attention can be supported by game mechanics that captivate the player's focus through engaging and relatable models. This ensures that players remember critical therapeutic techniques and information. For example, virtual characters demonstrating coping strategies in various scenarios can help players recall these strategies by observing and remembering their actions. This is crucial for individuals with SAD, as observing successful social interactions can help them internalize these behaviors.

B. Retention and Understand

The Retention component aligns with the "Understand" level of Bloom's taxonomy. Game mechanics should help players retain observed behaviors by encouraging them to explain and discuss coping strategies. For individuals with SAD, this reinforcement is crucial in enhancing their ability to remember and apply effective social strategies.

C. Reproduction and Apply

Reproduction aligns with the "Apply" level of Bloom's taxonomy, where players use learned behaviors in new situations. Game mechanics should help players practice coping strategies in simulated scenarios, building confidence for real-world social interactions, especially for individuals with SAD.

D. Reinforcement and Evaluate

Reinforcement ties to the "Evaluate" level of Bloom's taxonomy. Game mechanics should offer feedback and rewards to help players assess their coping strategies and make adjustments. For individuals with SAD, this feedback is crucial for tracking progress and identifying areas for improvement.

E. Advanced Cognitive Levels - Analyse and Create

SLT's principles can extend to Bloom's higher levels, such as "Analyse" and "Create." Game mechanics should encourage players to analyze the components of their anxiety triggers and develop new coping strategies, fostering deeper cognitive processing. Players could be tasked with designing personalized coping plans or creating new social scenarios to practice their skills, promoting creativity and analytical thinking. This higher-order thinking is particularly beneficial for those with SAD, as it empowers them to understand and control their anxiety.

IV. VRSG Design Guidelines using Social Learning Theory

Social Learning Theory (SLT) offers a effective framework for designing Virtual Reality Serious Games (VRSG). Albert Bandura's SLT underscores the significance of gaining knowledge of via remark, imitation, and modeling, supplying a robust basis for growing healing tools that deal with social tension. By integrating Social Learning Theory's (SLT) key components—attention, retention, duplicate, and reinforcement—into VRSG, builders can create immersive environments that now not best engage customers however also promote the acquisition and application of crucial social capabilities [38].

Three professional therapists and psychologists have contributed precious insights into the design suggestions, emphasizing the significance of commentary-based totally gaining knowledge of, immersive environments for modeling behaviors, and reinforcement mechanisms to positively affect healing outcomes, making sure effective, evidence-based interventions for managing and overcoming social tension.

A. Attention

In order for users to focus on medical issues, the VRSG should include interesting and relevant scenarios that accurately mimic real-life interactions. These scenarios should be carefully structured to reflect the circumstances and situations in which social anxiety is most likely to manifest itself. Features such as interactive avatars, virtual systems, and dynamic events can greatly enhance the user's immersive experience, helping to better capture and retain their attention [39]. The design recommendations for this factor are as follows:

1. Diverse Social Contexts within VRSG:
   - Create VRSG settings that mimic diverse social contexts like classrooms, offices, and public spaces.
   - Make these environments detailed and dynamic, adapting to user actions.
   - Include spontaneous events like conversations and group activities to keep users engaged.
2. Gamification Elements for Motivation:
   - Integrate gamification elements like levels and rewards to motivate users.
   - Gradually increase scenario difficulty to build confidence and competence.
   - Provide immediate feedback and post-interaction summaries for reflection and improvement.
3. Engaging Scenarios for Learning and Retention:
   - Design realistic social scenarios with adaptive elements that adjust to user performance, offering personalized challenges and feedback.
   - Include interactive role-playing with immediate feedback, allowing users to make decisions and reflect on their actions.
   - Gradually increase scenario complexity to build confidence, incorporating emotional elements to enhance engagement and retention.

B. Retention

To aid memory retention within VRSG, it is crucial to design scenarios that are clear, structured, and conducive to

learning. These scenarios should incorporate repetitive and reinforcing elements to reinforce memory encoding and retrieval processes. Additionally, the integration of visual and auditory cues can further enhance the effectiveness of memory retention strategies within the virtual environment [40]. The following are the design guidelines for this component:

1. Clear and Contextual Learning:
   - Define clear objectives with a step-by-step progression.
   - Embed learning in relevant, real-life contexts for better comprehension.
2. Repetitive and Chunked Information:
   - Repeat key concepts in different contexts to reinforce memory.
   - Break information into small chunks to ease processing.
3. Interactive Engagement with Feedback:
   - Encourage active participation using interactive tasks and consistent visual and auditory cues.
   - Provide immediate feedback and ensure a logical sequence of learning activities.

C. *Reproduction*

In VRSG, it is essential to provide users with numerous opportunities to practice and replicate observed behaviors within a safe and controlled environment. This can be accomplished through the incorporation of role-playing scenarios and interactive feedback mechanisms, both of which contribute to a more comprehensive and effective learning experience [41]. The design suggestions for this component are outlined below:

1. Role-playing Scenarios with Varying Difficulty Levels:
   - Develop a series of VRSG scenarios that gradually increase in complexity, simulating social interactions from basic to challenging situations.
   - Each scenario should vary in difficulty, featuring different social dynamics, communication challenges, and emotional triggers.
   - This variety allows users to practice coping strategies in diverse contexts, fostering gradual skill development and building confidence in social situations.
2. Real-time Feedback Mechanisms:
   - Introduce real-time feedback mechanisms that offer immediate, personalized insights on user performance during social interactions.
   - Ensure feedback is specific, pinpointing strengths and areas for improvement, enabling users to adjust behavior and communication in real-time.
   - Use visual and auditory cues, like facial expressions, tone of voice, and virtual gestures, to reinforce feedback effectively.
3. Role-playing Features for Perspective-taking:
   - Integrate role-playing features for users to take on different social roles and perspectives.
   - Allow users to experience various personas, such as conversation initiator or active listener, to tackle diverse social dynamics.
   - Role-playing enhances empathy and communication skills by providing multiple viewpoints.

D. *Reinforcement*

Positive reinforcement is a key component of behavioral adoption and skill development, especially in virtual reality serious games (VRSG) effective reward systems combined play an important role in encouraging and consuming desirable behaviors in the intervention phase [42]. VRSG programs should prioritize reward mechanisms that provide immediate and continuous feedback on implementation, ensuring rapid and effective reinforcement of be practices. By incorporating these reward systems, VRSG can create a supportive and motivating environment that facilitates behavior change and skill acquisition. Suggestions for this feature are listed below:

1. Immediate Positive Feedback:
   - Implement a reward system that provides immediate positive feedback for successful interactions.
   - Rewards like points, badges, or verbal praise can be earned by users for demonstrating desired behaviors or reaching milestones within the VRSG environment.
2. Long-term Progress Tracking:
   - Implement long-term progress tracking features to motivate continued use of the VRSG and drive improvement.
   - Use visual indicators like progress bars, levels, or virtual trophies to represent achievements and milestones, encouraging ongoing engagement.
3. Social Reinforcement and Community Support:
   - Enable social reinforcement by integrating multiplayer interactions or community support features.
   - Allow users to connect with others, share experiences, and receive peer feedback, creating a supportive and collaborative VRSG environment.

Integrating Social Learning Theory (SLT) principles into Virtual Reality Serious Games (VRSG) for treating Social Anxiety Disorder (SAD) provides a distinctive framework that enhances therapeutic outcomes through structured observational learning, as defined by SLT. Prior studies focusing on VR-based interventions for social anxiety have

979-8-3315-1147-0/24/$31.00 ©2024 IEEE

primarily emphasized exposure therapy alone, which lacks the structured, SLT-based feedback mechanisms crucial for reinforcing learned behaviors [43] - [45]. Studies that utilize gamified environments often employ static or repetitive scenarios that do not dynamically adapt to users' actions or track progress over time, thereby reducing opportunities for skill reinforcement within varied, realistic social contexts [46] - [48].

Our VRSG framework addresses these gaps by directly applying SLT's core behavioral change mechanisms—attention, retention, reproduction, and reinforcement—in a cohesive, interactive design tailored specifically for social anxiety treatment. This model creates detailed, realistic social scenarios that enable users to observe, practice, and reinforce social skills within a controlled and safe setting. Unlike traditional VR-based therapies, which typically lack adaptive feedback and structured reinforcement essential for behavior modification in social anxiety contexts, our approach incorporates gamification elements like progressive rewards and real-time feedback, fostering an engaging experience that has shown promising preliminary results in building social skills and alleviating anxiety in practice settings. Additionally, compared to conventional CBT approaches, which typically focus on static, one-size-fits-all interventions, our framework offers dynamic, personalized interaction within virtual environments, enhancing the potential for behavior modification.

Based on a literature review examining virtual reality exposure therapy and serious games within cognitive behavioral therapy stages [49], this study underscores how integrating psychological principles into game design can enhance mental health treatment outcomes. This ensures that patients, as players, not only engage with the game but also receive meaningful therapeutic benefits through a structured, comprehensive process. Findings reveal promising avenues for further exploration, positioning VR-based serious games as an effective therapeutic alternative for addressing social anxiety disorder.

Implementing VRSG based on SLT for SAD presents several challenges that must be addressed, including the complexity of designing realistic and engaging social scenarios aligned with SLT principles, the technical requirements for developing adaptive feedback systems, and ensuring accessibility for diverse users, including those with limited familiarity with VR technology. Achieving a cost-effective and scalable solution while maintaining therapeutic efficacy is also a significant hurdle [50]. However, by exploring the possibilities of combining VRET, serious games, and smartphone technology within CBT for social anxiety, there is an opportunity to revolutionize the field [51]. This approach could offer individuals a more effective, engaging, and accessible path to overcome social anxiety, ultimately enhancing their quality of life. Overcoming these challenges will be crucial in refining the framework and ensuring its practical application in real-world therapeutic settings.

The results of this study present the development of a VRSG framework for Social Anxiety Disorder (SAD), designed using principles from Social Learning Theory (SLT) and Bloom's Taxonomy, intended for implementation in a mobile-based application. This framework aims to enhance user engagement, foster a stronger sense of mastery, and improve satisfaction in social interactions, addressing the limitations of traditional VR approaches. These findings align with previous studies demonstrating the therapeutic potential of VR-based interventions. For instance, VR exposure therapy has been shown to achieve higher Liebowitz Social Anxiety Scale (LSAS) scores compared to CBT alone, emphasizing its efficacy in addressing social anxiety [52]. Similarly, short-term individual CBT sessions integrated with VR have proven effective, suggesting that even brief, targeted interventions can yield significant therapeutic outcomes [53]. Serious games such as *ReWIND* [54] and the *Social Phobia Game* [55] have further validated the value of gamified approaches in anxiety management, with findings highlighting reduced anxiety symptoms, enhanced self-awareness, and improved control over social anxiety. Building on these insights, the proposed VRSG approach incorporates dynamic role-playing scenarios, real-time feedback, and diverse social contexts, creating an immersive and adaptive environment. By integrating SLT-based behavioral guidelines, this model represents a significant advancement in therapeutic gaming for social anxiety disorder.

V. Conclusion

This study highlights the potential of Virtual Reality Serious Games (VRSG) to enhance the treatment of social anxiety disorder (SAD) by applying the principles of social learning theory (SLT). By incorporating SLT components—attention, retention, reproduction, and reinforcement—VRSG can create a structured and effective therapeutic environment that fosters observational learning and facilitates behavior change. This approach offers a novel method for addressing SAD, leveraging VR technology to simulate social interactions in a safe, controlled setting, which may improve treatment outcomes.

Future work will focus on conducting empirical studies to validate the design guidelines and further refine the VRSG framework, incorporating user feedback, clinical outcomes, and integration with cognitive behavioral therapy (CBT) principles. A pilot study involving 50-100 participants with SAD will assess effectiveness using validated tools such as the Liebowitz Social Anxiety Scale (LSAS) and engagement metrics. Initial usability testing will inform refinements, followed by a controlled study comparing VRSG outcomes with traditional therapies, including CBT-based interventions. Moreover, a prototype tailored to therapists' needs will be co-developed with mental health professionals, ensuring alignment with therapeutic goals and practical clinical application. Longitudinal studies will then evaluate the long-term impact of the prototype on anxiety reduction and social functioning, supporting its potential for broader clinical implementation and scalability.

VI. Acknowledgments

The authors would like to thank the three professional therapists and psychologists for their valuable insights into

the design suggestions presented in this research. Gratitude is also extended to the individuals diagnosed with Social Anxiety Disorder (SAD) for their anonymous contributions, which provided critical perspectives to enhance the study. The authors acknowledge the support provided by Institut Informatika Indonesia (IKADO) Surabaya and the Center for Excellence in Disruptive Learning Innovation at Universitas Negeri Malang (PUI Disruptive Learning Innovation UM), whose resources and innovation-driven environment significantly contributed to the completion of this work

VII. REFERENCES

[1] A. Belmaqrout, B. E. Ghali, N. Daoudi, and A. Haqiq, "The convergence of Virtual Reality and Personalized medicine," In *2023 14th International Conference on Intelligent Systems: Theories and Applications (SITA)* (pp. 1-6). IEEE, Nov, 2023, doi: https://doi.org/10.1109/sita60746.2023.10373711.

[2] C. de-Juan-Ripoll, J. L. Soler-Domínguez, I. A. Chicchi Giglioli, M. Contero, and M. Alcañiz, "The Spheres & Shield Maze Task: A Virtual Reality Serious Game for the Assessment of Risk Taking in Decision Making," *Cyberpsychology, Behavior, and Social Networking*, vol. 23, no. 11, pp. 773–781, Nov, 2020, doi: https://doi.org/10.1089/cyber.2019.0761.

[3] C. Anthes, R. J. Garcia-Hernandez, M. Wiedemann, and D. Kranzlmuller, "State of the art of virtual reality technology," *2016 IEEE Aerospace Conference*, Mar, 2016, doi: https://doi.org/10.1109/aero.2016.7500674.

[4] F. Aziz, S. Putra, and Desi Trianita, "THE EFFECT OF VIRTUAL THERAPY ON ANXIETY DISORDERS IN ADOLESCENTS," Jurnal Kajian Pendidikan dan Psikologi, vol. 1, no. 2, pp. 143–152, Dec. 2023, doi: https://doi.org/10.61397/jkpp.v1i2.88.

[5] O. Calancie, L. Ewing, L. D. Narducci, S. Horgan, and S. Khalid-Khan, "Exploring how social networking sites impact youth with anxiety: A qualitative study of Facebook stressors among adolescents with an anxiety disorder diagnosis," *Cyberpsychology: Journal of Psychosocial Research on Cyberspace*, vol. 11, no. 4, Dec. 2017, doi: https://doi.org/10.5817/cp2017-4-2.

[6] R. O. Febriani, M. Ramli, and N. Hidayah, "Cognitive Behavior Modification untuk Menurunkan Prokrastinasi Akademik Siswa Sekolah Menengah Atas," *Jurnal Kajian Bimbingan dan Konseling*, vol. 5, no. 3, pp. 132–141, Sep. 2020, doi: https://doi.org/10.17977/um001v5i32020p132.

[7] S. El-Shawa, N. Kraemer, S. Sheikholeslami, R. Mead, and E. A. Croft, "'Is this the real life? Is this just fantasy?': Human proxemic preferences for recognizing robot gestures in physical reality and virtual reality," *Intelligent Robots and Systems*, Jan. 2017, doi: https://doi.org/10.1109/iros.2017.8202178.

[8] A. Rumjaun and F. Narod, "Social learning theory—albert bandura," *Springer Texts in Education*, vol. 1, no. 1, pp. 85–99, Sep. 2020, doi: https://doi.org/10.1007/978-3-030-43620-9_7.

[9] W. Rahayuningtyas, R. T. Wulandari, A. Pramono, and A. I. Hj. Ismail, "Self-Efficacy in Topeng Malang Dance Learning Using Modeling Technique," *Proceedings of the 2nd International Conference on Arts and Design Education (ICADE 2019)*, 2020, doi: https://doi.org/10.2991/assehr.k.200321.024.

[10] M. Cella *et al.*, "Virtual Reality Therapy for the Negative Symptoms of Schizophrenia (V-NeST): A pilot randomised feasibility trial," *Schizophrenia Research*, vol. 248, pp. 50–57, Oct. 2022, doi: https://doi.org/10.1016/j.schres.2022.07.013.

[11] O. Pino, L. Squadroni, and B. N. A, "Design and implementation of a VR environment aimed at enhancing the Social Anxiety Disorder's (SAD) treatment. Evaluation of the sense of presence and immersion," *ACTA BIO-MEDICA DE L'ATENEO PARMENSE*, vol. 95, no. 2, May 2024, doi: https://doi.org/10.23750/abm.v95i2.15683.

[12] T. Stolz *et al.*, "A mobile app for social anxiety disorder: A three-arm randomized controlled trial comparing mobile and PC-based guided self-help interventions.," *Journal of Consulting and Clinical Psychology*, vol. 86, no. 6, pp. 493–504, Jun. 2018, doi: https://doi.org/10.1037/ccp0000301.

[13] P. Lindner *et al.*, "Therapist-led and self-led one-session virtual reality exposure therapy for public speaking anxiety with consumer hardware and software: A randomized controlled trial," *Journal of Anxiety Disorders*, vol. 61, pp. 45–54, Jan. 2019, doi: https://doi.org/10.1016/j.janxdis.2018.07.003.

[14] T. R. Fuadi, E. S. Bahriah, and S. Agung, "Analysis of final semester assessment questions (PAS) in grade XI chemistry online learning based on cognitive domain level of revised Bloom's taxonomy," *Jurnal Pendidikan Kimia*, vol. 14, no. 1, pp. 53–62, Apr. 2022, doi: https://doi.org/10.24114/jpkim.v14i1.30847.

[15] Y. Zhang, H. Liu, S.-C. Kang, and M. Al-Hussein, "Virtual reality applications for the built environment: Research trends and opportunities," *Automation in Construction*, vol. 118, p. 103311, Oct. 2020, doi: https://doi.org/10.1016/j.autcon.2020.103311.

[16] S. Liu, G. H. K. Zaigham, R. M. Rashid, and A. Bilal, "Social Media-Based Collaborative Learning Effects on Student Performance/Learner Performance With Moderating Role of Academic Self-Efficacy," *Frontiers in Psychology*, vol. 13, pp. 1–12, Jul. 2022, doi: https://doi.org/10.3389/fpsyg.2022.903919.

[17] S. Afrin, T. Raihan, A. I. Uddin, and Md. A. Uddin, "Predicting Innovative Work Behaviour in an Interactive Mechanism," *Behavioral Sciences*, vol. 12, no. 2, p. 29, Jan. 2022, doi: https://doi.org/10.3390/bs12020029.

[18] S. Riches, S. Pisani, L. Bird, M. Rus-Calafell, P. Garety, and L. Valmaggia, "Virtual reality-based assessment and treatment of social functioning impairments in psychosis: a systematic review," *International Review of Psychiatry*, vol. 33, no. 3, pp. 337–362, Apr. 2021, doi: https://doi.org/10.1080/09540261.2021.1918648.

[19] J. S. Artal-Sevil, "APPLICATION OF SERIOUS GAMES IN HIGHER EDUCATION. WHAT ARE THEY? HOW, WHERE AND WHEN TO USE THEM?," *INTED proceedings*, Mar. 2020, doi: https://doi.org/10.21125/inted.2020.2354.

[20] H. A. Rosyid, A. Y. Pangestu, and M. I. Akbar, "Can Diegetic User Interface Improves Immersion in Role-Playing Games?," *IEEE Xplore*, Oct. 01, 2021. Available at: https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9616732

[21] H. Armanto, H. A. Rosyid, Muladi, and G. Gunawan, "Evolutionary Algorithm in Game – A Systematic Review," *Kinetik : game technology, information system, computer network, computing, electronics, and control*, May 2023, doi: https://doi.org/10.22219/kinetik.v8i2.1714.

[22] H. A. Rosyid, M. Palmerlee, and K. Chen, "Deploying learning materials to game content for serious education game development: A case study," *Entertainment Computing*, vol. 26, pp. 1–9, May 2018, doi: https://doi.org/10.1016/j.entcom.2018.01.001.

[23] F. Almeida, "Adoption of a Serious Game in the Developing of Emotional Intelligence Skills," *European Journal of Investigation in Health, Psychology and Education*, vol. 10, no. 1, pp. 30–43, Jul. 2019, doi: https://doi.org/10.3390/ejihpe10010004.

[24] M. F. Hariadi, D. Kuswandi, and A. Wedi, "Development of Gamification Based Supplementary Listening Materials to Improve Students' High Order Thinking Skills," *Advances in social science, education and humanities research*, Jan. 2021, doi: https://doi.org/10.2991/assehr.k.211210.021.

[25] P. Slovak, A. N. Antle, N. Theofanopoulou, C. D. Roquet, J. J. Gross, and K. Isbister, "Designing for emotion regulation interventions: an agenda for HCI theory and research," *ACM Transactions on Computer-Human Interaction*, vol. 30, no. 1, Nov. 2022, doi: https://doi.org/10.1145/3569898.

[26] N. Sevcenko, T. Appel, M. Ninaus, K. Moeller, and P. Gerjets, "Theory-based approach for assessing cognitive load during time-critical resource-managing human–computer interactions: an eye-tracking study," *Journal on Multimodal User Interfaces*, Nov. 2022, doi: https://doi.org/10.1007/s12193-022-00398-y.

[27] D. Hackfort and R. J. Schinke, *The Routledge International Encyclopedia of Sport and Exercise Psychology*. Routledge, 2020. doi: https://doi.org/10.4324/9781315187259.

[28] T. Brackenbury and L. Kopf, "Serious Games and Gamification: Game-Based Learning in Communication Sciences and Disorders," *Perspectives of the ASHA Special Interest Groups*, vol. 7, no. 2, pp. 482–498, Apr. 2022, doi: https://doi.org/10.1044/2021_persp-21-00284.

[29] A. Christopoulos and S. Mystakidis, "Gamification in Education," *Encyclopedia*, vol. 3, no. 4, pp. 1223–1243, Oct. 2023, doi: https://doi.org/10.3390/encyclopedia3040089.

[30] E. Wiecek, A. Torres-Robles, R. L. Cutler, S. I. Benrimoj, and V. Garcia-Cardenas, "Impact of a Multicomponent Digital Therapeutic Mobile App on Medication Adherence in Patients with Chronic Conditions: Retrospective Analysis," *Journal of Medical Internet Research*, vol. 22, no. 8, p. e17834, Aug, 2020, doi: https://doi.org/10.2196/17834.

[31] E. Subiyantoro, A. Ashari, and Suprapto, "Cognitive Classification Based on Revised Bloom's Taxonomy Using Learning Vector Quantization," *2020 International Conference on Computer Engineering, Network, and Intelligent Multimedia (CENIM)*, Nov. 2020, doi: https://doi.org/10.1109/cenim51130.2020.9297879.

[32] A. Sabir, Imam Suyitno, G. Susanto, and Wichayanee Inthase, "THE UNLOCKING HIGHER-ORDER THINKING: BLOOM'S TAXONOMY AND TEACHER QUESTIONS IN INDONESIAN LANGUAGE INSTRUCTION," *Lentera Pendidikan Jurnal Ilmu Tarbiyah dan Keguruan*, vol. 27, no. 1, pp. 78–100, Jun. 2024, doi: https://doi.org/10.24252/lp.2024v27n1i6.

[33] A. K. Dewi, B. Y. Cahyono, and N. Zubaidi, "The Effectiveness of Summary Writing Strategy with Bloom Taxonomy Questions," *Lectura Jurnal Pendidikan*, vol. 15, no. 2, pp. 405–419, Aug. 2024, doi: https://doi.org/10.31849/lectura.v15i2.20257.

[34] T. M. Larsen, B. H. Endo, A. T. Yee, T. Do, and S. M. Lo, "Probing Internal Assumptions of the Revised Bloom's Taxonomy," *CBE—Life Sciences Education*, vol. 21, no. 4, Dec. 2022, doi: https://doi.org/10.1187/cbe.20-08-0170.

[35] E. Naa, J. V. Mensah, and Aborampah Amoah-Mensah, "Social learning theory outcomes and organizational performance: evidence from Ghana telecom firms," *Journal of Management & Governance*, Jul. 2024, doi: https://doi.org/10.1007/s10997-024-09713-z.

[36] R. Valk and G. Planojevic, "Addressing the knowledge divide: digital knowledge sharing and social learning of geographically dispersed employees during the COVID-19 pandemic," *Journal of Global Mobility: The Home of Expatriate Management Research*, vol. 9, no. 4, pp. 591–621, Oct. 2021, doi: https://doi.org/10.1108/jgm-02-2021-0019.

[37] D. Amsari, Etri Wahyuni, and Fadhilaturrahmi Fadhilaturrahmi, "The Social Learning Theory Albert Bandura for Elementary School Students," *Jurnal Basicedu*, vol. 8, no. 2, pp. 1654–1662, 2024, doi: https://doi.org/10.31004/basicedu.v8i2.7247.

[38] D. Checa and A. Bustillo, "A review of immersive virtual reality serious games to enhance learning and training," *Multimedia Tools and Applications*, vol. 79, no. 9–10, pp. 5501–5527, Dec. 2019, doi: https://doi.org/10.1007/s11042-019-08348-9.

[39] C. Kyrlitsias and D. Michael-Grigoriou, "Social Interaction With Agents and Avatars in Immersive Virtual Environments: A Survey," *Frontiers in Virtual Reality*, vol. 2, Jan. 2022, doi: https://doi.org/10.3389/frvir.2021.786665.

[40] J. K.-Y. Essoe, N. Reggente, A. A. Ohno, Y. H. Baek, J. Dell'Italia, and J. Rissman, "Enhancing learning and retention with distinctive virtual reality environments and mental context reinstatement," *npj Science of Learning*, vol. 7, no. 1, pp. 1–14, Dec. 2022, doi: https://doi.org/10.1038/s41539-022-00147-6.

[41] J. Othlinghaus-Wulhorst and H. U. Hoppe, "A Technical and Conceptual Framework for Serious Role-Playing Games in the Area of Social Skill Training," *Frontiers in Computer Science*, vol. 2, Jul. 2020, doi: https://doi.org/10.3389/fcomp.2020.00028.

[42] T. Ouariachi, C.-Y. Li, and W. J. L. Elving, "Gamification Approaches for Education and Engagement on Pro-Environmental Behaviors: Searching for Best Practices," *Sustainability*, vol. 12, no. 11, p. 4565, Jun. 2020, doi: https://doi.org/10.3390/su12114565.

[43] P. M. G. Emmelkamp, K. Meyerbröker, and N. Morina, "Virtual Reality Therapy in Social Anxiety Disorder," *Current Psychiatry Reports*, vol. 22, no. 7, 2020, doi: https://doi.org/10.1007/s11920-020-01156-1.

[44] H. Lee, J. Choi, D. Jung, J.-W. Hur, and C.-H. Cho, "The Effects of Virtual Reality (VR) Treatment on Prefrontal Cortex Activity in Patients with Social Anxiety Disorder: fNIRS measurement for VR-derived video exposure (Preprint)," *Journal of Medical Internet Research*, Jul. 2021, doi: https://doi.org/10.2196/31844.

[45] N. H. Zainal, W. W. Chan, A. P. Saxena, C. B. Taylor, and M. G. Newman, "Pilot randomized trial of self-guided virtual reality exposure therapy for social anxiety disorder," *Behaviour Research and Therapy*, vol. 147, p. 103984, Dec. 2021, doi: https://doi.org/10.1016/j.brat.2021.103984.

[46] I. D. Báldy, N. Hansen, and T. Bjørner, "An Engaging Serious Game Aiming at Awareness of Therapy Skills Associated with Social Anxiety Disorder," *Mobile Networks and Applications*, Mar. 2021, doi: https://doi.org/10.1007/s11036-021-01743-3.

[47] D. C. Beidel, P. W. Tuerk, J. Spitalnick, C. A. Bowers, and K. Morrison, "Treating Childhood Social Anxiety Disorder with Virtual Environments and Serious Games: A Randomized Trial," *Behavior Therapy*, vol. 52, no. 6, Mar. 2021, doi: https://doi.org/10.1016/j.beth.2021.03.003.

[48] L. Cadieux and M. Keenan, "Can Social Communication Skills for Children Diagnosed With Autism Spectrum Disorder Rehearsed Inside the Video Game Environment of Minecraft Generalize to the Real World?," *JMIR Serious Games*, vol. 8, no. 2, p. e14369, May 2020, doi: https://doi.org/10.2196/14369.

[49] T. J. Pattiasina, Harits Ar Rosyid, Anik Nur Handayani, Hartarto Junaedi, and E. M. Trianto, "A Review of Virtual Reality and Serious Games within Cognitive Behavioral Therapy for Social Anxiety Disorder," *Jurnal Pekommas*, vol. 9, no. 1, pp. 93–108, Jun. 2024, doi: https://doi.org/10.56873/jpkm.v9i1.5317.

[50] J. Torous *et al.*, "The Growing Field of Digital psychiatry: Current Evidence and the Future of apps, Social media, chatbots, and Virtual Reality," *World Psychiatry*, vol. 20, no. 3, pp. 318–335, Sep. 2021, doi: https://doi.org/10.1002/wps.20883.

[51] A. M. Kammerer, "Treating Anxiety Disorders with VR-based Exposure Therapy- A Scoping Review - University of Twente Student Theses," *Utwente.nl*, 2023, doi: https://purl.utwente.nl/essays/94320.

[52] I. Stefaniak, K. Hanusz, P. Mierzejewski, P. Bieńkowski, T. Parnowski, and S. Murawiec, "Preliminary Study of Efficacy and Safety of Self-Administered Virtual Exposure Therapy for Social Anxiety Disorder vs. Cognitive-Behavioral Therapy," *Brain Sciences*, vol. 12, no. 9, p. 1236, Sep. 2022, doi: https://doi.org/10.3390/brainsci12091236.

[53] H. S. Jeong, J. H. Lee, H. E. Kim, and J.-J. Kim, "Appropriate Number of Treatment Sessions in Virtual Reality-Based Individual Cognitive Behavioral Therapy for Social Anxiety Disorder," *Journal of Clinical Medicine*, vol. 10, no. 5, p. 915, Feb. 2021, doi: https://doi.org/10.3390/jcm10050915.

[54] Y. K. Heng, J. S. Y. Liew, M. F. I. L. Abdullah, Y. Tang, and N. Prestopnik, "ReWIND: A CBT-Based Serious Game to Improve Cognitive Emotion Regulation and Anxiety Disorder," *International Journal of Serious Games*, vol. 10, no. 3, pp. 43–65, Sep. 2023, doi: https://doi.org/10.17083/ijsg.v10i3.603.

[55] N. M. M. Saleh, H. M. Sarim, and S. F. M. Noor, "Game based implementation of Cognitive Behavioral Therapy for introspective treatment of Social Anxiety Disorder," *Geografia: Malaysian journal of society and space*, vol. 19, no. 2, May 2023, doi: https://doi.org/10.17576/geo-2023-1902-08.

Pioneering a New Era in Mental Health Treatment: A Framework for Virtual Reality Serious Game Design

ORIGINALITY REPORT

10%
SIMILARITY INDEX

PRIMARY SOURCES

1	pdfs.semanticscholar.org Internet	114 words — 2%
2	www.mdpi.com Internet	79 words — 2%
3	elib.dlr.de Internet	40 words — 1%
4	Anik Nur Handayani, Muhammad Iqbal Akbar, Harits Ar-Rosyid, Muhammad Ilham, Rosa Andrie Asmara, Osamu Fukuda. "Design of SIBI Sign Language Recognition Using Artificial Neural Network Backpropagation", 2022 2nd International Conference on Intelligent Cybernetics Technology & Applications (ICICyTA), 2022 Crossref	24 words — 1%
5	jbasic.org Internet	19 words — < 1%
6	Harits Ar Rosyid, Matt Palmerlee, Ke Chen. "Deploying learning materials to game content for serious education game development: A case study", Entertainment Computing, 2018 Crossref	12 words — < 1%
7	cyber-gateway.net Internet	12 words — < 1%

8	www.atlantis-press.com Internet	12 words — < 1%
9	www.cell.com Internet	10 words — < 1%
10	www.pubs.ascee.org Internet	10 words — < 1%
11	"Designing Futures", Springer Science and Business Media LLC, 2025 Crossref	9 words — < 1%
12	Daniel Rodríguez, Adrián Borrego, Marco Guzmán, Roberto Llorens. "Acoustic characteristics of voice production in virtual reality-simulated and physical environments. A comparative study in university professors", Research Square Platform LLC, 2023 Crossref Posted Content	9 words — < 1%
13	Hendrawan Armanto, Harits Ar Rosyid, Muladi, Gunawan. "Improved Non-Player Character (NPC) behavior using evolutionary algorithm—A systematic review", Entertainment Computing, 2025 Crossref	9 words — < 1%
14	journal.seriousgamessociety.org Internet	9 words — < 1%
15	jurnal.kominfo.go.id Internet	9 words — < 1%
16	"Information Technology and Systems", Springer Science and Business Media LLC, 2024 Crossref	8 words — < 1%
17	core.ac.uk Internet	8 words — < 1%

18	dokumen.pub Internet	8 words — < 1%
19	journals.sagepub.com Internet	8 words — < 1%
20	medinftech.org Internet	8 words — < 1%
21	ojs.trp.org.in Internet	8 words — < 1%
22	samples.freshessays.com Internet	8 words — < 1%
23	jpmtr.org Internet	7 words — < 1%
24	Clinton D Kilts, Jeffrey E Kelsey, Bettina Knight, Timothy D Ely et al. "The Neural Correlates of Social Anxiety Disorder and Response to Pharmacotherapy", Neuropsychopharmacology, 2006 Crossref	6 words — < 1%
25	Izabela Stefaniak, Krzysztof Hanusz, Paweł Mierzejewski, Przemysław Bieńkowski, Tadeusz Parnowski, Sławomir Murawiec. "Preliminary Study of Efficacy and Safety of Self-Administered Virtual Exposure Therapy for Social Anxiety Disorder vs. Cognitive-Behavioral Therapy", Brain Sciences, 2022 Crossref	6 words — < 1%
26	Nayeefa Chowdhury, Ahsan H. Khandoker. "The gold-standard treatment for social anxiety disorder: A roadmap for the future", Frontiers in Psychology, 2023 Crossref	6 words — < 1%

EXCLUDE QUOTES	OFF	EXCLUDE SOURCES	OFF
EXCLUDE BIBLIOGRAPHY	ON	EXCLUDE MATCHES	OFF