Enhancing Emotion Regulation Through Virtual Reality Design Framework for Social-Emotional Learning (VRSEL)

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Abstract—**Virtual reality (VR) has swiftly progressed, transitioning from a niche technology primarily associated with gaming to a versatile tool with broad applications across entertainment, healthcare, education, and beyond. Social-emotional learning (SEL) is increasingly recognized for its role in enhancing individuals' social skills and emotional regulation. However, despite the growing body of research on VR, the development of specific design frameworks for integrating VR with SEL remains underexplored. This study addresses this gap by employing thematic analysis to identify the critical components necessary for a Virtual Reality Design Framework for Social-Emotional Learning (VRSEL) aimed at improving emotion regulation among Malaysian adolescents. Through qualitative data derived from expert interviews in SEL and VR, this research proposes a framework that leverages immersive VR technology to create realistic, interactive scenarios that facilitate the practice and development of social-emotional skills. The framework emphasizes key design principles, including user interface (UI), presentation layer (PL), and brain activity (BA). Our findings suggest that VRSEL is a powerful tool for SEL, offering significant potential for educational environments. However, challenges such as technical barriers, content development, and educator training must be addressed to fully realize its benefits. This research highlights the promising role of VR in advancing SEL and lays the groundwork for further exploration and refinement of VRSEL in diverse educational settings.**

Keywords—Virtual reality; design; framework; social-emotional learning; emotion regulation

I. INTRODUCTION

Virtual reality (VR) can be described as a computer-generated simulation technology which allows a user to interact with a computer-simulated environment [1] by employing specialized electronic apparatus [2]. Modern virtual reality (VR) technology commonly utilizes head-mounted displays (HMDs), also known as VR headsets, which allow users to immerse themselves in a virtual environment by obscuring their perception of the actual world [3]. VR offers a novel setting in users to experience being immersed. Immersion is the state where a user becomes deeply engaged in a virtual environment, leading to a detachment from the reality of time and their physical surroundings [4]. The immersive experience enables audiences to completely diverge from the actual world. Through the provision of well-defined concepts, elements, and methods,

it ensures consistency, fosters collaboration, and enables the growth of design efforts. VR represents the integration of hardware and software systems to generate the accurate and immersive experience of being physically present in another dimension. VR design entails the development of immersive digital environments that can effectively and realistically engage with users. To achieve this, it is crucial to possess a comprehensive design framework.

Partelow emphasizes that, as stated by The Cambridge Dictionary, frameworks are "a structural foundation upon which something can be constructed; a set of regulations, concepts, or principles used for organizing or determining something" [5]. A design framework is a structured approach used to direct the design process throughout several stages, including software and app development and more. A design framework is a concise and visually structured system that enhances the organization of information and ideas related to an issue, resulting in improved effectiveness. Frameworks are visual or written representations of the elements, ideas, or variables of a phenomenon [6]. This framework facilitates the development process, guaranteeing that the result is captivating, operational, and easily reachable. The process of designing and developing software or any other product can be intricate. In the presence of several obstacles, we are required to have a have a well-defined framework and methodologies to effectively conceptualize, construct, evaluate, and refine optimal ideas. Through the adoption of frameworks, we can enhance their comprehension of problems and discern alternate strategies and answers that may not be immediately evident. Frameworks provide a systematic approach to organizing the process, igniting creativity, and promoting cooperation. They are fundamental components that direct the development of design solutions. Frameworks help structure the process, spark innovation, and stimulate collaboration which are essential building blocks for guiding design solutions. Several VR design frameworks are utilized in diverse fields, including healthcare [7] and education [8].

Social-emotional learning (SEL) is defined as the process through which individuals, particularly students, learn to recognize and control their emotions [9], develop empathy for others, establish positive relationships, and make responsible decisions [10]. It encompasses a set of skills that are essential

for personal and social development, including emotional awareness, emotional regulation, social awareness, relationship skills and decision making. SEL is crucial for fostering not only emotional intelligence but also academic success. Programs that effectively implement SEL strategies have been shown to improve students' social skills, enhance their academic performance, and reduce behavioural problems [11]. As SEL widens its attention to include teenage populations, it adopts the widely acknowledged theoretical framework proposed by an organization called CASEL or the Collaborative for Academic, Social, and Emotional Learning [12]. CASEL has released a framework to help spread SEL curriculum widely [13]. This framework organizes SEL competencies and helps identify well-designed, evidence-based SEL programs in a systematic manner. Schools strive to foster a nurturing atmosphere that enhances students' emotional well-being and academic performance by incorporating SEL into their educational framework. The ultimate objective is to provide students with the essential abilities and mindset to achieve outstanding academic performance and prosper in several other areas of life [13]. SEL is an essential element of education involves cultivating abilities such as empathy and emotional regulation.

Emotion regulation (ER) refers to the processes of individuals manage or control their emotional experiences and expression [14], modifying the initiation or length of emotions [15], and emotional modulation [16]. The area of emotion regulation is experiencing rapid growth within the realm of psychology [17]. Through the assistance of ER, individuals can manage their emotions, when they feel it, and how they express them. This includes both conscious and unconscious techniques. Being able to regulate one's emotions is crucial for thriving in social settings when letting one's guard down is generally frowned upon. ER is a regular and necessary process for maintaining wellbeing, and it is used flexibly in various everyday situations [18].

VR has been a rapidly developing technology with various potential applications, including in the field of psychology and mental health to treat depression and anxiety [19]. However, there is limited research that focus on enhancing emotion regulation in adolescent using VR. Therefore, the goal of this study is to develop a virtual reality design framework for social-emotional learning (VRSEL) that enhances emotion regulation in Malaysian adolescents. VR is being actively promoted as a highly promising technique for teaching and learning in various educational settings [20]. The utilization of VR offers an additional chance to effectively improve SEL through immersive educational experiences. This is accomplished by promoting improved regulation of emotions, which contributes to an individual's general state of mental health. Thematic analysis is employed to utilize qualitative data from interviews with experts in the creation of VRSEL. Thematic analysis (TA) is a systematic approach used to find, analyse, and interpret patterns of meaning or themes within qualitative data [21]. It entails a methodical procedure of analysing and reviewing data, such as transcripts of interviews or discussions in focus groups, to identify important themes that encapsulate the core of the dataset. The VRSEL framework will provide a vital guideline for other researchers to develop a specific framework in the context of emotion regulation by promoting SEL.

The aim of this study is to design a specific framework that integrate VR with SEL to enhance emotion regulation in Malaysian adolescents. This study fills this gap by utilizing thematic analysis to discern the essential elements required for VRSEL framework, applying qualitative data obtained from expert interviews in SEL and VR.

II. LITERATURE REVIEW

A. Virtual Reality Design Framework

Design frameworks are essential for directing the developing phase and enabling successful creation of goods or systems that prioritize the needs of the user. The application of design frameworks has been explored in various domains, including user experience design, service design, and interaction design, demonstrating their versatility and effectiveness in addressing different design challenges. The field of VR design has evolved significantly in recent years that focused on refining VR design frameworks to improve usability [22], user experience [23], and the overall effectiveness [24] of VR apps across various domains.

1) Improvement of design skills: The potential of virtual reality for strengthening design skills is rapidly being acknowledged. Studies suggest that immersive settings promote embodied experiences, leading to improved creative problem-solving and design-thinking abilities [25].

2) Consumer assessment in VR: Consumer examination of items in VR environments is another important field of study. A review has highlighted key characteristics related to how customers evaluate items in VR, indicating that VR can be a valuable platform for marketers to conduct testing and prototype development (Branca et al., 2024).

3) Skill training frameworks: An extensive analysis of VR characteristics for skill training emphasized the importance of using VR technology in specific contexts (Tusher et al., 2024). The study highlighted that the efficacy of VR in training situations relies on the congruence between VR attributes and desired learning objectives.

4) Unified adoption framework: A comprehensive investigation, including both qualitative and quantitative methodologies, has put forward a novel paradigm for the unified implementation of VR (Fares et al., 2024). This review investigates the factors that impact consumer involvement with VR technology. The primary objective of this framework is to offer a thorough comprehension of the elements that either help or impede the adoption of VR in the context of design.

In the education sector, VR frameworks aim to enhance learning experiences through immersive environments that promote engagement and retention. Educational VR applications often incorporate gamification elements to make learning more interactive and enjoyable (Lyu et al., 2023). The integration of VR in education has shown promising results in various domains, including science, history, and language learning (McGovern et al., 2020). However, its application in SEL is relatively underexplored. Prior research suggests that immersive VR experiences can significantly impact users' emotional and social skills by placing them in realistic,

emotionally charged scenarios (Marín-Morales et al., 2020). This study builds on this foundation to create a targeted framework for SEL.

B. Human Computer Interaction and Design Principle

Human-Computer Interaction (HCI) is a discipline that focuses on the optimization and efficacy of user interfaces in relation to computer systems, user-friendly input and output technology, and the psychological elements of user interfaces [26]. The domain of HCI has broadened to encompass a diverse array of devices and technologies, such as mobile devices, the Internet of Things, and virtual reality. VR technology, along with HCI, plays a crucial role in software development by minimizing errors and achieving higher levels of accuracy and quality.

This is achieved through the utilization of design principles that specifically target the user interface and presentation layer. User Interface (UI) design is a critical aspect of HCI that focuses on the look and feel, responsiveness, and interactivity of digital products. Efficient UI design guarantees that people can interact with systems effectively and provides a visually appealing presentation layer. The presentation layer (PL) of HCI refers to how information is displayed to users. UI is greatly influenced by several key components, including information architecture, visual hierarchy, and responsive design. The design of the presentation layer should prioritize the user's needs, ensuring that it is both aesthetically pleasing and practical, with a user-friendly interface. Research highlights the need of adaptive interfaces that can adjust to user context and preferences, hence improving usability and pleasure [27].

C. Social-Emotional Learning and Emotion Regulation

Twenty SEL and emotion regulation are foundational to students' academic success, school readiness, and overall well-being [28], [29]. SEL involves the process of acquiring and effectively utilizing the knowledge, attitudes, and skills necessary to understand and regulate emotions, make responsible decisions, and maintain positive social relationships (Elias & Zins, 2006; Ross & Tolan, 2018). Emotion regulation, a critical aspect of SEL, refers to the strategies and processes that individuals use to manage their emotional experiences effectively [17]. Research has consistently shown that strong emotion regulation skills are positively associated with social competence and can serve as predictors of future social functioning [31]. In collaborative learning environments, these skills are essential for managing group dynamics, maintaining positive interactions, and fostering a sense of school belonging, particularly for students with specific learning disorders. Effective emotion regulation can lead to fewer psychosocial difficulties, contributing to a more inclusive and supportive learning environment [32], [33].

The importance of integrating SEL and emotion regulation into educational curricula cannot be overstated. Emotion regulation significantly impacts mental health by shaping emotional responses and overall psychological well-being, particularly during adolescence critical period for cognitive, social, and emotional development. Recent trends indicate that adolescents are increasingly struggling to manage their emotions effectively, which raises concerns about the potential consequences on their mental health and academic performance.

Educators play a pivotal role in supporting the development of these skills through various approaches, including experiential learning, mindfulness, and simulation-based exercises [34]. Frameworks such as the RULER approach and Lobczowski's model provide structured methodologies for implementing SEL and understanding emotion formation in collaborative settings [28], [35]. By embedding emotion regulation strategies into daily educational practices, educators can enhance both their own and their students' emotional intelligence, ultimately leading to improved academic outcomes and overall well-being.

D. The Role of Virtual Reality in Enhancing Social-Emotional Learning

Cultural VR has emerged as a promising tool for enhancing SEL in children and adolescents, providing immersive environments that facilitate key skills such as perspective-taking, empathy, and responsible decision-making. VR interventions have been proven effective in enhancing SEL, especially for children with autism spectrum disorders (ASD). ASD often involve challenges with social interactions, communication, and understanding social cues. VR offers a unique, controlled, and immersive environment where children with ASD can practice and develop these essential social skills in a safe, structured setting. The studies have demonstrated the effectiveness of VR interventions in promoting SEL, particularly for children with autism spectrum disorders, where it aids in the development of social skills [36], [37]. For instance, VR can simulate real-life social situations that children with ASD might find challenging, allowing them to rehearse and refine their responses in a way that is both engaging and low-risk.

These simulations can include scenarios like having a conversation, recognizing emotions, or navigating social events. By repeatedly practicing these scenarios in a VR environment, children with ASD can build confidence and competence in their social interactions, which can translate to improved social skills in real-world settings. By offering experiential learning opportunities, VR enhances student engagement and learning outcomes across various domains, including emotional regulation, cognitive skills, and social competencies (Kamei & Harriott, 2020; Murphy et al., 2021). It shows how VR's ability to create these dynamic, engaging learning experiences leads to better retention and application of skills, making it a powerful tool in education. Furthermore, the integration of VR and augmented reality tools has shown potential in developing emotional intelligence skills, benefiting both neurotypical individuals and those with autism [40]. These findings underscore VR's role as an effective pedagogical tool for promoting SEL in diverse educational settings.

E. Comparison with Other Methods

Table I presents a comparison with various models, demonstrating that the VRSEL framework excels due to its comprehensive approach to improving emotion regulation in adolescents leveraging VR technology. Through integrating immersive experiences with tailored learning pathways and secure practice environments, it mitigates numerous constraints linked to conventional educational approaches, including restricted participation and passive learning.

TABLE I.   COMPARISON WITH OTHER METHODS

Methods	Advantages	Limitations
Traditional Learning	Familiarity, structured curriculum	Limited engagement, passive learning
Online Learning Platforms	Flexibility, accessibility	Lack of immersive experience, potential isolation
Role-Playing Activities	Interactive engagement, real-world application	May not fully simulate emotional scenarios
VRSEL Framework	Immersive, personalized, risk-free practice, enhanced collaboration	Requires access to technology, potential initial learning curve

Building on this foundation, immersive technologies like VR extend their potential beyond SEL to also play a significant role in emotion regulation and the induction of positive emotions. The immersive nature of VR enhances emotional experiences by increasing the sense of presence, which can boost positive emotions and arousal [41]. Moreover, VR scenarios that offer virtual social support have been found to effectively mitigate negative emotions caused by social exclusion [42]. These applications of VR in emotion regulation span various contexts, from clinical interventions to mood induction, providing dynamic opportunities to assess and intervene in emotional processes [43], [44]. While VR holds promise for facilitating transitions from negative to positive emotional states, challenges remain in accurately representing emotions and providing design guidance [45]. Future research should focus on leveraging VR's capabilities to enhance social interactions and couple experiential training with reflective moments, further expanding its applications in emotion regulation contexts.

Despite significant advancements in VR design frameworks aimed at improving usability, user experience, and effectiveness across various domains, a critical gap exists in their application for SEL and emotion regulation. While VR has shown promise in enhancing social skills and emotional intelligence, especially for individuals with autism spectrum disorders, there is limited research on how to effectively design VR environments specifically for emotion regulation. Addressing this gap is crucial as emotion regulation is a vital component of mental health and well-being, particularly in adolescents who are increasingly struggling with managing their emotions. Understanding how VR can be optimized to support emotion regulation could lead to the development of powerful tools that not only enhance SEL but also contribute to better mental health outcomes. This study is important because it seeks to create a VR design framework that specifically targets emotion regulation, offering a new avenue for educational and therapeutic interventions in this critical area.

III.   METHODOLOGY

Fig. 1 shows the methodology flowchart illustrating the study's complete process, which includes six steps in the development of the VRSEL framework.

A. Research Deign

1) Objective: The study aims to develop a specialized virtual reality design framework for SEL with the goal of enhancing emotion regulation among adolescents. As part of this study, interviews were conducted to explore and

understand the virtual reality components essential for creating a design framework tailored to SEL contexts.

2) Qualitative approach: The study utilizes qualitative methodologies, emphasizing the in-depth data gathered through interviews. The interview questions were developed based on the initial data collected during the first phase of the research, which helped shape the conceptual framework of the study.
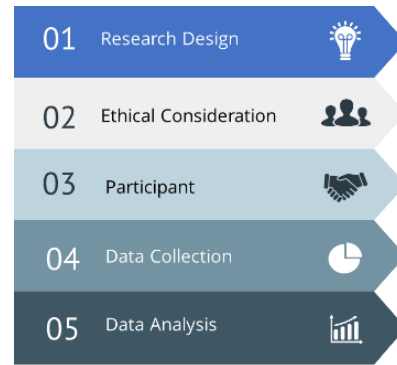

Fig. 1.   Methodology flowchart.

B. Ethical Consideration

1) Ethical approval: This study has earned over the Research Ethics Committee's approval, The National University of Malaysia with the ethics approval number, UKM PPI/111/8/JEP-2023-111. The Malaysian Ministry of Education has also given its permission (KPM.600-3/2/3-eras (15996)).

2) Confidentiality: We maintained the participant's confidentiality by anonymizing the data. All data collected during the study was securely stored and maintained under strict confidentiality for the entire duration of the research.

C. Participant

1) Data sampling: The data sampling involves six participants from two distinct domains of expertise: VR and SEL. Participants were selected based on their specialized knowledge relevant to the study.

2) Participant selection criteria: The selection of participants was based on their specialized knowledge in two critical areas namely, virtual reality (VR) and social-Emotional learning (SEL). This dual expertise is essential for providing a comprehensive evaluation of the VRSEL framework. Participants were chosen for their ability to contribute insights that align with the study's objectives:

a) VR experts: Individuals with a strong background in VR technology, design, and implementation. Their insights are crucial for understanding the technical aspects of the VRSEL framework and its effectiveness in creating immersive learning experiences.

b) SEL experts: Professionals with expertise in social-emotional learning theories, practices, and interventions. Their perspectives are vital for evaluating the framework's alignment with established SEL principles and its impact on emotional regulation.

3) Demographics: The six participants ranged in age from 30 to 65 years. The participant group included both men and women, ensuring a balanced representation that can contribute to a more comprehensive understanding of the VRSEL framework's impact across different gender perspectives.

4) Informed Consent: Informed consent was obtained from all participants, ensuring that the study adhered to ethical standards.

D. Data Collection

1) Interview procedure: We conducted the semi-structured interview both face-to-face and online.
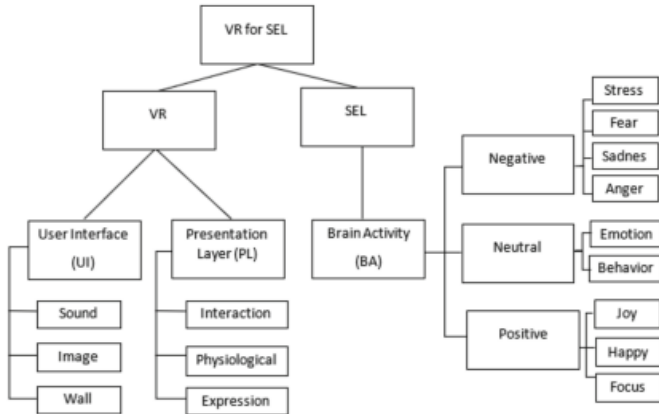

Fig. 2. Conceptual framework of VRSEL.

2) Interview guide: The preliminary data from phase one of the study, which established the study's conceptual framework [46], served as the basis for designing the interview question. Hamzah stated that it is important to have a set of requirements for making a virtual reality for social and emotional learning that could help Malaysian teens better control their feelings. Fig. 2 shows the conceptual framework of virtual reality design framework that has been designed for social-emotional knowledge developed in the earlier phase of the study by [46].

3) Recording and transcription: We recorded the interview using a voice recorder. The interview data were then transcribed using software by Google Cloud, speech-to-text, to ensure accuracy in capturing participants' responses.

E. Data Analysis

The data is analyse using thematic analysis. Thematic analysis (TA) is an adaptable method for analysing qualitative data and patterns to identify the underlying meaning. Braun and Clarke state that thematic analysis is not constrained by any one theoretical framework, rendering it a flexible instrument in qualitative research [21]. Fig. 3 displays the initial thematic map that has been produced through the process of thematic analysis. The process of TA typically involves several key steps:

1) Familiarization: The interview transcriptions were subjected to thematic analysis to ensure thorough familiarization with the data through repeated reading and examination of the transcripts.

2) Initial coding: The procedure of deriving initial codes from the data has been completed. The codes are essential since they establish the groundwork for themes.

3) Theme development: The study grouped codes into potential themes as a way of summarizing sections of the data. This involves the iterative process of reviewing themes, refining them, and ensuring they accurately represent the data. Fig. 3 represents the initial thematic map that we create at the start of data processing. The map was subsequently utilized in the development of the VRSEL framework. The theme was further examined in the discussion section of the study by providing further details on the quotation from the interview dialogue.
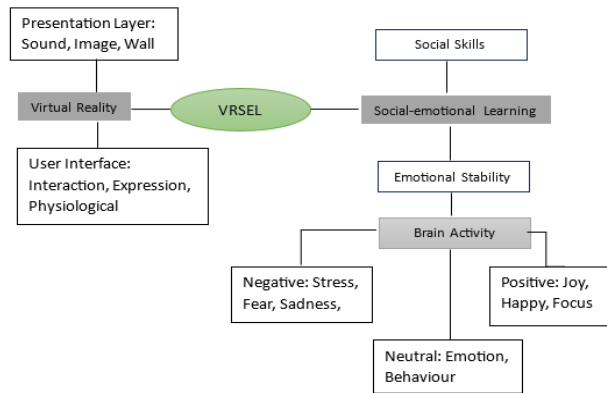

Fig. 3. Initial thematic map.

4) Reviewing themes: The themes were cross-referenced with the dataset to verify their coherence and significance.

5) Defining and naming themes: Table II indicates the definition and naming of the themes.

TABLE II.   THEME DEFINITION

Themes	Sub Themes	Attributes
Virtual Reality (VR)	User Interface (UI)	Sound
		Image
		Wall
	Presentation Layer (PL)	Interaction
		Physiological
		Expression
Social-emotional Learning (SEL)	Social Skills (SS)	
	Emotional Stability (ES) Brain Activity	Stress
		Fear
		Sadness
		Anger
		Emotion
		Behavior
		Joy
		Happy
		Focus

Each theme has been delineated based on the objectives of the investigation. Subsequently, we selected the suitable titles that effectively capture the fundamental nature of the subjects. The primary focal points revolved around virtual reality and social-emotional development.

IV. FINDINGS

Fig. 4 illustrates the process of developing the VRSEL framework. The VRSEL framework is a structured approach to research that consists of four distinct stages:

Fig. 4. VRSEL framework development process.

A. Critical Literature Revie

The first stage is conducting a comprehensive examination of the current literature that is pertinent to the study area. A preliminary literature review was conducted in the initial phase of the project [46]. The study highlighted any deficiencies in knowledge, comprehending the present state of VR framework for SEL, and providing a rationale for the necessity of the study. It provides information on the research questions and objectives, which helps to drive the overall progress of the project.

B. User Requirement Data

During the second phase, data has been collected pertaining to user requirements. This entails identifying the requirements, interests, and expectations pertaining to the extent of the investigation. Method such as interviews have been utilized to gather qualitative data. This phase is crucial for guaranteeing that the framework being constructed is focused on the user and effectively tackles current issues. The utilization of theme analysis in this data analysis yields valuable insights that may be employed to tailor the research to meet the specific needs of users, hence enhancing its relevance and efficacy.

C. Framework Design

The third phase is dedicated to the development of the framework's design. This entails integrating the knowledge acquired from the literature review and user requirement data to develop a logical framework that directs the study. The framework has explicitly outlined the interconnections among different components of the study, including variables, themes, and attributes as illustrated in the Fig. 5.

1) Key themes identified: Several significant topics pertinent to the VRSEL paradigm emerged through thematic analysis:

a) Theme 1: Virtual Reality (VR): It includes subtheme of user interface (UI) and presentation layer (PL).

b) Theme 2: Social-Emotional Learning (SEL): It includes subtheme of social skills (SS) and emotional stability (ES).

D. Testing and Validation

The final phase involves the validation of the VRSEL framework and assessing the usability of the VRSEL framework in the next study. This is accomplished by utilizing experimental approaches to evaluate the efficacy and dependability of the framework for future investigations. Validation and usability testing may include pilot studies, expert review, user feedback, and VR app development based on the results obtained. Continuous testing and validation help in refining the framework, making it more robust and applicable to real-world scenarios.
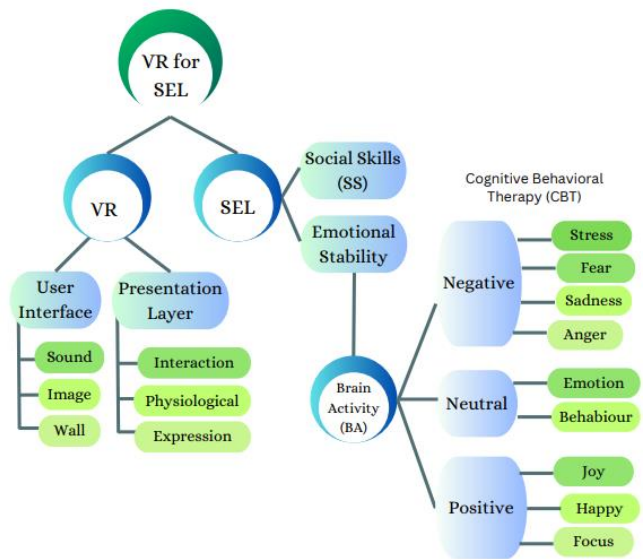

Fig. 5. VRSEL framework.

Fig. 5 highlights the primary findings of the study, which revolve around the VRSEL framework. The VRSEL framework encompasses two primary themes, specifically virtual reality (VR) and social-emotional learning (SEL). The VR theme comprises two subthemes such as user interface (UI) and presentation layer (PL). The UI features include sound, image, and wall. The characteristics of the PL encompass interaction, physiological responses, and expression. Meanwhile, the SEL theme comprises two subthemes namely, social skills (SS) and emotional stability (ES). The ES has a sub-subtheme called brain activity (BA). The BA possesses traits that can be categorized as negative, neutral, or good. The subtheme of ES is integrated with cognitive behavioural therapy (CBT).

V. DISCUSSION

A. Design Principles of the VRSEL Framework

The findings indicate that the VRSEL framework offers the necessary components for creating a targeted VR design within the context of SEL, as compared to the prior study on design framework. Table III displays the code that was produced during

the process of thematic analysis, which included interviews with all participants. Participant 3 highlight that "Social emotional development is divided into two, namely, social skills and emotional stability."

TABLE III.   VRSEL INTERVIEW CODE

Codes	Interview Clip
Sound	"We need to place the sound according to the suitability of our VR application"
Image	"The objective of these computerized graphics is to get a greater impact through visuals"
Wall	"So apart from the wall, why don't we use virtual reality to visually represent avatars and other individuals?"
Interaction	"Interactive VR is one of the most important elements to get input from the user"
Physiological	"VR requires physiological movement"
Expression	"You are the virtual storyteller. You represent your own world."
Social Skill	"Social skill is an ecologically valid social skill step."
Emotional Stability	"Emotional stability is needed for someone to learn about emotions"

The VRSEL interview codes play a role in advancing the VRSEL framework. The finding highlights four fundamental design principles for its development:

1) User Interface (UI): Interaction design principles are a set of standards that assist in the creation of user interfaces that are both intuitive and engaging. These principles aim to replicate real-world social circumstances, resulting in lifelike scenarios. Sound is essential in constructing engaging and credible virtual reality settings. Sound contributes to the establishment of a feeling of being present and fully engaged in the virtual environment. The use of realistic and spatially precise audio enhances the authenticity and persuasiveness of the VR experience, immersing the user more profoundly into the scenario [47]. Creating a VR scenario needs to incorporate a diverse range of visual components, such as 360-degree image, 3D models, textured backgrounds, lighting, and interactive features [47]. Moreover, an image illustrating the concept of virtual reality, where a virtual environment may be explored using an avatar. In addition to using a virtual wall, we can enhance the immersion of virtual reality by incorporating an avatar. An avatar serves as the user's representative in the virtual world, allowing them to interact with the environment [2]. Avatars serve as digital embodiments of users, playing a vital role in creating a feeling of being present in the virtual world. Through interacting with their avatars, users could manifest their unique characteristics and personal sense of self, thereby intensifying their involvement and emotional connection to the overall experience [48].

2) Presentation Layer (PL): The presentation layer (PL) is an essential element in the design of VR, specifically in relation to interaction, physiological aspects, and user expression. It enables users to engage with virtual characters and situations to develop SEL capacities. The PL is accountable for overseeing user interactions within the VR environment. VR experiences can induce notable physiological effects on users, including symptoms such as motion sickness, eye strain, and weariness. The PL must be carefully crafted, taking into consideration these considerations, to ensure that visual elements are optimized to reduce any discomfort. The PL in social VR experiences must facilitate user expression through avatars and other virtual representations. These aspects must precisely communicate the user's movements, gestures, and facial expressions, facilitating authentic and captivating interactions with other users.

3) Social Skills (SS): Social skills are a crucial component of SEL, encompassing the abilities necessary for effective communication and building connections with others. These skills include understanding and empathizing with others, resolving conflicts in a positive manner, and demonstrating cultural humility and respect for diversity.

4) Emotional Stability (ES): Emotional stability (ES), as defined by SEL, is the capacity to skilfully control and regulate one's emotions, ensuring a harmonious emotional state in the face of diverse circumstances. This concept is closely linked to brain activity (BA) and how individuals respond to negative, neutral, and positive stimuli. BA that encompasses responses such as negative, neutral, and positive provides prompt feedback and a chance for introspection to enhance learning and incorporate cognitive brain therapy (CBT).

In Table II, SEL theme demonstrates the display of negative emotions such as stress fear, sadness, or anger. When exposed to negative stimuli, the amygdala in the brain becomes activated, resulting in intensified emotional reactions such as anxiety or wrath. Individuals who possess ES could effectively handle these responses, using techniques acquired via SEL to reduce the influence of negative feelings. Neutral stimuli, such as emotions and behaviours, typically do not elicit intense emotional reactions, enabling humans to analyse information without any prejudice. Emotional stability allows an individual to sustain concentration and lucidity in neutral circumstances, which is crucial for making decisions and resolving problems. Positive stimuli elicit the release of neurotransmitters, such as dopamine, which stimulate feelings of enjoyment and motivation such as joy happy and focus that is illustrated in Fig. 5. Individuals who possess ES can completely participate in pleasant events, which in turn improves their emotional well-being and strengthens their ability to adjust to different situations.

VI.   FUTURE WORK

The results suggest that the VRSEL framework has significant potential to facilitate SEL by providing immersive and interactive experiences that foster emotional and social development. However, it is crucial to conduct thorough testing and validation of the VRSEL framework. A forthcoming phase will involve integrating the VRSEL framework into the development of a VR application for rigorous testing and validation. Implementing VR for SEL presents several challenges, including technical limitations, content development complexities, and the necessity for specialized training. From a technical perspective, VR systems demand high-performance hardware and software to deliver immersive experiences, which

can be costly and challenging to maintain, particularly in educational settings with limited resources. Additionally, creating content that is both engaging and pedagogically sound requires substantial expertise in VR technology and SEL principles. Developing realistic, interactive scenarios that effectively teach social-emotional skills necessitates close collaboration among educators, VR developers, and psychologists. Furthermore, educators and facilitators need comprehensive training not only to use VR tools but also to integrate them meaningfully into SEL curricula. This often involves a steep learning curve and ongoing support, which can hinder widespread adoption. To address these challenges, schools and institutions might consider forming partnerships with VR developers, investing in scalable training programs, and exploring cost-effective VR solutions that still offer immersive learning experiences. Additionally, ongoing research and feedback loops are essential to refining VR content and enhancing its accessibility and effectiveness across diverse educational environments.

VII. CONCLUSION

The VRSEL framework marks a significant advancement in integrating technology with educational practices, particularly in fostering SEL. By harnessing the immersive nature of VR, this framework creates interactive, lifelike scenarios where learners can actively engage in experiences that cultivate emotional intelligence, empathy, and other essential SEL skills among adolescents especially in Malaysia. Through virtual environments that replicate real-world social situations, VRSEL allows students to practice and enhance their emotional responses, decision-making, and interpersonal interactions in a safe, controlled setting. This experiential approach offers a deeper understanding and retention of SEL concepts compared to traditional methods.

However, the successful implementation of VRSEL in educational settings necessitates careful design and consideration of various factors. The framework's effectiveness hinges on the alignment of virtual experiences with learning objectives and the seamless integration of the technology into existing curricula. Designing these virtual environments requires a solid foundation in SEL principles and must be tailored to the diverse needs of learners, including varying learning styles and abilities. Additionally, ensuring that the content is culturally relevant and inclusive is vital for creating a positive learning experience for all students. Continued research and development are essential to fully realize the VRSEL framework's potential. While the benefits are evident, challenges such as technical limitations, content development, and the need for comprehensive educator training must be addressed. Ongoing studies are necessary to refine the framework, optimize the user experience, and assess the long-term impact of VRSEL on student outcomes. By overcoming these challenges and fostering innovation, VRSEL has the potential to transform SEL education, making it more engaging, effective, and accessible to learners worldwide.

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