Augmented Sensory Experience and Retention: ASER Framework

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***Abstract*—In the process of shifting from traditional teacher-centred systems to more student-engagement ones, Augmented Reality (AR) is coming into its own as a way of improving how information is delivered and received. However, while the use of AR is commonly attributed to increasing engagement, the potential of this technology to support deep, long-term learning is not fully explored. The ASER Framework (Augmented Sensory Experience and Retention) offers a new approach to this gap by integrating emotional memory, interactive storytelling, and gamification within AR environments. After analyzing the current state of AR education research, this study found a lack of frameworks that combine these elements systematically, thus offering a chance to improve cognitive retention and meaningful learning. A multi-sensory model proposes ASER for emotional connection, participation, and knowledge consolidation. The theoretical foundation is strong; however, further empirical validation is required to determine its real-world effectiveness across diverse educational settings. These recommendations provide a starting point for future research and implementation strategies that seek to change the rules of instructional design for engaging and enduring learning experiences.**

***Keywords*—Augmented Reality (AR); emotional memory; interactive storytelling; gamification; Augmented Sensory Experience and Retention (ASER) Framework**

I. Introduction

AR is changing the education system by providing real-world application of the theoretical concepts learned in the classrooms. In its simplest form, AR involves using digital information in the real world and, therefore, provides a way of making learning more practical, enjoyable and meaningful [1]. As pointed out by Alhebaishi, even though the use of AR in education has been found to improve students' engagement and understanding, the impact of AR on long-term memory is still unclear.

Current research has mainly focused on short-term cognitive results with little or no concern about how AR-based simulation can help in encoding and retrieval in the long run. Studies in emotional engagement reveal that the incorporation of emotional content in the learning context improves both the cognitive and memory processes [2]. According to Alhebaishi, emotional engagement helps to make a connection with the learning content and thus enhances the memory processes of encoding and retrieving. When AR experiences are created to elicit emotional responses from the user in the form of stories, narratives, or games, then the content becomes more meaningful and easily remembered. The absence of standardized tools for evaluating the effectiveness of AR in the retention of knowledge is a major research deficiency. This omission is crucial to guarantee that AR is applied not only as a fun way to learn but as a means of enhancing retention and understanding [3]. Thees have identified how AR can improve the learner's interest, passion, and the retention of the matter through the creation of holistic and complex learning environments [4]. The conventional way of teaching is passive and includes such processes as telling, demonstrating, or showing the students something, while AR provides an active way of learning where digital objects can be interacted with, problems can be solved, and instant feedback can be received [5].

Nevertheless, there are various advantages of AR in the educational sector, which are still waiting to be discovered and used in the process of identifying the most effective pedagogical strategies for deep learning and memorization. The biggest problem with AR learning is the absence of a framework that would integrate cognitive, affective, and motivational factors to optimize the learning process [3]. Conventional learning strategies may be unable to maintain students' interest and may also cause cognitive overload, resulting in poor long-term knowledge acquisition [6]. It is, therefore, important to suggest an integrated learning theory that incorporates AR together with other effective teaching strategies, not just for the purpose of achieving surface learning but for the production of meaningful, long-lasting learning experiences. In an attempt to fill this gap, the present framework proposes a new conceptual framework that integrates three core aspects: emotional memory, storytelling, and gamification. This study is guided by the following research question: How can a new augmented reality (AR)-based educational framework be designed to improve student engagement and enhance long-term knowledge retention in learning environments? To address this question, the ASER Framework is proposed as an integrative model that leverages emotional memory, storytelling, and gamification within AR environments.

Emotional memory has an important role to play in education because it is easier to encode and retrieve emotions than other types of information [7]. In this paper, it is suggested that AR can be used to induce emotions through narrative-based experiences and interactive components of the framework, which in turn improves the cognitive aspect of memory by creating an association between the learning content and emotions.

This connection is strengthened by interactive storytelling, which engages learners in meaningful environments where they can learn through stories [8]. Research in cognitive psychology has shown that narrative is an effective way of arranging information in a way that is easy to understand and remember [9]. When AR is incorporated into the storytelling process, the learners are no longer passive recipients but active participants, increasing cognitive involvement.

Gamification, which involves the use of elements such as reward, progress, competition, and real-time feedback to keep the learner motivated and engaged. Most famous for its capacity to enhance the fun and goal-directed aspect of learning, gamification enhances students' persistence and performance [10]. In the context of AR-based learning, it not only helps in the development of critical thinking and problem-solving but also encourages constructive learning attitudes through dynamic rewards and personalized learning paths [11].

Although these components—emotional memory for retention, storytelling for motivation, and gamification for engagement—are effective, not many AR educational models have incorporated two of them into good pedagogical practice. Despite the fact that each of these aspects has been investigated separately in previous research, no effort has been made to understand how they can be combined to achieve a moderate level of learner involvement in AR environments. The proposed framework solves this problem by presenting a systematic, empirically based framework that incorporates these three elements into a coherent framework for designing AR-based learning experiences. Based on cognitive science, educational psychology, and human-computer interaction, it provides a new perspective on how AR can solve some of the problems of conventional teaching methods.

This paper aims to describe the theoretical underpinning, the strategies for putting the framework into practice, and the expected results of the proposed framework, including the effects on student engagement, learning, and cognition. Furthermore, it outlines the current deficiencies of AR education and claims that integrating emotional memory, storytelling, and gamification can significantly improve the quality of learning experiences in various educational settings.

A. Paper Organization

The remainder of this paper is organized as follows:

1) Objective: This section outlines the primary goal of the ASER Framework, emphasizing its role in enhancing long-term knowledge retention through emotional memory, storytelling, and gamification.

2) Previous frameworks: A review of existing AR-based educational models, discussing their strengths, limitations, and gaps that the ASER Framework seeks to address.

3) Previous works: This section explores related research on emotional memory, storytelling, and gamification, demonstrating their individual effectiveness in education.

4) The Effect of background music on cognitive and emotional memory: A discussion on the cognitive and emotional impact of background music and its potential role in enhancing memory retention.

5) Introducing ASER framework: This section presents the ASER Framework, its theoretical underpinnings, and how it integrates emotional memory, storytelling, and gamification.

6) Framework overview: An explanation of the structure and mechanisms of ASER, detailing how it enhances learning experiences.

7) Core components: A breakdown of the three fundamental elements—emotional memory, interactive storytelling, and gamification—illustrating their roles and interactions.

8) Structured integration of background music, storytelling, and gamification: This section describes how these components are systematically combined to maximize engagement and retention.

9) Synergistic integration for enhanced learning: Analyzing how the combined use of emotional memory, storytelling, and gamification creates a holistic and immersive learning environment.

10)Layered approach to learning enhancement in AR: ASER framework: A structured breakdown of ASER into the Theory Layer, AR Application Layer, and Outcome Layer, highlight-ing its implementation and impact.

11)Conclusion: A summary of the study's contributions, implications for educational practice, and directions for future research.

II. Objective

The primary purpose of this framework is to develop a theoretical model that can be used to improve the learning effectiveness of techniques that aim to enhance the long-term memory of knowledge. This improvement could be achieved through the combination of cognitive load theory and the latest technological tools, such as emotional memory, interactive storytelling, and gamification techniques.

The framework aims to reveal new ways and means that can help to increase the impact of educational interventions, with a special emphasis on the role of emotional arousal and story-based instructions in the process of memory consolidation. With the help of these factors, the framework is to offer a more comprehensive view of education, to the exclusion of conventional teaching methodologies in the aspect of retaining information in the long run.

This framework is significant as it has the potential to change the way educational practices are carried out. By proposing a new way of thinking about the integration of technology and cognitive science, this framework aims to solve the problems of students' attention and memory, as well as the durability of learning outcomes. Its findings are especially significant in settings where traditional approaches have failed to deliver the desired results, thus calling for more creative and engaging ways of teaching and learning.

The originality of this framework lies in the fact that it establishes a theoretical basis for a new strategy of enhancing the retrieval of knowledge from long-term memory within the context of education, with the primary focus being on the cognitive and technological factors and not on the actual results. The concept of emotional memory and interactive storytelling as retention tools is a new perspective in educational research that the framework introduces. The framework is intended to stimulate further academic work, including discussion and development. In the end, the idea presented in this framework may help to inform further research and application, so that future educational interventions will be more innovative, effective, and memorable, and thus more likely to engage learners and improve memory retention.

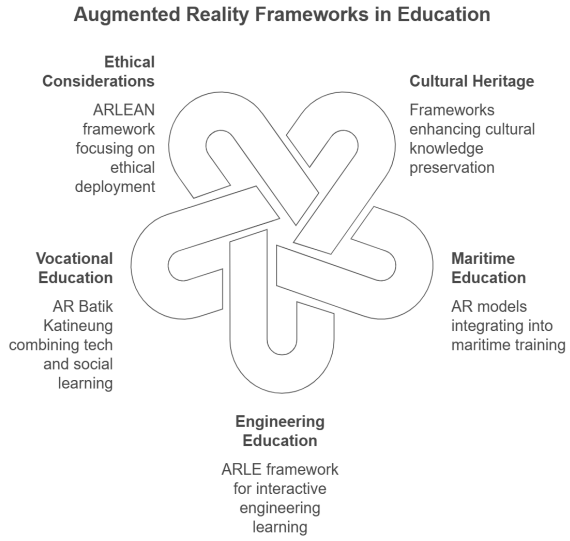

Fig. 1. An overview of various AR frameworks used for educational purposes [12] [13] [14].

III. Previous Frameworks

Various fields have spanned the exploration of AR frameworks to offer innovative solutions to improve educational and professional practices. The framework developed by Innocente is used to leverage immersive XR technologies in the domain of cultural heritage [12]. This framework is based on a user-centred design approach in conjunction with the PRISMA guidelines to conduct a systematic review of XR applications. It greatly aided in the conservation and distribution of cultural information and delivered more immersive and engaging experiences for users to interact with historical information. In maritime education, Balcita and Palaoag proposed an AR model framework to incorporate AR technologies into conventional maritime training [13]. This framework provided practical skill development through the provision of practical simulations and realistic training scenarios, but it had some problems in the integration of the technology and the users' adaptation to it. In engineering education, Faridi also designed an ARLE framework which applied 3D models and mobile applications to build a 3D AR environment for learning [14]. The framework designed for the implementation of AR in the learning environment (ARLE) helped the students to learn, as they could interact with virtual objects and had a chance to visualize complex engineering concepts. Christopoulos and Mystakidis proposed the ARLEAN Ethical Framework for integrating learning analytics with educational technology [15]. It also highlighted the ethical issues that are associated with the use of AR technologies, leakage and hence bias, and balanced usage of technology in learning. In vocational education, AR was integrated, and Widiaty developed the framework of AR Batik Katineung [16]. The framework integrated technological skills with social learning skills to build a comprehensive curriculum that included both technical skills and cultural skills. Challenor also applied AR in cultural heritage education to design a framework that could enable storytelling to make historical and cultural content more engaging and accessible. This framework was intended to develop an emotional connection with the material to support knowledge retention and transfer [1]. These frameworks, therefore, demonstrate the varied uses of AR in different fields and how AR can be used to solve particular educational or professional problems (see Fig. 1). But they also have common challenges, such as the need for high-quality hardware, technical support, and equity. Further research should be done to overcome these challenges, improve the scalability, availability, and ethical implications of AR technologies and find new applications of AR in emerging fields to unleash the full potential of AR in learning and other industries.

IV. Previous Works

Emotional memory is a critical factor that can help to make the learning process more effective within the AR environment. Number of studies also confirm the significance of emotional engagement in designing effective and engaging learning processes. In the study by Leinonen, emotional engagement was observed through collaborative storytelling. The connection between the stories and the emotional responses helped the children to learn and engage in the content more easily. The high emotional responses induced by this AR-based storytelling showed the effectiveness of emotional memory in the learning process [17]. In another important research, Muhammad explained how AR-based learning environments enhance motivation and emotional attachment to the content. This emotional engagement, which was facilitated by the interactive AR experiences, improved both the engagement and the retention of the content, which supports the role of emotional memory in educational contexts [6]. In museum environments, AR was found to significantly increase emotional connections and, therefore, knowledge retention. Gong established that AR provided an enhanced emotional experience through the physical interaction with the museum objects in order to improve the long term memory [5]. This effect was also observed

in the area of science education where AR was capable of acting as an emotional trigger to enhance students' academic achievement and retention of knowledge [18]. Furthermore, the real-time data analysis during the laboratory experiments using AR made the hitherto abstract concepts more tangible and emotionally appealing and thus helped in the retention of complex concepts. Thees also provided evidence for this effect by showing that the emotional connection to real-time data improved retention [4]. In Sabbah study, emotional engagement was linked to motivation, which in turn increased retention. Even though emotional memory was not directly measured, the ARCS-V model (which is based on attention, relevance, and satisfaction) showed that emotional interest made the learning experiences more meaningful and meaningful [19]. For instance, in Lai's study, immersive AR environments helped students to develop an emotional relationship with the content to improve retention through engagement.

In other cases, the emotional memory is implied indirectly through motivation and engagement results [20]. In addition, Aydogdu showed that AR-enhanced motivation and attention, producing interesting experiences that could well prove useful for future learning [21]. Amores, and Ciloglu also reported that AR could help students develop an emotional affinity towards the content and, in turn, improve their motivation and memory retention [22][23].

It is important to note that gamification is one of the most successful features of AR-based learning that has been used and proven to be effective in increasing motivation, engagement, and retention in various studies. It includes elements of the game, such as plot, mini-quizzes, and character actions, which increase the learner's motivation and help them remember the information better. For example, Li presents how a gamified AR environment with interactive storytelling increases retention by keeping the learners engaged.[8] In the same manner, Muhammad integrates quizzes and other interactive features into the learning process and reveals that gamification enhances both motivation and retention [6]. Syskowski establishes that the AR-based gamified elements in physics education increase students' interest, achievement, and participation.[24] Furthermore, Yoo argues that the gamified interactions in the AR environments increase the motivation and engagement of the learners and, therefore, improve retention of the content [25]. In the area of vocabulary learning, Belda found that gamified AR learning was more effective in retention and performance than the conventional method.[11] Furthermore, Delgado presented how motivation and student performance were enhanced through gamification in AR applications, leading to increased retention.[26] Lastly, in the area of chemistry, Liu shows that gamified AR experiences are engaging to students and thus improve retention [27]. This pattern holds across studies by Jdaitawi and elik where the immersive and gamified nature of AR enhances both learning and retention [10][28].

This paper aims to explore how storytelling helps enhance learners' sensory engagement, retention, and overall participation in the AR environments. As a pedagogical tool, storytelling acts as an anchor that helps learners connect with the content on an emotional level, thus ensuring that the content is well-committed in the long-term memory. In this paper, Sanchez shows that storytelling was an important factor that led to improved retention of the material through the development of emotional links with the learners [9]. This is in consonance with the findings of Li where dynamic and player-adaptive narratives helped in maintaining the attention of the learners and improving memory retention [8]. However, in AR, storytelling can be used to make the learning process more relevant and engaging, especially in language-learning classrooms. Ersanli found that AR applications that use narratives increased vocabulary learning because they were engaging [29]. Similarly, Zuo argued that the fantasy and real-life narratives in the game-based AR increase the cognitive engagement and memory retrieval [30]. In addition, it can be noted that in the process of reflective thinking and motivation, storytelling also plays a significant role. Sabbah also points out that AR-based storytelling tools can improve reflective thinking to positively influence learning [19]. In cultural heritage education, the stories are used to engage the learners in emotionally charged experiences. De Paolis established that the use of AR in storytelling increased engagement by offering detailed historical and cultural information [31]. Similarly, Singh stresses the role of interactive and adaptive narratives in the creation of immersive learning environments that enhance retention [32]. Not always the storytelling is the main focus in AR applications, but it is usually incorporated into them. Chen, reflective prompts were used to guide students through the learning process, acting as a narrative structure to help them understand and retain the learnt matter [33]. Sometimes, the storytelling elements are combined with traditional teaching methods. Despite the fact that some studies, for example, Christopoulos, do not include storytelling as a specific strategy, they employ immersive AR environments that provide narrative-like guidance through a sequence of learning tasks [34].

A. The Effect of Background Music on Cognitive and Emotional Memory

Background music has been found to improve cognitive performance and the management of emotional memory in learning environments. Azmi's research also indicates that including Lo-Fi and classical music in the classroom improves attention, memory, and mood, which in turn creates a positive and productive learning atmosphere by decreasing stress in students. Instrumental music with a slow beat (60-80 BPM) was the best for tasks that require focus over a long period of time, while music with a moderate pace (80-100 BPM) was suitable for quick thinking and problem-solving. Background music should be played at a volume that does not interfere with the instructor's ability to convey information and should usually be between 30% to 40%[35]. Similarly, Rickard explored how relaxing music can be played after being exposed to emotionally charged content to help regulate memory recall. The study revealed that post-event music acted as a moderator of increased emotional memory consolidation, meaning that background music can be used to manage the emotional effects of learning [7]. This is also supported by Que, who investigated the effect of music on task performance and emotional control. The result of the research revealed that background music decreased students' level of frustration and improved their reading comprehension performance, thus revealing that music can be used to improve concentration during difficult tasks [36]. Last, Tyng explained how learning

is affected by music-induced emotions whether positive or negative. The study established that, by synchronising music with the emotional content of the material, memory retention and attention can be improved and that music can, therefore, be used to regulate mood to enhance learning [37]. Taken together, these studies suggest that the appropriate choice of background music can enhance learning by improving attention, decreasing anxiety, and shaping emotional responses. Thus, background music can be used by educators to produce an optimum learning environment and better emotional as well as cognitive development of the students.

V. Introducing ASER Framework

The ASER Framework represents a novel approach to enhancing long-term knowledge retention in educational settings by integrating emotional memory, interactive storytelling, and gamification. Based on cognitive science and the latest developments in educational technologies, the framework seeks to improve both engagement and retention at the same time. The Previous Works section presents a demonstration of this through a review of the existing AR-based learning research, which reveals a significant absence of studies that simultaneously incorporate all three elements. Each of these elements, emotional memory, storytelling and gamification, have been shown to enhance learning on their own, but their joint use has not been well explored. This finding indicates a missed opportunity in the current AR education to fully tap into the potential for building rich, long-lasting and emotionally rich learning experiences. The ASER Framework fills this gap by proposing a unified model of these elements and recommending that future attempts should focus on more holistic integration for greater learning effectiveness.

A. Framework Overview

To enhance knowledge retention, the ASER Framework uses the following approaches: Multi-sensory engagement, Emotional connection, and Interactive storytelling. The main purpose of this framework is to develop engaging and enjoyable ways of learning that cannot be achieved through conventional teaching. ASER Framework consists of several components that help to make the learning process more meaningful and easier to remember through the use of different senses, emotional engagement, and interesting stories. In this way, the ASER Framework seeks to enhance engagement and productivity in the learning process in order to enhance the retention of learned matter. To support cognitive development, ASER integrates Bloom's Taxonomy as a foundational structure for cognitive progression in AR-based learning environments(see Fig. 2). Hence, emotional memory assists in the acquisition of Knowledge and Comprehension, while interactive storytelling supports Application and Analysis, and gamification encourages Synthesis and Evaluation. Thus, through alignment with Bloom's hierarchical model of learning, ASER ensures that the educational interventions not only engage the learners in the immediate moment but also support the development of progressive and lasting cognitive growth.

B. Core Components

1) Emotional connection: This component seeks to generate strong, lasting impressions by tapping into emotional

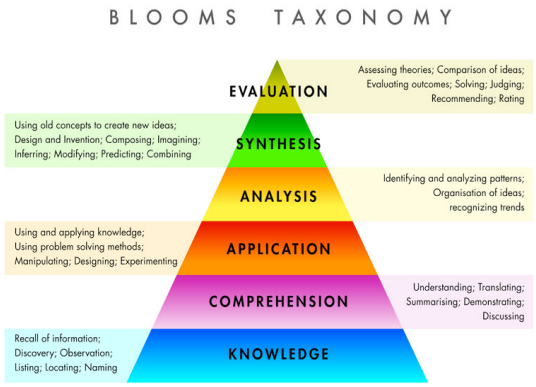

Fig. 2. Structure of bloom taxonomy [38].

memory. Emotions are powerful drivers of memory, and by incorporating emotionally resonant content [39], the framework helps learners connect with the material in a deeper way, making it easier to remember. Emotional memory is invoked through the use of background music, which makes the learning environment more engaging. Background music is used to help students make emotional connections with the content of the lesson in order to encourage emotional involvement. For instance, when teaching a chemistry lesson on chemical reactions, using energetic background music when showing an interesting experiment, for instance a color changing reaction, can help students feel more interested and emotionally involved in the activity. That means that emotional engagement enhances their attention, increases the depth of understanding, and facilitates the long-term storage of science concepts, including the difficult ones. Background music stimulates emotional responses that, in turn, enhance focus and understanding for better recall and learning (see Fig. 3). In this case, the emotional involvement serves to reinforce the learning material in the long-term memory and thus enhance both the retention and the satisfaction with the learning process.

Interactive Storytelling: This component uses the power of narrative to situate the content within a context. In addition, through the use of interactive storytelling, learners can learn about various scenarios and their possible outcomes while being an active part of the learning process. Not only does this make the material more fun for the students, but it also enhances their understanding and memory of the information. Interactive storytelling comes with a twist to make the stories more relatable and linked to the students' lives. Although the use of globally recognized stories is effective at first, they may not be enough to capture the attention of today's students, who are known to have a very short attention span and are easily distracted. In order to solve this issue, the lesson content is developed to include narratives that are similar to the students' lives thereby improving the learning concentration and memory. Storing familiar themes in a different way makes the storytelling process more interesting, thus engaging learners and helping them learn more easily [40]. This approach not only enhances the appeal of the lessons but also assists students in retaining information by relating it to their own experience and environment, thus making the learning process more effective and enjoyable (see Fig. 4).

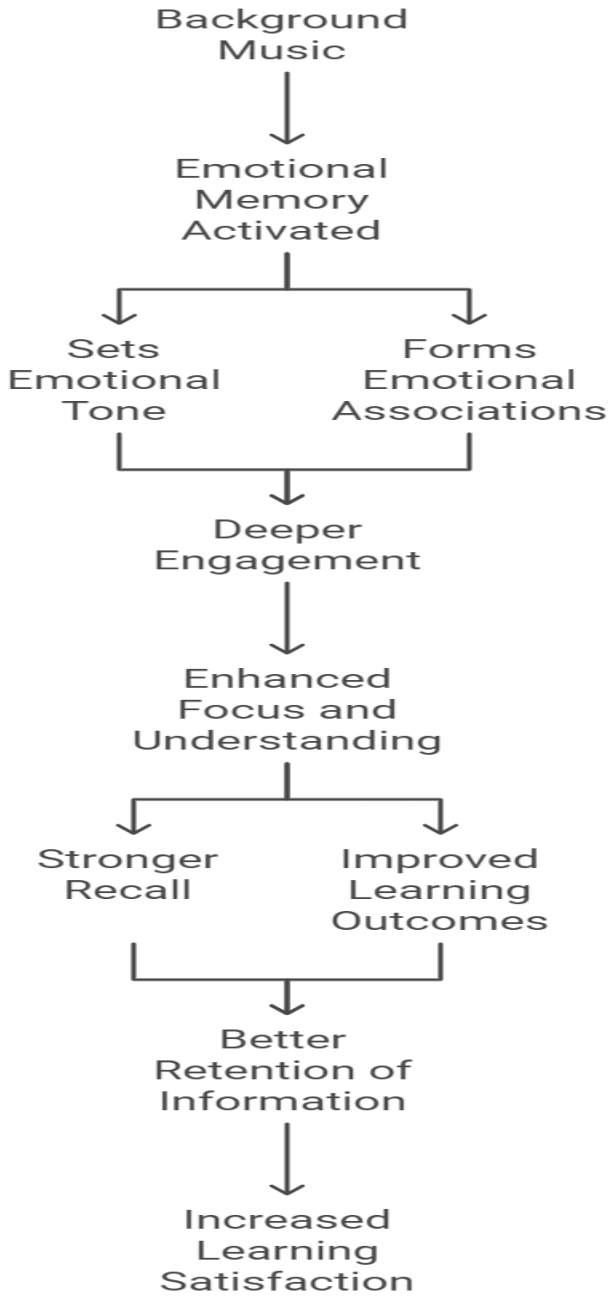

Fig. 3. Role of background music in activating emotional memory.

2) Gamification: ASER Framework has implemented gamification to enhance the process of transforming boring classroom activities into more interesting and engaging tasks that would make students want to participate and do their best in the process (see Fig. 5). In this approach, students get level-ups for giving the right answer in class, making it a fun process. All the level-ups are combined with motivational background music to make the experience even better for the students and increase their motivation. The combination of immediate reward and music makes the environment positive, and the students are likely to remain interested and want to improve their status.

However, if a student is struggling or gives a wrong answer,

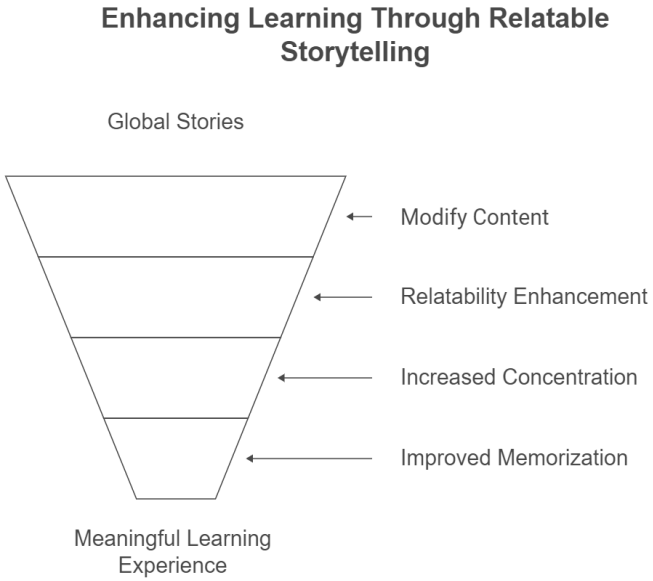

Fig. 4. Enhancing learning through relatable storytelling.

the framework uses another plan: Encouraging the student through gentle prompts and positive messages, not punishing them. This way, there is a more balanced approach between the positive and the negative aspects of the learning process, and the motivation is kept high throughout the lesson. In the meantime, students are encouraged to learn from their mistakes, which are considered as lessons rather than failures. This approach is based on the premise that mistakes are inevitable in the learning process and should be re-engineered as learning experiences from experiential learning theories to enhance understanding and memory in education [41]. In this case, the gamification elements are applied, and therefore, the classroom environment is similar to a game, which makes students more active, learn more and desire to improve themselves.

C. Structured Integration of Background Music, Storytelling, and Gamification

The ASER Framework recommends using background music as an emotional trigger for memory in conjunction with interactive storytelling, which is supported by character-driven and narrative-based approaches. Enhanced with gamification elements like badges and music cues, it seeks to develop a more lively and engaging learning process. It is emotionally tuned through background music by prompting learning phases with motivator cues such as cheerful music during achievement intervals and calm music during introspection, which helps in recalling the different states associated with the critical points in the learning process. It enhances the focus, comprehension, and retention of the material since music helps in the formation of strong roots of cognitive and affective associations with the content [42]. The storytelling element includes three approaches that should be incorporated into the narrative structure of the project: Interactive Storytelling: It means that learners can make decisions that will affect the overall direction of the unfolding story, which will help to develop critical thinking and personalization of the learning

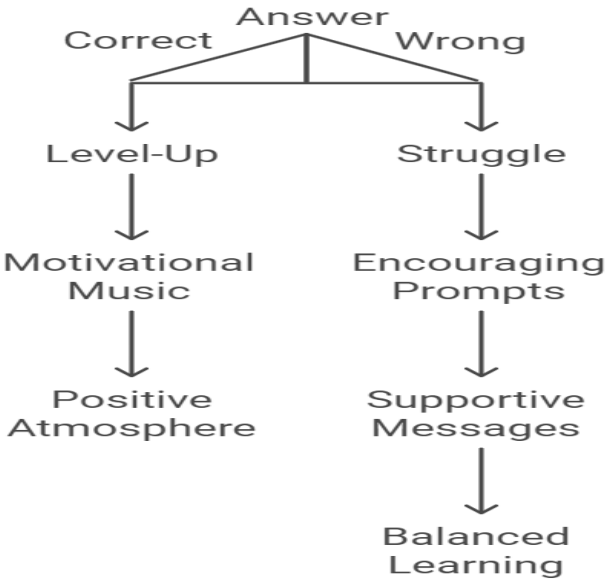

Fig. 5. Gamification response system in learning.

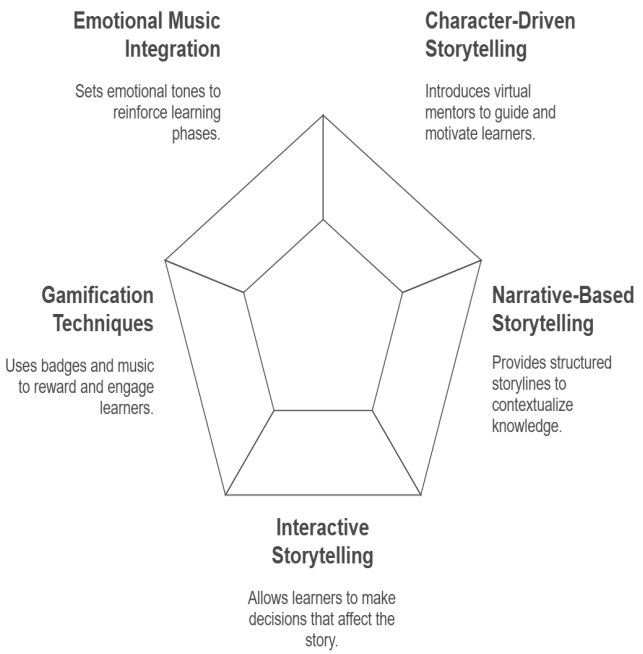

Fig. 6. Gamification response system in learning.

process. Narrative-Based Learning is a type of Learning in which a structured storyline is provided to learners so that their knowledge acquisition becomes contextualized and meaningful; Character-driven storytelling: The use of virtual mentors and companions to provide mentoring, encouragement, and real-time feedback. Gamification: ASER also incorporates elements of gamification, say, through the use of different badges and achievements to motivate learners to achieve challenges, a clear performance tracking system to update the learners on their performance in real-time, and music cues to engage, motivate, and create an emotional connection to the learning content (see Fig. 6). These all combine to create a synched up, dynamic, and emotionally charged learning environment, which should in turn lead to better engagement, a more profound understanding, and improved long term retention.

D. Synergistic Integration for Enhanced Learning

The three components must be cohesively integrated to achieve the intended outcomes; emotional connection is activated through background music, which is strategically used at key moments to match the lesson's emotional content, aiding memory recall. This approach uses tempo, rhythm and tone variations to engage emotion and link content to long-term memory, making the learning process more engaging and personalised. Interactive storytelling also helps to place the material in context and uses engaging, relatable narratives that can be customised to students' responses. These narratives are based on real-life situations that students can easily relate to, hence making the content easy to comprehend. Also, role play and virtual storytelling are active participation tools, while narrative-based assessments enhance understanding. Gamification makes most classroom activities fun and engaging tasks that students learn from by turning them into games complete with a level-up system and instant feedback. In order to use this framework effectively, teachers need to be trained to include music, storytelling, and gamification into their teaching and adjust them to the specific situation in the classroom. Online resources can help to integrate the various elements easily, and feedback from students and analysis of data can help refine the components of the framework for maximum learning benefit (see Fig. 7). Thus, specifying the criteria for evaluating the effectiveness of ASER Framework in enhancing retention, engagement, and emotional learning, it is possible to create a framework that would not only help students learn better in the short term but also retain the information and enjoy the learning process more.

VI. Layered Approach to Learning Enhancement in AR: ASER Framework

ASER Framework employs a multi-layered approach to maximize learning engagement and retention within AR environments. This approach integrates three main layers:

A. Theory Layer

1) Foundation of learning enhancements: This layer includes the basic theoretical concepts— emotional memory, storytelling, and gamification, which are the basis of the ASER Framework. These components are critical in the development of an effective and interesting learning process and thus form the basis of a more holistic approach.

B. AR Application Layer

1) Implementation of the theory in practice: This layer focuses on the real-life use of the theory in the AR environment,

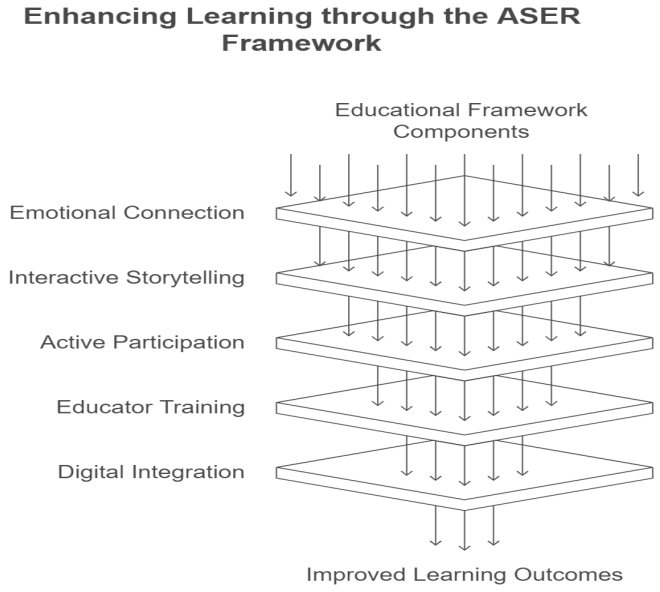

Fig. 7. Multi-Layered ASER framework for enhancing learning.

with the help of various elements to make the place come to life. Emotional memory is stimulated by the background music, storytelling is linked to the students' real-world situations, and gamification makes learning more fun and rewarding. These strategies in combination help to capture and maintain learners' attention and focus, as well as encourage them to remember information while being in the AR environment.

C. Outcome Layer

1) Analyzing the learning effect: This last layer looks at the results of the framework, which measures the students' learning, retention, and participation. Based on the work of Bloom, this layer uses the taxonomy as a way of measuring the cognitive gain and for the development of higher-order thinking skills and thus the success of the framework in the attainment of both acute and future learning results.

The evaluation process starts with identifying whether students are able to recall and understand concepts introduced through the AR-based storytelling so they have learned the basic facts. Then students are tested on their ability to apply and analyze this information by solving problems or making decisions within the AR environment, thus showing more complex thinking. Last, the evaluation and creation levels of Bloom's Taxonomy are addressed by requiring students to think about their learning experience and come up with their own ideas and solutions based on what they have learned in the immersive environment. This is a systematic way of ensuring that the ASER Framework does not only improve on the rates of learning and retention but also the development of critical thinking skills thus providing for a more effective and impactful learning process (see Fig. 8).

By integrating these layers, ASER Framework provides a structured, immersive learning experience that connects theory, practical application, and evaluation, ultimately enhancing both engagement and long-term retention.

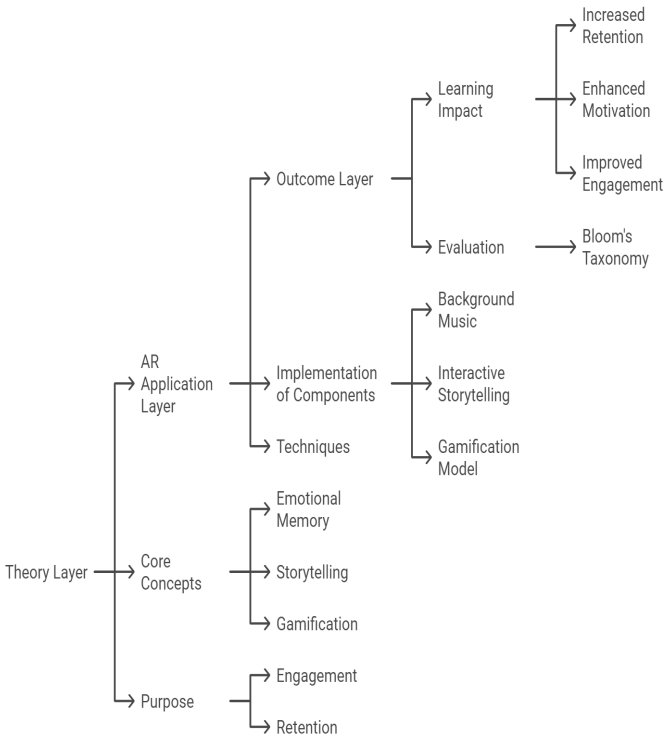

Fig. 8. The structure of ASER framework.

VII. Conclusion

The ASER Framework is a theoretical framework that was proposed to change the way we deliver educational experiences with the help of emotional memory, storytelling, and gamification within the AR environment.

The paper identifies a significant research gap in the integration of emotional memory, storytelling, and gamification in AR-based educational environments, thus signaling a possibility to enhance the application of AR in education. Through the integration of these elements, the ASER Framework seeks to overcome the limitations of current educational practices and offer learners greater emotional involvement, contextualization through stories, and playfulness.

ASER Framework has been postulated as a theoretical framework to stimulate the development of subsequent studies and the creation of more sophisticated AR applications that integrate all three components.

The possible directions for future research can be connected with the implementation of this framework in various educational settings, evaluating its effectiveness for various users, subjects, and settings. Thus, the ASER Framework can be considered as a starting point for the enhancement of educational practices and, therefore, as a way of enhancing the quality, usability, and duration of the learning process. By addressing potential challenges such as technology accessibility and educator training, the ASER Framework can serve as a foundation for advancing educational practices, ultimately leading to more sustainable, engaging, and effective learning outcomes.

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