



An Interdisciplinary Study on Generative AI: Exploring Its Efficacy in Mental Health Interventions within the Gaming Ecosystem

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ABSTRACT

The integration of generative artificial intelligence with game mechanics in e-health innovations holds promise for addressing mental health challenges. However, the extent to which this inter-section can provide effective, applicable, and safe interventions remains unclear. In this regard, this paper evaluates the effectiveness, usability, and benefits of integrating generative AI and gaming in e-health innovations for mental well-being. (1) Background: Through a multidisciplinary approach and the utilisation of secondary sources drawn from various disciplines like healthcare, psychology, and computer science, the study seeks a comprehensive understanding of the study topic. Findings show that the integration of generative AI with game mechanics in mental health interventions offers effective and engaging interventions, fostering emotional connection, therapeutic outcomes, and usability. However, ethical considerations, content filtering, and data privacy issues should be addressed for safe implementation. (2) Methods: Through a multidisciplinary approach with regard to theory triangulation, investigator triangulation, and utilisation of secondary sources drawn from various disciplines like healthcare, psychology, computer science, and databases such as PubMed, Science Direct, and BMC Public Health, the study seeks a comprehensive understanding of the study topic. Numerous quantified sources published on or after 2020 were investigated for design triangulation in terms of determinants, indicators, and deductive rigour in the formation of search terms. (3) Results: The thematic analysis shows that the integration of generative AI with game mechanics in mental health interventions offers effective and engaging interventions, fostering emotional connection, therapeutic outcomes, and usability. However, ethical considerations, content filtering, and data privacy issues should be addressed for safe implementation. (4) Conclusions: Generative AI-driven game mechanics interventions have illustrated significant increases in emotional connection, engagement, and therapeutic outcomes in mental health interventions. Particularly, the increased emotional connection, engagement, and positive therapeutic outcomes associated with generative AI-powered game mechanics enhance the quality-of-service delivery to people with mental health as the enjoyment and motivation of playing games increase the effectiveness and acceptance of AI in the healthcare environment.

Keywords: Generative artificial intelligence, Gaming, Serious Games, e-health, eHealth, Healthtech, Mental health, OpenAI, ChatGPT, Google Brain, IBM Watson, Google Bard, Deepmind, Health Informatics, digital therapeutics.

INTRODUCTION

Rationale of Study

The field of artificial intelligence (AI) has witnessed remarkable advancements in recent years, particularly in the area of generative AI. As defined by Pavlik [16], generative artificial intelligence is the application of machine learning techniques to generate new and original content like text, music, and images, based on patterns and examples learned from existing data. Unlike traditional cyber-physical artificial intelligence systems that have relied on pre-defined rules, generative AI models can produce novel outputs that resemble the training information they were exposed to [17; 18; 19; 20; 21; 22]. Existing evidence shows that the integration of generative AI, exemplified by companies like OpenAI [23], IBM Watson [24], Google Bard [25], and Google Brain-Team [26], with gaming presents effective and personalised e-health interventions for mental well-being [1; 2; 3; 4; 5; 27; 28; 29; 18; 19; 20; 60]. For instance, Deniz-Garcia et al. [5] suggest that the integration of generative AI and gaming enables the creation of personalised narratives and characters that resonate with individuals (patients), promoting emotional connection and engagement. Also, Montag et al. [32] affirm that through generative AI, adaptive gameplay experiences that dynamically respond to the mental states of the user can be created, providing appropriate challenges, support, and feedback. Therefore, by leveraging generative AI techniques, gaming platforms dynamically adapt to generate content in real-time, tailoring experiences to the specific needs and preferences of individuals [3; 4; 5; 6; 7; 8].

The current design-oriented triangulation study will examine generative AI's role in fostering healthtech innovations within the gaming ecosystem with respect to established generative AI companies such as Google Bard [25], IBM Watson [24], Google Brain-Team [26], and OpenAI [23].

Mental health and well-being have emerged as critical concerns in an increasingly fast-paced and digitally connected society [7; 8; 9]. Advancements in technology have opened up new possibilities for addressing mental health challenges, and one promising avenue is the integration of generative artificial intelligence with gaming within the context of e-health innovations [5; 10; 11; 12; 13; 14; 15; 16; 17; 30; 31; 32; 33; 34; 35; 36; 37]. Conversely, despite the growing interest in this area, there remains a need to establish the extent to which generative AI, when intersected with gaming, can provide beneficial, applicable, and notably safe technological and digital interventions for mental health and well-being [18; 19; 20; 38; 39; 40; 41; 42]. Although the existing body of research elaborates on the potential of both generative AI and gaming in mental health interventions, there is a comprehensive understanding of the specific contributions and implications of integrating the two domains [43; 44; 45; 46; 47; 48]. Additionally, there is a need for a multidisciplinary approach in the sense of design-oriented triangulation to the current study phenomenon, as the intersection of generative AI, gaming, and healthcare requires expertise from various fields, including healthcare, computer science, and psychology [49; 49; 50; 51; 52; 53; 54].

Therefore, this paper embraces an interdisciplinary perspective in attaining its aim of evaluating the extent to which the integration of generative AI and gaming in e-health innovations is effective, usable, and beneficial with respect to mental health and well-being.

Three objectives with regard to theory and the investigator triangulation approach are sought in the current study, as listed below:

1. To assess the effectiveness of generative AI-driven interventions in the context of gaming and e-health for promoting mental health and well-being.
2. To explore the usability and user experience of generative AI-powered gaming interventions in the context of e-health.
3. To investigate the safety considerations associated with integrating generative AI with game mechanics in e-health innovations.

The following research questions help in attaining the aforementioned study objectives:

1. What is the impact of generative AI-produced content, like personalised narratives and characters, on emotional connection, engagement, and therapeutic outcomes?
2. How does the user experience with regard to DIN EN ISO 9241-11 of individuals engaging with generative AI-powered gaming interventions, including factors like enjoyment, motivation, ease of use, and immersion, influence the effectiveness and acceptance of such interventions for promoting mental well-being?
3. What are the risks and ethical considerations related to AI-generated content?

Previous Studies

Existing literature demonstrates a significant impact of generative AI-generated content on emotional connection, engagement, and therapeutic outcomes in the context of mental health [55; 56]. Many established generative AI companies have made notable advancements in the area, showcasing the potential of generative AI-driven innovations to enhance the effectiveness of mental health interventions [20; 57; 58; 59; 60]. For example, IBM Watson's [24] and OpenAI's [23] generative AI technologies have been used to create personalised narratives and characters that resonate with individuals, fostering emotional connection and engagement [61; 62]. With collaboration with mental health professionals, IBM Watson [24] has developed virtual characters that offer empathetic interactions and support for persons dealing with anxiety, depression, and stress-related disorders [21; 63; 64; 65; 66; 67; 68; 69]. Similarly, within the context of mental health, OpenAI [23] has been employed as a conversational agent to provide support, guidance, and information to individuals facing mental health challenges [22; 70; 71]. For example, OpenAI's ChatGPT [23] uses natural language processing capabilities to engage in human-like conversations and generate responses that are empathetic, non-judgmental, and tailored to the specific concerns of the user [72; 73; 74; 75; 76; 77; 78; 79]. On the other hand, the Google Brain [26] team has developed generative models for creating personalised mental health interventions in the form of digital avatars [80; 81; 82; 83; 84].

These avatars are driven by generative AI algorithms and can converse with users to provide tailored advice, emotional support, and coping strategies [85; 86; 87; 88; 89; 90]. Furthermore, Google's latest chatbot, Bard [25], has shown progressive improvements and holds the potential to be a significant advancement in the field of conversational AI, which could be useful in powering gaming interventions for people with mental health issues [91; 92; 93; 94]. These examples from IBM Watson (2023), Google Brain [26], and ChatGPT [23] showcase the positive impact of generative AI algorithms in creating personalised and (re-)adaptive experiences that enhance user engagement, facilitate deeper emotional connections, and improve therapeutic outcomes [95; 96; 97].

Evidence suggests that user experience factors in the sense with regard to DIN EN ISO 9241 of generative AI-driven innovations such as enjoyment, ease of use, motivation, and immersion influence the overall impact and acceptance of such interventions in the mental health context [14; 15; 18; 19; 20; 60; 98; 99; 100]. For instance, Shahsavar and Choudhury's [14] evaluation of OpenAI's ChatGPT [23] user experience shows that the model's ease of use is a critical factor that influences its acceptance and effectiveness. ChatGPT's [23] ability to produce empathetic and helpful responses, together with its intuitive interface, has enhanced its ease of use and acceptability among individuals seeking mental health support [14; 23; 101; 102; 103; 104; 105; 106]. Google Brain [26] has also capitalised on its user experience to enhance its impact and acceptance in the area of technological interventions for mental health [107; 108; 109; 110; 111; 112; 113; 114]. For example, Google Brain's [26] immersive virtual reality (VR) offers appropriate support and feedback, engages, motivates, and encourages users to invest more time and effort in the innovation, leading to better outcomes [117; 115; 116; 117; 118; 119; 120]. Similarly, the user experience factor with regard to DIN EN ISO 9241-11 in terms of an efficient, effective, and satisfying user-centred experience of enjoyment is vital to the acceptability of generative AI-driven interventions because individuals are more likely to engage with innovations that they find enjoyable [121; 122; 123; 124; 125; 126; 127]. As in the case of IBM Watson [24], the model's ability to tailor narratives and characters to specified user preferences and needs captivates experiences that enhance enjoyment and promote sustainable engagement [15; 128; 129; 130; 132; 132M 133; 134; 135]. Because of their ability to offer enjoyable user experiences, gamified innovations developed using IBM Watson's [24] generative AI have gained huge acceptance and impact in the field of e-health interventions for mental well-being [136; 137; 138]. By examining various generative AI-driven interventions, it is clear that user experience in the sense of DIN EN ISO 9241, through the factors of motivation, immersion, ease of use, and enjoyment, significantly influences the effectiveness and acceptance of such interventions for promoting mental well-being [18; 19; 20; 60; 139; 140; 142; 165; 175].

Existing records also point to potential risks and ethical considerations associated with generative AI-produced content, and the privacy and data security implications of gathering and analysing data within generative AI-driven interventions [142; 143; 144; 145; 146; 165]. According to Paul et al. [10], generative AI-produced content may be exposed to bias risk and discriminatory outcomes resulting from biases in the existing data used by the generative AI models. This implies that if generative AI models are trained using biased datasets, they may generate content reflecting such biases, causing detrimental effects on the mental well-being of users and systematic discrimination [147; 148; 149]. Also, Cheng and Hua [150], Badita [151], Munshi [152] and Pellilo et al. [153] elaborate that generative AI has a potential risk of producing inappropriate or triggering content, which can be distressing or harmful to individuals engaging with the interventions. Additionally, Ray [12] identifies significant privacy and security implications that arise from the collection and analysis of user data within generative AI-driven interventions. While the user's personal information gathered through user interactions, preferences, and emotional states does enhance the effectiveness of the interventions, it also raises concerns regarding user privacy and data protection [154; 155; 156; 157]. To address the risks and ethical considerations arising from the use of generative AI-driven mental health interventions, established AI firms like IBM Watson [24], Google Brain [26], and OpenAI's ChatGPT [23] should adopt responsible and transparent approaches [159; 160; 161; 162; 163]. These approaches may include conducting regular audits and external

evaluations to ensure compliance with ethical standards and best practises [164; 165; 166]. In addition, generative AI companies should implement stringent data security measures to protect user data from unauthorised access.

MATERIALS AND METHODS

The current design-oriented triangulation study aimed to provide in-depth insights into the user's engagement, acceptance, and impact through generative AI-powered interventions.

This empirical examination investigated the user experience of individuals engaging with generative AI-powered gaming interventions and its influence on the effectiveness and acceptance of such interventions for promoting mental well-being. The study was conducted within the context of established generative AI companies, including IBM Watson [24], Google Brain [26], OpenAI's ChatGPT [23], and others, serving as case studies. To explore the current phenomenon, this study drew on research from various disciplines, including healthcare, psychology, human-computer interaction, and gaming studies. By leveraging insights from previous studies in these fields that have explored aspects related to enjoyment, immersion, motivation, and ease of use, the paper provided a comprehensive understanding of the user experience factors that contribute to the effectiveness and acceptance of generative AI-driven gaming interventions. The paper's findings contribute to the advancement of knowledge in the field of e-health interventions, specifically focusing on the integration of generative AI with gaming to enhance mental health outcomes.

The paper used a design-oriented triangulation methodology approach [167; 168; 169; 170]. Triangulation is a technique utilised in research to improve the validity and reliability of findings by using multiple sources to examine a specific phenomenon [167; 171; 172; 173]. Particularly, theory triangulation is a technique that entails the application of multiple concepts to examine the research problem [167; 174; 175; 176]. By drawing on different theoretical views, this research has developed a more robust and comprehensive insight into the cases under examination [167; 175]. Theory triangulation permits deductive recognition of commonalities, discrepancies, and gaps in the existing theories, which can result in the creation of new theoretical frameworks [177]. More importantly, theory triangulation assists in the mitigation of possible bias or limitations inherent in a single theory by offering a wider context for the investigation [167; 178; 179; 180; 182; 182; 183].

On the other hand, investigator triangulation abductively entails the collaboration of many investigators in the course of the research [167; 183; 184; 187; 188]. By incorporating the views of researchers with different backgrounds and expertise, investigator triangulation fosters a more balanced and insightful analysis of the research data [180; 181; 182; 183]. However, method triangulation concentrates inductively on the utilisation of many data collection techniques to get information about the research topic [183; 184; 185; 186]. instance, by using different techniques, the research can cross-validate and corroborate findings, thereby enhancing the reliability and credibility of the research [175; 183]. For this research, design-oriented triangulation incorporates document analysis to gather information about the research problem. Design-oriented triangulation typically combines a range of methods to generate research findings aimed at designing products, services, systems, or experiences, as given in the present research subject [175; 183; 190; 191]. In the context of this design-oriented research, which employs a systematic literature review using deductive theory triangulation

and investigator triangulation as one of its methods, the use of the PRISMA Flow Diagram lends itself to a systematic as well as cybernetic representation of the literature review and selection process [189]. This categorically ensures an increase in transparency and traceability in terms of intersubjectivity and scope, which in turn strengthens the validity of the results of the literature review and the accompanying triangulation that enables hermeneutic circular reasoning in terms of a plausibility check. The approach enabled researchers to grasp different views of the research phenomenon and remedy the limitations related to a single method [190]. According to Lutz [191], triangulation is specifically significant in the context of inductive deficits in science. Inductive reasoning entails inferring general rules from particular cases. On the contrary, the availability of deficit inductive parts like limited data determines the strength and generalizability of inductive arguments [192]. Triangulation helps address these deficits by incorporating diverse sources and views [193]. For example, theory triangulation compensates for deficits in inductive parts by offering extra theoretical concepts to either support or criticise the emerging themes [194]. Likewise, investigator triangulation helps overcome the limitation of a single researcher's subjectivity because the incorporation of collaborative discussions and debates from researchers with diverse backgrounds and views discloses concealed assumptions, biases, or blind spots, thus improving the validity and reliability of the inductive reasoning process [187; 195].

Hence, a qualitative method in the sense of design-oriented triangulation as research on comprehensibility was employed in exploring the experiences and meanings in terms of effectiveness and acceptance associated with generative AI-driven gaming interventions for mental well-being. The qualitative method was adopted because exploring the current study phenomenon required an in-depth understanding that could best be captured through qualitative inquiry [50]. Also, the research embraced an interpretivist philosophy in the form of a hermeneutic circular argument for the purpose of an inductive plausibility check because it sought to gain insight into the diverse perspectives and the complex interplay of the factors that influence the effectiveness and acceptance of generative AI-driven gaming interventions, as reported in the empirical literature [196]. As affirmed by Žukauskas et al. [197], through an interpretivist lens, researchers can uncover the nuanced understandings and interpretations present in the literature, contributing to a more comprehensive understanding of the phenomenon. The researcher considered an inductive research approach, which allowed for the generation of new conceptual frameworks based on the empirical evidence and the exploration of the rich context and complexities of the research topic [198; 199; 200; 201]. Through a systematic review of the literature with regard to theory triangulation and investigator triangulation, the researcher obtained a comprehensive and structured analysis of the existing empirical literature on the study subject. As elaborated by Liberati et al. [202], the process involves searching and selecting relevant studies, critically appraising their quality and relevance, and synthesising the findings to provide a robust overview of the current state of knowledge [201].

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This paper adopted a multidisciplinary approach; thus, sources from various disciplines were targeted, including peer-reviewed journals, official reports, industry publications, and reputable organisations' and research institutions' websites. A systematic search process was conducted in online libraries, the Google search engine, and various research databases, including PubMed, Science Direct, BMC Public Health, and Elsevier. Boolean operators like "AND," "OR," and "NOT" were employed during the web searches, enabling the combination of keywords and refining search queries. This strategy of using Boolean operators enhanced the search process, saving time and increasing the relevance of the retrieved sources [203; 204; 205]. Some of the combined keywords and phrases adopted in the search strategy included "IBM Watson OR ChatGPT OR Google Brain/Google Bard AND e-health AND well-being," "User experience AND emotional connection OR engagement AND generative AI gaming," "effectiveness AND acceptance AND generative AI gaming interventions," and "user perception OR enjoyment AND motivation OR immersion AND generative AI-powered gaming," as shown in Table 1 below.

Table 1 Search strategy.

Search No.	Search terms	PubMed	BMC Public Health	Science Direct
S1	Generative Artificial Intelligence* (words in title)	21,615.00	3,981.00	26.00
S2	Healthtech innovations* (words in title)	2,807.00	4,727.00	25.00
S3	Generative AI-powered gaming* (words in title)	1,842.00	2,444.00	19.00
S4	S1 OR S2 OR S3	32,345.00	21,987.00	67.00
S5	IBM Watson*	4,588.00	23,039.00	8,752.00
S6	ChatGPT	1,654.00	2,652.00	3,192.00
S7	Google Brain/Google Bard	4,427.00	1,451.00	3,452.00
S8	eHealth	1,026.00	206.00	1,212.00
S9	S5 OR S6 OR S7 OR S8	13,925.00	10,198.00	1,635.00
S10	User perception	42,134.00	13,098.00	360.00
S11	Emotional connection	24,264.00	2,007.00	280.00
S12	S10 OR S11	111,099.00	13,987.00	49.00
S13	Engagement	14,765.00	26,127.00	115.00
S14	Enjoyment	15,892.00	23,098.00	227.00
S15	Motivation	1,115.00	1,987.00	158.00
S16	S13 OR S14 OR S15	57,986.00	26,987.00	300.00

S17	S4 AND S9 AND S12 AND S16	346.00	256.00	87.00
S18	Study	126,789.00	78,967.00	26,256.00
S19	S17 AND S18	267.00	192.00	168.00
Database search limit used				
By date: less than 10 years		254.00	125.00	80.00
By peer reviewed/academic journal type		185.00	101.00	53.00
Language		102.00	59.00	23.00

The current study adopted an inclusion/exclusion policy that ensured the relevance, validity, and reliability of the selected sources, as shown in Table 2 below.

Table 2 Inclusion/Exclusion criteria.

Inclusion/Exclusion Criteria	Included	Excluded
Geographical location of the study	Sources with research carried out within the America, Europe, and Asia	Sources with research carried out outside the America, Europe, and Asia
Exposure of interest	Participants in the research sources must have worked in the generative AI incorporated within healthcare mental health departments	Research sources with participants working in other industries other than healthcare, or not familiar with generative AI operations
Date	Sources published on, or after 2020	Sources published before 2020
Language	Sources written in English language	Sources written in non-English language
Peer-reviewed	Sources must be Peer-reviewed. Also, organizational websites	Sources that are not peer reviewed and not organizational websites.

The screening of the sources that were selected for the research is summarised in the PRISMA chart shown in Figure 1 below.

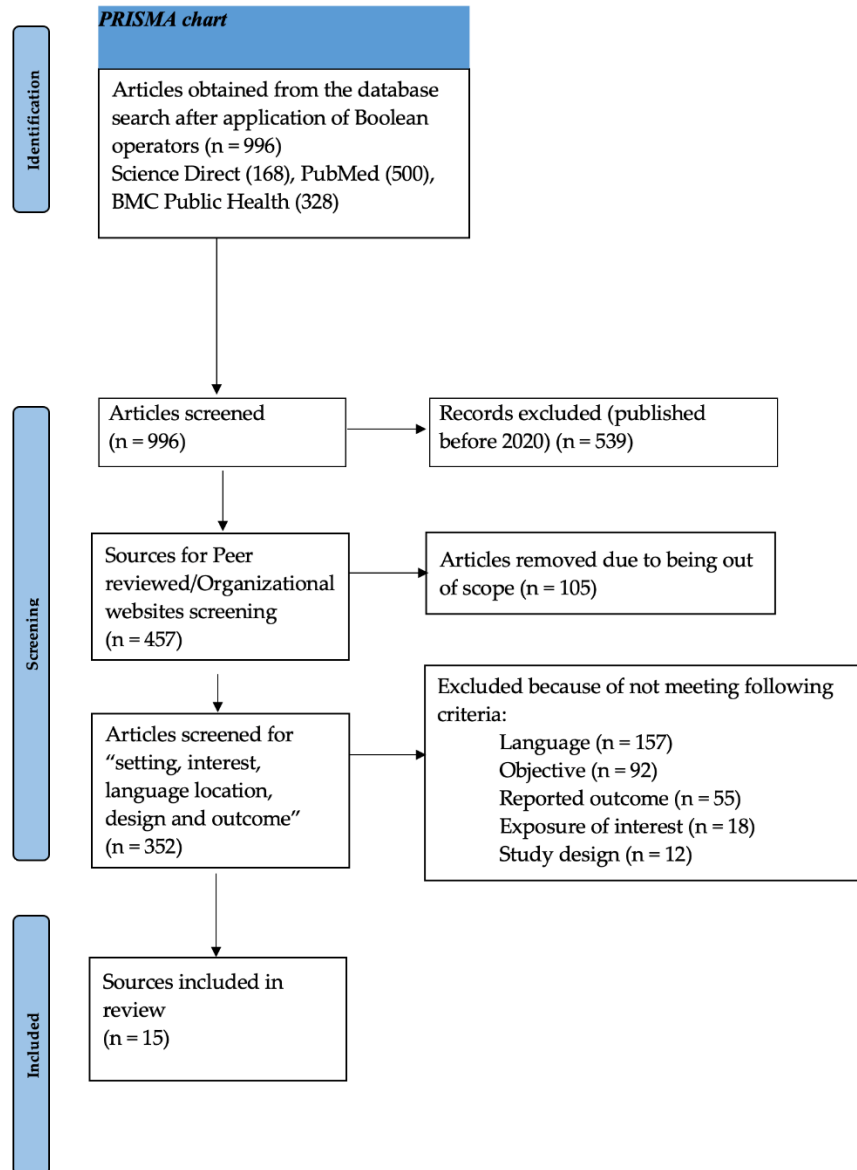


Figure 1 PRISMA chart (selection of eligible sources).

Based on the PRISMA chart shown in Figure 1 above, the number of sources found from the database search following the use of the boolean operators was 996 (Science Direct 168, PubMed 500, and BMC Public Health 328). The next procedure involves the exclusion of sources that were published before 2020. For instance, by focusing on sources published from 2020 onward, the research removed 539 sources. In addition, source selection was restricted to peer-reviewed articles and manuscripts from reputable academic journals and organisational websites, guaranteeing a higher standard of research quality and credibility, and the strategy led to the exclusion of 105 sources. Also, to maintain consistency and facilitate comprehension of the selected sources, the researcher included only sources written exclusively in English, a widely recognised primary language for scientific communication, which resulted in the exclusion of 157 sources. Furthermore, the researcher ensured that all included sources aligned with the research objectives, reported outcomes, exposure of interest, study design, and

geographical location to provide robust evidence for analysis and interpretation, and the move resulted in the exclusion of 337 sources. The research included 15 sources that were analysed using thematic analysis. The process involved a systematic examination and categorization of the qualitative text to identify themes and relationships within the content [6]. Furthermore, the adopted information was appropriately cited and accredited to its authors, and no other researchers' work was printed without their consent. Therefore, the current study adhered to all secondary research ethics [165; 166].

RESULTS

This chapter presents themes that emerged from the analysis of the appraised sources through content analysis. Themes reported were only those that were consistent with the study objectives.

Effectiveness of Generative AI-Powered Interventions for Mental Health

The analysed content demonstrated that generative AI-driven gaming interventions have impacts on emotional connection, engagement, and therapeutic results among users [13; 207; 208; 209].

One significant impact of generative AI-produced content is its ability to foster emotional connection through personalised narratives and characters, which evoke emotions and resonate with individuals on a deeper level. For instance, OpenAI's ChatGPT [23] has demonstrated the capability to generate conversational agents that engage users in meaningful and emotionally resonant interactions [210; 211; 212]. OpenAI's ChatGPT [23] conversational agents simulate human-like conversations, understanding user inputs and responding with relevant and personalised narratives [13]. Also, as in the case of IBM Watson [24], generative AI content has a positive impact on user engagement. According to Ganguly [213], IBM Watson [24] has been used to develop (re-)adaptive games that adjust the game mechanics and challenges in real-time to match the user's abilities and maintain an optimal level of engagement that enhances the motivation and enjoyment of the user [208; 214; 215; 216]. Additionally, the effects of generative AI-driven innovations extend to therapeutic outcomes. Research by Lee et al. [35] shows that generative AI interventions can be customised to address specific mental health concerns, like depression or anxiety. A good example is Google Brain, which has been used to create virtual reality experiences for exposure therapy, where individuals with phobias can safely confront their fears in a controlled environment [35]. Such targeted and personalised therapeutic experiences have been proven to enhance outcomes and support mental health interventions.

Generative AI-driven interventions have shown promise in contributing to improved mental health outcomes compared to traditional interventions. Specifically, generative AI techniques have the potential to overcome limitations associated with traditional interventions, including limited availability, high cost, and stigma [97; 217; 218; 219; 220]. Generative AI interventions can be delivered through cyber-physical platforms, making them accessible to a wider population as the users can engage with the innovations at their convenience, eliminating the barriers of time and location [97]. According to research conducted for example by the Indian Council of Medical Research [218] that explored the use of virtual reality in exposure therapy for individuals with phobias, significant reductions in phobia-related symptoms and increased treatment adherence were reported compared to traditional in-person therapy. Similarly,

Shahsavari and Choudhury's [14] study that examined the use of OpenAI's ChatGPT [23] in providing mental health support to individuals experiencing stress and anxiety established that the AI-powered intervention was effective in reducing symptoms and improving overall well-being. Therefore, the examples provided by IBM Watson [24], Google Brain [26], and OpenAI's ChatGPT [23] demonstrate the potential of generative AI-produced content to significantly impact emotional connection, engagement, and therapeutic outcomes.

Usability and User Experience with Regard to DIN EN ISO 9241-11 for Generative AI-Driven Gaming Innovations for Mental Well-Being

Enjoyment, ease of use, motivation, and immersion are essential user experience factors that influence the effectiveness and acceptance of generative AI-powered gaming interventions, as elaborated by examples from established generative AI companies such as OpenAI's ChatGPT [23] and Google Brain [9; 11; 12; 26; 105]. For instance, Google Brain [26] has been at the forefront of developing enjoyable gaming interventions through their DeepMind project, which creates engaging and enjoyable gaming experiences that captivate the user's attention and stimulate positive emotions [11]. Also, Google Brain's [26] DeepMind project has utilized generative AI algorithms to create immersive environments for therapeutic purposes [222; 223; 224; 225; 226; 227]. Immersion, in this case, refers to the extent to which individuals feel deeply engaged and absorbed in the virtual environment or experience [228; 229; 230]. For instance, Google Brain [26] has developed the DeepSea virtual reality game that simulates underwater exploration [231]. The game adapts to the individual's behaviour and emotions, creating an immersive experience that promotes relaxation and stress reduction [9]. Google Brain's [26] ability to create enjoyable and immersive user experiences has led to increased motivation to continue engaging with the interventions, enhancing the potential benefits for mental well-being [232; 233; 234; 235; 236; 237]. This is because individuals are more likely to engage with generative AI-powered interventions that are immersive and enjoyable [238; 239; 240; 241].

Examples from IBM Watson [24] and OpenAI's ChatGPT [23] demonstrate how the motivation and ease of use aspects of generative AI-driven gaming interventions have improved the user experience of the interventions, leading to their increased usage, effectiveness, and acceptance [12; 242]. When individuals are motivated to engage with the interventions, they are more likely to invest time and effort into the experience, leading to better outcomes. IBM Watson [24] is a good example of generative AI-powered gaming intervention that motivates users through its virtual coaches and fitness trainers [242; 243; 244]. The intervention provides personalised feedback, encouragement, and goal-setting features that enhance users' motivation and engagement, leading to improved mental well-being outcomes. In regard to the ease-of-use aspect of the user experience, user-friendly and intuitive interventions enable users to navigate and interact with them effectively, enhancing the overall experience [13]. OpenAI's ChatGPT [23], for example, offers conversational AI interfaces that are designed to be user-friendly and natural to interact with [245; 246; 247; 248; 249; 250; 251]. Individuals easily engage in meaningful conversations and receive personalised support through the intervention's seamless and intuitive interface [12; 139]. The ease of use in the sense of DIN EN ISO 9241-11 makes OpenAI's ChatGPT [23] more accessible and increases user satisfaction, leading to a positive impact on mental health outcomes [252; 253]. Thus, as elaborated in the examples, the effectiveness and acceptance of generative AI-driven interventions for promoting mental well-being are closely tied to factors of user experience. Interventions that focus on aspects such as

enjoyment, motivation, ease of use, and immersion have a great impact in terms of usability and acceptance with regard to DIN EN ISO 9241-11 [18; 19; 20; 60; 165; 175].

Safety Considerations Associated with Generative AI-Powered Interventions in e-Health

Although generative AI-driven interventions offer promising opportunities for promoting mental well-being, the use of generated AI-produced content brings about certain risks and ethical considerations that need to be addressed [165; 254; 255; 256; 257; 258].

The risks, for instance, revolve around issues like bias, inappropriate or triggering content, and unintended consequences. According to Almadhor et al. [259], AI models learn from existing data, which may reflect biases present in the training data. For example, Google Brain's [26] AI language model, BERT, has been shown to exhibit racial and gender bias in its outputs, raising ethical concerns as such biases reinforce stereotypes and discrimination [2; 165]. Also, generative AI models can generate inappropriate or triggering content, which can be offensive, harmful, or distressing to the users [260]. For example, OpenAI's ChatGPT [23] has faced criticism for generating responses that were offensive, biased, or promoted misinformation. Such content has caused psychological effects on users and undermined the goal of promoting mental health [261; 261; 263]. In addition, the complexity of AI models and the nature of generative algorithms can sometimes lead to unpredictable or unintended outputs. OpenAI's GPT-3 [23], for instance, has shown a tendency to provide plausible but inaccurate information when generating responses, highlighting the need for caution when relying on generative AI-generated content [264; 265; 266]. Therefore, biases, inappropriate content, and unintended consequences are potential risks associated with generative AI- powered interventions that need careful attention.

As established by Gerke et al. [144], collecting and analysing user data within generative AI-powered interventions raises important considerations in regard to privacy and data security because the interventions rely on personal data like user behaviour and preferences. Therefore, users must have clear consent mechanisms and control over their data, and developers should follow established data protection guidelines. Also, AI systems and models store and process large amounts of sensitive data, including personal and health-related information; thus, users' data can be exposed to unauthorised access and breaches [242].

Nevertheless, established generative AI companies have recognised the importance of addressing these risks and data privacy concerns and implemented measures to ensure fairness, safety, and privacy in their interventions. For example, Google Brain [26] has actively worked on reducing biases in their AI models, and IBM Watson [24] has incorporated ethical guidelines into their AI development process [165; 242; 267; 268; 269; 270]. Similarly, OpenAI's ChatGPT [23] has made efforts to improve content filtering and moderation to prevent the generation of inappropriate or harmful responses [12]. The companies have also implemented privacy policies, data protection measures, and transparency practises to mitigate privacy and data security risks. For example, IBM Watson [24] and Google Brain [26] have emphasised the importance of user consent, anonymization of data, and secure data storage and transmission [271; 272; 273]. By implementing the aforementioned measures, the positive impact of generative AI on promoting mental well-being has been maximised while ensuring user trust, safety, and privacy in the digital landscape.

DISCUSSION

This design-oriented triangulation study investigated the extent to which generative AI-powered gaming interventions are effective, usable, and beneficial with regard to mental health and well-being. In terms of effectiveness, the current findings suggest that generative AI-powered interventions for mental health have shown effectiveness in fostering emotional connection, engagement, and therapeutic outcomes.

Generative AI interventions like IBM Watson [24] and OpenAI's ChatGPT [23] enhance engagement by simulating human-like interactions with game mechanics that adjust in real-time (re-)adaptively. Also, generative AI-driven interventions offer advantages over traditional approaches by being more accessible, cost-effective, and reducing stigma. The appraised studies affirmed that e-health interventions for mental health that employ generative AI techniques lead to significant symptom reductions and improved treatment adherence. These findings are consistent with existing literature, which highlights the significant influence of generative AI-generated content on emotional connection, engagement, and therapeutic outcomes in mental health interventions. For instance, Hopkins et al. [74] and Grodniewicz and Mateusz [8] affirm that OpenAI's ChatGPT [23] and IBM Watson [24] have utilised generative AI technologies to develop personalised narratives and characters that deeply resonate with individuals, fostering emotional connection and engagement. On the other hand, Powles and Hodson [225] elaborate on how Google Brain [26] has employed generative AI models to create personalised mental health interventions in the form of digital avatars capable of delivering customised advice, emotional support, and coping strategies. Furthermore, according to Ahmed et al. [1], Google Bard [25] holds significant promise in powering gaming interventions for individuals with mental health challenges. Therefore, with examples of IBM Watson [24], Google Bard [25], OpenAI's ChatGPT [23], and Google Brain [26], both existing literature and this paper affirm that generative AI-powered gaming innovations have significant positive impacts on emotional connection, engagement, and therapeutic outcomes in mental health interventions.

Also, the current showed that generative AI-driven innovations foster usability in mental health interventions through generative AI-driven innovations foster usability in mental health interventions through enhanced enjoyment, motivation, ease of use, and immersion. For instance, Google Brain's Deepmind [26; 275] project exemplifies the creation of enjoyable and captivating gaming experiences that stimulate positive emotions and deeply engage users [225]. Its Deepsea game immerses individuals in underwater exploration, adapting to their behaviour and emotions to promote relaxation and stress reduction. Similarly, IBM Watson [24] motivates users through virtual coaches and trainers that offer personalised feedback and goal-setting features. Additionally, user-friendly and intuitive interfaces with regard to DIN EN ISO 9241-11, as seen in OpenAI's ChatGPT [23], enable users to easily engage in meaningful conversations and receive personalised support. These user experience aspects of generative AI-powered innovations have enhanced the effectiveness and acceptance of mental health interventions because motivated and satisfied users are more likely to invest time and effort, leading to improved outcomes. Similarly, existing literature establishes user experience aspects such as enjoyment, ease of use, and motivation in mental health gaming interventions powered by generative AI [14; 15; 276; 277]. For instance, according to Shahsavar and Choudhury [14], OpenAI ChatGPT's [23] user-friendly interface and empathetic responses have contributed to its acceptance and effectiveness in providing mental health support. Likewise, Van Rijmenam

[276] asserted that Google Brain's [26] immersive virtual reality experiences offer appropriate support, feedback, and motivation, encouraging users to invest more time and effort for better outcomes. IBM Watson [24], on the other hand, as elaborated by Xie et al. [15], has tailored narratives and characters that enhance enjoyment and sustain engagement, leading to significant acceptance of e-health mental interventions. Overall, the current research and existing literature identify user-centred and user-friendly factors like immersion, motivation, enjoyment, and ease of use in generative AI-powered interventions for mental health. These factors have enabled generative AI-powered gaming innovations to greatly influence the effectiveness and acceptance of generative AI interventions for promoting mental well-being.

In addition, the current design-oriented triangulation study investigated the safety considerations associated with generative AI-powered gaming interventions for mental health and well-being. Whereas generative AI interventions show promise in promoting mental well-being, this paper establishes ethical considerations and risks associated with such interventions that need to be addressed [165].

For example, bias is a significant concern in generative AI models because the models can inherit biases from their training data, perpetuating stereotypes and discrimination. Similarly, inappropriate or triggering content generated by generative AI like OpenAI's ChatGPT [23] has raised concerns and undermined mental health goals. Furthermore, issues of unintended consequences have arisen in generative AI interventions due to their complex nature, which leads to the generation of inaccurate information. In regard to privacy and data security, the current study showed that user data collected by generative AI interventions must be handled with care, ensuring consent, control, and protection. Due to the potential risks and privacy concerns facing generative AI innovations, established AI firms like Google Brain [26], Google Bard [25], IBM Watson [24], and OpenAI's ChatGPT [23] have taken measures to reduce bias, improve content filtering, and prioritise privacy and data collection.

In concurrence with the current findings, previous studies show that generative AI-driven interventions carry potential risks and ethical concerns, including bias in generated content and privacy implications [10; 12; 165]. For instance, Paul et al. [10] established that biased training data can result in discriminatory outcomes in interventions, negatively impacting the user's mental well-being. Similarly, Ray [12] asserts that generative AI models can be distressing to users as the AIs can produce triggering or inappropriate content. In conclusion, the risks and privacy concerns in generative AI models as established in the current study and existing literature affirm that AI companies like OpenAI's ChatGPT [23] and Google Brain [26] should adopt strict data measures to safeguard user information. Such measures will mitigate risks and protect user privacy, promoting the interventions' effectiveness and acceptance.

CONCLUSIONS

Summary of Findings

This paper investigated the effectiveness, usability, and safety considerations of generative AI-powered interventions for mental health and well-being. The findings revealed that AI-powered interventions have shown effectiveness in promoting emotional connection, engagement, and therapeutic outcomes. For example, innovations such as IBM Watson [24], Google Bard [25], OpenAI's ChatGPT [23], and Google Brain [26] have utilised generative AI techniques to create personalised narratives and characters that deeply resonate with the users,

enhancing emotional connection and engagement. Compared to traditional approaches, generative AI-driven interventions offer greater advantages like accessibility, cost-effectiveness, and reduced stigma in mental health management. For example, the Deepsea game immerses users in underwater exploration, adapting to their behaviour and emotions to promote relaxation and stress reduction. Also, this research highlighted the importance of usability in mental health interventions. Specifically, the design-oriented triangulation study established enjoyment, ease of use, motivation, and immersion as crucial factors that facilitate the effectiveness and acceptance of generative AI-powered interventions for individuals with mental well-being. For instance, IBM Watson [24] has tailored narratives and games that improve enjoyment and sustain engagement, resulting in acceptance of e-health mental interventions. However, generative AI models face potential risks and safety concerns that require attention. Established potential risks include the generation of biased and inappropriate content and producing data that may have unintended consequences. On the other hand, privacy and data security require careful handling to ensure user consent, control, and protection. In conclusion, generative AI-driven gaming interventions have shown a significant positive impact on emotional connection, engagement, and therapeutic outcomes in mental health interventions. Particularly, the increased emotional connection, engagement, and positive therapeutic outcomes associated with generative AI-powered games enhance the quality-of-service delivery to people with mental health as the enjoyment and motivation of playing games increase the effectiveness and acceptance of AI in the healthcare environment. By addressing safety considerations and prioritising user experience, these interventions can contribute effectively and ethically, with regard to DIN EN ISO 9241-11, to the promotion of mental well-being [139; 165].

Study Implications

The current study revealed that generative AI-powered interventions have great potential for effectively fostering emotional connection, engagement, and therapeutic results. This implies that by simulating human-like interactions and creating personalised and transmediated narratives and characters, innovations such as OpenAI's ChatGPT [23], IBM Watson [24], Google Brain [26] or Google Bard [25] have the potential to deeply resonate with users and enhance their engagement. Also, this research showed that generative AI models have advantages over traditional approaches by being more accessible, cost-effective, and reducing stigma. Therefore, by incorporating usability benefits like immersion and user-friendly interfaces, generative AI interventions can be utilised to promote user satisfaction and sustained engagement, leading to improved outcomes. Additionally, this paper emphasises the importance of addressing safety considerations associated with generative AI innovations. Ethical guidelines and measures, like bias reduction techniques, content filtering, and privacy safeguards, should be implemented by AI companies to ensure ethical and responsible use of such interventions [165]. Furthermore, practitioners can leverage the insights gained from this study to inform the design and implementation of generative AI-powered interventions in real-world settings.

Limitations and Further Study Recommendations

Although this study offers valuable insights into generative AI-powered gaming interventions for mental health, it is not without limitations. For instance, the current study solely relied on secondary sources of information. While the researcher carefully selected and included peer-reviewed articles and scholarly publications, there is a potential for bias or incomplete information. Some documents might be missing due to age, and researchers cannot determine

the author of the document [278]. However, as much as secondary sources may lack authenticity, this research overcame the limitation by searching documents that were published on or after 2020 to ensure authenticity. Also, the current study focused primarily on the positive aspects and potential benefits of generative AI interventions, neglecting potential drawbacks or negative effects. For instance, some mental problems are associated with learning difficulties that may make the use of generative AI less enjoyable and motivating [279]. In addition, the study faced a limitation regarding the generalizability of the findings to populations on all the global continents [280]. Particularly since the examined sources focused on the American, European, and Asian populations, it is challenging to generalise the findings to the global population [281; 282; 283; 284]. Due to the aforementioned study limitations, this paper recommends future research that will overcome these limitations by utilising primary data collection methods, exploring potential risks, and ensuring that the global population is well represented in the sample used to enhance the generalizability of the findings [165]. Therefore, consortial research suggests itself, which the author is currently conducting under a different context factor: "Learning theory and transmedia approaches in learning-centred contexts with regard to DIN EN ISO 9241 within the metaverse."

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