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A FRAMEWORK FOR GAMIFYING MOBILE HEALTH APPLICATION TO ENHANCE USER ENGAGEMENT

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CONFIRMATION BY PANEL OF EXAMINERS

I certify that a Panel of Examiners has met on 14 November 2025 to conduct the final examination of Siti Nurkhairina binti Yahizan on her Masters of Science thesis entitled "A Framework for Gamifying Mobile Health Application to Enhance User Engagement" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiner recommends that the student be awarded the relevant degree. The Panel of Examiners was as follows:

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Mobile health (mHealth) applications have surged in recent years, with over 100,000 apps now available globally for smartphones and more than 500 million users. mHealth apps have significantly transformed healthcare delivery by leveraging smartphone technology to engage users in managing their health, potentially improving quality of life and reducing healthcare costs. However, despite their widespread adoption, there is still a limited understanding of how gamification is implemented in real-world mHealth applications, and there is a lack of standardized guidelines to apply gamification effectively. This has led to poor user engagement, with many users abandoning the apps after short-term use. Therefore, this study aims to address these challenges by developing a conceptual framework, namely GMHealth, for gamifying mHealth applications to promote sustained user engagement. The methodology of this study involves four phases. Phase 1: Problem Investigation, which explores, defines, and understands the research problem through literature review and preliminary study. Next, Phase 2: Framework Development involves content analysis to identify and analyze the proposed themes and elements of the GMHealth framework. The initial draft of the GMHealth framework was validated by expert review through face validation and content validation. The finalized and validated GMHealth framework has eight themes: Guidance, Self-Representation, Improvement, Socializing, Self-Management, Continuous, Enjoyment and Esteem, with 25 elements. Based on these insights, Phase 3: Framework Evaluation involves an evaluation of a prototype demonstration, namely, *LetsGoFit*: A Stretching Fitness App that implements a validated GMHealth framework. The evaluation of the prototype revealed a high level of user engagement, with 91.4% of participants interacting with the app and demonstrating a strong commitment to using it. Phase 4 focuses on the comprehensive documentation of the entire study. At this stage, all data collected throughout the research,from the initial investigation to the framework evaluation were compiled, organized, and presented systematically.The findings of this study suggest several potential directions for future research, including the exploration of additional gamification elements for wearable devices as well as the integration of multi-user or multiplayer functionality to further enhance user engagement and interaction within mHealth applications. This research contributes to developing a more effective, user-centred approach to gamification in mobile health applications, offering a valuable framework for developers seeking to create engaging, long-term solutions for health management.

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LIST OF SYMBOLS

Symbols	
N	The total number of experts
Ne	Number of experts agreeing on a rating of 3 or 4

CHAPTER 1
INTRODUCTION

1.1 Research Background

Mobile health (mHealth) applications have experienced exponential growth over the past decade, with over 350,000 smartphone apps currently available globally across various health domains (Statista, 2024; Supramaniam et al. 2024). Among these, applications targeting exercise, diet, and weight management constitute a substantial portion, reflecting an increasing user demand for accessible digital health tools (Ashar et al., 2025; Lieder et al.,2024; Sharif & Woolley, 2022; Zolfaghari et al., 2021). The global mHealth user population has surpassed 700 million, indicating its profound potential to engage individuals in personal health management, particularly those with complex medical needs (Wang et al.,2022).

Smartphones' ubiquity across social and demographic strata provides unprecedented opportunities for delivering healthcare interventions. Their portability and access to multimedia interfaces, touchscreens, and external device integrations (e.g., wearables) enable continuous, interactive health monitoring (Alharthi, 2025; Devices et al.,2024; Kanai et al.,2025; Roslan & Salim, 2023). mHealth applications harness these technological capabilities to facilitate personalized feedback, real-time reminders, and performance tracking, which collectively enhance motivation and adherence to health goals (Czerska, 2024; Gkintoni et al.,2024)

Recent developments underscore the transformative role of gamification, which applies game-design elements such as challenges, points, rewards, and leaderboards to increase user engagement and sustain behavior change in health contexts (Bas-Sarmiento et al.,2025; Gkintoni et al.,2024; Xu et al.,2022). Concurrently, healthcare systems have adopted mHealth platforms to improve care quality and cost-effectiveness by empowering users to assume proactive health roles (Su et al.,2025).

The COVID-19 pandemic exemplified the critical role of mHealth, with Malaysia's MySejahtera app as a pivotal tool in epidemic management. It facilitated early symptom detection via self-assessments, real-time hotspot tracking, and centralized dissemination of authoritative updates, enhancing public compliance and

outbreak control (Ashar et al.,2025). The app's user-centric design contributed to its extensive adoption and public health resilience (Khambali Hambali et al.,2022).

Among gamified health interventions, *Fitocracy* exemplifies sustained user engagement through integrated game mechanics, including goal setting, badges, quests, competitions, and virtual coaching, collectively motivating exercisers and fostering community. Its expanding user base and recognition attest to the efficacy of gamification in promoting fitness behaviors.

Fitocracy uses rewards to encourage people to use the app, which is one of its main tactics. Users are rewarded whenever they earn a badge or unlock an award (Sharif & Woolley, 2022; Soo & Lee, 2022). This application reinforces good behaviour and makes people want to keep using the app. This game-based method keeps people motivated and gives them a sense of progress and accomplishment as they work out. Fitocracy also adds tasks and competitions to keep users more interested. Quests are structured tasks that users can complete to earn extra rewards.

On the other hand, competitions let users compete, which builds community and healthy competition among users. The purpose of these features is to keep users interested in the app and keep them motivated over time. Moreover, *Fitocracy* also offers virtual coaching from professional trainers so users can get help and advice from the best exercise professionals in the world. This personalised method improves the app by helping users stick to their fitness plans and reach their goals (Fitrocracy,2014).

Emerging literature increasingly supports gamification as a viable strategy to enhance adherence to health interventions and facilitate psychological well-being (Ferrari et al.,2022; Gkintoni et al.,2024; Hsu et al.,2025; Zolfaghari et al.,2021). However, inconsistent implementation standards and a lack of interactive features in many mHealth applications have resulted in suboptimal engagement and user dissatisfaction (Deniz-Garcia et al.,2023; Giebel et al.,2024).

Addressing these gaps, this study proposes the development of the GMHealth Framework, a comprehensive framework designed to implement gamification elements into mobile health applications systematically. The framework seeks to align game mechanics such as points, badges, leaderboards, challenges, and rewards with evidence-based health objectives and user preferences. Moreover, GMHealth emphasizes iterative design and user feedback mechanisms to ensure sustained relevance and engagement.

The framework will also prioritise the significance of user feedback and iterative design to guarantee that the gamified elements remain pertinent and captivating throughout the duration. Hence, GMHealth: A Framework for Gamifying Mobile Health Application to Enhance User Engagement is the proposed name for the framework.

1.2 Problem Statement

There is a lack of understanding about how gamification is applied in real-world mHealth apps (Mustafa et al., 2023; Wang et al.,2021). Several studies highlight the need for more research on the effectiveness of gamification in healthcare (Six et al.,2021; Yu et al.,2025). A lack of standardized guidelines for mobile health applications, such as dialysis apps, results in poor usability and low engagement (Chao et al.,2024). A study by Shabadurai et al.,(2024) stated that it is worth mentioning that a sustainable gamification design should provide an understandable and comprehensible objective to reduce boredom to the user.

Additionally, there is a shortage of empirical evidence on how gamification elements motivate users (Sanchez et al.,2023; Yu et al.,2025). Furthermore, gamification has been successfully used in business, marketing, and e-learning to improve engagement and motivation. However, its application in mobile healthcare is still developing. Recent studies have begun to explore its effectiveness in promoting physical activity, improving mental health resilience, and enhancing patient adherence. For instance, Yu et al., (2025) conducted a systematic review and meta-analysis showing that mobile health-based gamification interventions yielded small but significant improvements in physical activity among individuals with cardiovascular diseases, with feedback and avatar design elements proving most effective (Yu et al. ,2025). Similarly, Damasevicius, Maskeliunas, and Blazauskas (2023) provided a meta-review of gamification in healthcare, highlighting the growing use of mobile platforms and the need for standardized evaluation frameworks. There is limited understanding of how to apply gamification effectively in real-world health apps, and best practices are not well established (Mustafa et al.,2023).

Moreover, many health applications lack standardized guidelines, leading to inconsistent gamification implementations that result in poor user experiences (Aguiar

et al. ,2025; Freyer et al.,2024). If gamification elements are poorly integrated, users will likely become bored, reducing the overall effectiveness in promoting healthy behaviors (Xu et al.,2022).

In addition, a significant issue is the lack of theoretically informed research linking health behavior with digital gaming, leading to superficial implementations (Dewitz, 2022). Many apps do not distinguish between gamification and serious games, leading to fragmented approaches that undermine user engagement (Freyer et al, 2024). Furthermore, there is growing interest in using gamification to enhance user engagement and encourage healthy behaviors. A 2024 systematic review found that gamification in health-related interventions can positively influence behavior change, particularly in promoting physical activity, adherence to treatment, and overall wellness (Alzghoul, 2024). However, mobile health apps face low user engagement, with many users discontinuing use due to a lack of interest.

Furthermore, mobile health apps often suffer from low user engagement, with many users discontinuing use shortly after download due to waning interest and motivation. Research indicates that approximately one-quarter of users only interact with an app once before abandoning it (Jakob et al.,2025). Factors contributing to this decline include a lack of personalized content, insufficient motivational features, and poor integration of engaging elements, which together reduce the app's ability to sustain long-term user commitment (Aguiar et al.,2025; Freyer et al.,2024) Consequently, addressing these challenges by enhancing app usability, personalization, and meaningful gamification is essential to promote sustained engagement and positive health behaviors (Mohd Johari et al.,2025).To overcome long-term engagement issues with the mobile health application, it can be improved through physical activity with virtual helpers, gamification, and contingent rewards (Camacho-Rivera et al,2020).

Next, the absence of empirical validation for theoretical frameworks creates uncertainty about the effectiveness of gamification in inducing behavioral change and enhancing engagement (Hsu et al.,2025). Despite its popularity, gamification in digital health has not always been effective, partly due to the lack of personalized customization that caters to users' health objectives (Gajardo Sanchez et al.,2023). Anwar et al.,(2025) and Mazeas et al.,(2022) report that health interventions lacking a theoretical foundation and relying on superficial gamification yield inconsistent outcomes, whereas meaningful challenges and goal-aligned rewards promote long-term

engagement. The importance of meaningful challenges and feedback systems is echoed in several studies. For instance, Mustafa et al, emphasise the role of challenges and feedback in enhancing intrinsic motivation and sustaining engagement in mHealth apps. Their study found that perceived autonomy and feedback significantly influenced intrinsic motivation, which in turn affected continued use of the apps (Mustafa et al. ,2023)

Similarly, Xu et al., discuss using game design elements like progress bars and badges to promote motivation and engagement in patients with coronary heart disease, suggesting that these elements can effectively encourage physical activity (Xu et al., 2022). These findings underscore the need for standardized guidelines, theoretically grounded research, and comprehensive gamification strategies to improve user engagement and effectiveness in health applications.

1.2.1 Research Gap

Based on the problems mentioned in the previous paragraph, it is clear that there is a significant lack of an overall framework to guide the incorporation of gamification into mobile health applications. The problems discovered emphasize the requirement for a systematic approach that clearly defines how gamification can be efficiently planned and executed in mHealth, improving user engagement and overall experience.

Given the importance of these critical areas that need to be solved, creating a thorough framework that guides the building of mHealth applications with gamification elements is essential. An effective framework should encompass both the theoretical foundations and practical instructions for developers to successfully use gamification tactics that align with health and wellness objectives.

It is essential to mention that current gamification frameworks mainly focus on marketing, business, and education (Christopoulos & Mystakidis, 2023; Shenavar, 2022). Hence, it is crucial to address this gap by creating a specific framework designed explicitly for gamified mobile health applications,the GMHealth Framework. This framework is specifically developed to include various elements essential for effectively developing and implementing gamified mobile health applications.

The GMHealth Framework will be developed by enhancing the current gamification framework, The Wheel of Sukr by AlMarshedi et al.,(2017). The Wheel

of Sukr framework, effective in addressing chronic disease management through gamification, is limited by its narrow focus on chronic conditions. This focus overlooks other critical health areas, such as preventive health, mental well-being, acute care, and lifestyle modifications. Consequently, the framework may not fully engage users seeking broader health management tools, limiting its applicability and effectiveness in comprehensive mobile health solutions. Expanding the framework to incorporate a broader range of health behaviors and conditions could enhance its usability and impact across diverse user needs.

Hence, the GMHealth Framework combines knowledge from prior research and optimal methods to seamlessly include gamification elements into any category of mobile health applications, not only focused on chronic diseases. The framework attempts to enhance user engagement in health-related situations by utilising recognised gamification concepts tailored to the specific demands of health and wellness applications. Furthermore, the GMHealth Framework aims to create gamified experiences that align with users' health goals and preferences. The gamification approach is structured, ensuring that every element, such as game mechanics and user feedback loops, contributes cohesively to the overall health goals.

Essentially, the GMHealth Framework is an essential advancement in mobile health applications. Its main objective is to connect the theoretical and practical aspects by providing a systematic framework to incorporate gamification. By utilising this framework, developers can improve the efficiency and attractiveness of gamified mobile health applications, encourage healthier lifestyles, and achieve better health results.

1.3 Research Questions

According to the problem statement earlier in this chapter, this study aims to answer the following research questions (RQ):

a) RQ1: What are the elements of a gamified mobile health framework that contribute to an engaging experience?
b) RQ2: How can a gamified mobile health be constructed to create an engaging experience?

c) RQ3: How suitable is a gamified mobile health framework for enhancing user engagement?

1.4 Research Objective (S)

This research's objectives are :

i) RO1: To identify the key elements of a gamified mobile health framework that contribute to an engaging experience,

ii) R02: To construct a gamified mobile health framework that contributes to an engaging experience while using gamified mobile health application,

iii) R03: To evaluate a gamified mobile health framework that contributes to an engaging experience through prototype evaluation.

1.5 Significance of the Study

This research aims to develop a new Gamified Mobile-Health Framework (GMHealth Framework) for gamifying mobile health applications. The GMHealth framework contains several benefits that work as a guideline to produce more engaging mobile health applications, such as:

1.5.1 Game Designer and Game Developer

For designers developing gamified mHealth applications, the GMHealth framework is invaluable for gaining insights into critical issues encountered during development. By providing a structured approach and comprehensive guidelines, the framework enables designers to navigate challenges effectively and make informed decisions throughout the application development lifecycle. Moreover, the GMHealth framework facilitates the seamless integration of gamification elements into mobile health applications, enhancing user engagement and motivation.

By leveraging the insights and best practices outlined in the framework, designers can create mobile health applications that address users' health needs and provide an immersive and rewarding experience. By strategically implementing gamification elements such as points, badges, challenges, and social interactions, designers can enhance user motivation, encourage behaviour change, and foster long-

term engagement with the application. By systematically analyzing these elements, designers gain a deeper understanding of how gamification can be effectively applied in the context of mobile health applications. With this knowledge, designers are better equipped to design and produce mobile health applications that offer a compelling and engaging user experience, ultimately contributing to improved health outcomes and user satisfaction.

1.5.2 Medical Practitioner

This study aims to gamify mHealth applications, presenting medical practitioners with an innovative and cost-effective platform to promote health awareness and facilitate significant public health impact. Through the gamification of these applications, medical practitioners gain access to a multifunctional tool that enhances patient engagement and streamlines healthcare delivery processes.

Utilizing mobile health applications allows medical practitioners to access patients' health records seamlessly, allowing for more informed decision-making during consultations and providing personalized care tailored to individual needs. Moreover, these applications enable practitioners to coordinate medical appointments efficiently and send timely reminders to targeted patients, improving appointment adherence and overall patient management (Öcal, 2023; Sharief, 2024).

Furthermore, the interactive features of mobile health applications empower medical practitioners to communicate and interact directly with users or patients, fostering greater engagement and facilitating ongoing support and education. Additionally, integrating social platforms within these applications addresses gaps in care by facilitating peer support, sharing experiences, and disseminating health-related information in a community-oriented setting (Sharief, 2024).

By embracing gamified mobile health applications, medical practitioners can leverage technology to enhance the efficiency and effectiveness of healthcare delivery, promote health literacy and awareness, and ultimately contribute to improved health outcomes and patient satisfaction. This innovative approach holds great promise for transforming healthcare delivery and advancing public health initiatives in a cost-efficient and accessible manner.

1.5.3 User

This study allows users to engage with more immersive and impactful mobile health applications, enhancing their overall quality of life. By incorporating game elements commonly found in gaming, such as challenges and rewards, into healthcare apps, users are empowered to tackle health-related goals with increased confidence (Mitra et al. ,2024; Tera et al. ,2024). These gamified mobile health applications provide users with a user-friendly platform to track their daily progress, share knowledge with others, complete challenges, and receive daily reminders to enhance their performance.

Moreover, gamified healthcare applications have effectively motivated users to remain engaged, promoting positive impacts on human life (Atzeni et al.,2024; Xu et al.,2022). They are a powerful tool in encouraging behaviour change, such as reducing health-risk behaviours (Nian et al.,2023). Drawing from insights by Mena and Pardo, (2023) and Tera et al.,(2024), gamification has been extensively applied in healthcare to enhance patient engagement and improve health outcomes by incorporating game elements such as goal-setting, feedback mechanisms, and reward systems.

This framework integrates gamification elements into mobile health applications, offering users a more engaging and enjoyable experience while pursuing their health goals. Through interactive features and motivational incentives, users are empowered to take control of their health, leading to improved adherence to healthy behaviours and ultimately enhancing their overall well-being. Thus, the GMHealth Framework represents a valuable resource for users seeking to optimize their health outcomes and lead healthier, more fulfilling lives.

1.6 Research Scope and Limitations

The GMHealth framework is the framework developed in this research to support the systematic integration of gamification into mobile health applications. Its primary objective is to enhance user engagement by strategically embedding gamification elements that make health-related tasks more appealing and engaging. By establishing a structured approach, the framework aims to guide developers in incorporating meaningful features that improve the overall user experience.

Building on this purpose, the GMHealth framework places specific emphasis on essential gamification elements commonly applied in mHealth apps. These include rewards, progress tracking, levels, and challenges,elements that designed to stimulate engagement and sustain user involvement over time. By integrating these carefully selected elements, the framework ensures that health applications offer a more enjoyable, interactive, and engaging experience, ultimately encouraging long-term use and positive health behaviours.

Furthermore,the GMHealth framework was developed through an extensive literature review, drawing on numerous studies that utilized content analysis and thematic mapping to identify key themes, elements, and tools. Once the framework was established, it underwent an expert review process to assess its effectiveness and usability through face validation and content validity evaluations. This expert feedback is a critical step that rigorously tests the framework, ensuring it meets its intended goals and is practical and user-friendly for real-world application. Such a thorough evaluation strengthens the framework's credibility and supports its potential to improve health outcomes via gamified mobile health interventions.

For the face validation, the study engaged two academic experts to verify that the questionnaire items were clear, relevant, and appropriate. In addition, content validity involved the insights of 22 experts from various fields, including academicians, healthcare professionals such as nurses, doctors, medical assistants, and industry specialists. More detailed information about the expert participants and the validation procedures will be presented in Chapters 3 and 4.

Additionally, a prototype will be developed to operationalize the GMHealth framework and promote higher levels of user engagement within mobile health applications. The target demographic for the prototype consists of individuals aged 18 to 49, encompassing both young adults and adults. This age range was selected because young adults represent the group with the highest usage of mobile health applications, particularly for fitness, wellness, and prevention purposes (Statista, 2024). This demographic is representative of the intended user base for mobile health interventions. The prototype, named *"LetsGoFit:* A Stretching Fitness Application," includes several features such as stretching programs and modules, an exercise library, personalized plans, tracking and progress monitoring, educational content, user guidance, and

community features. These components have been designed to incorporate the themes and elements outlined in the GMHealth framework.

Moreover, regarding the tools used for development, the prototype was created using software such as Adobe Photoshop for graphic design, Adobe Illustrator for crafting visual assets, and Android Studio for application development. This combination ensures that the prototype is optimized specifically for smartphones, offering compatibility and accessibility to users regardless of location or device.

It is essential to recognize that the GMHealth Framework has been specifically crafted for mobile applications and is meant for use on mobile devices such as smartphones. This design decision ensures that users can effortlessly and conveniently access the app whenever and wherever they wish, improving its overall functionality and attractiveness. One drawback of the *LetsGoFit* app prototype is that it was created exclusively for the Android operating system. As a result, only Android users can take advantage of the application, while iOS users cannot.

Additionally, the GMHealth Framework that has been developed is not restricted to a specific industry area; instead, it is capable of being utilised across a wide range of healthcare applications, including those that are focused on health and wellbeing. Because of the flexibility, developers can integrate the framework into various applications, allowing them to respond to various needs and user preferences.

1.7 Summary

This study primarily focuses on developing a framework to enhance user engagement within mobile health applications. Recognizing the importance of user engagement in promoting better health outcomes, integrating gamification elements within these applications serves as a strategy to increase user engagement and overall quality of life in healthcare.

The research begins with identifying the problem statement, which revolves around the need for improved user engagement and experience in mobile health applications. Through a systematic approach, the study aims to address three key research questions: (i) What are the elements of a gamified mobile health framework contribute to an engaging experience? (ii) How can a gamified mobile health framework

be constructed to create an engaging user experience? (ii) How suitable is a gamified mobile health framework for enhancing user engagement? The study seeks to achieve its overarching objective of developing the GMHealth Framework by answering these questions. This framework will serve as a structured approach to integrating gamification elements, such as rewards, challenges, and progress tracking, into mobile health applications. Doing so aims to enhance user engagement, motivation, and adherence to health-related behaviours, ultimately promoting better health outcomes and a higher quality of life.

Furthermore, the study clearly outlines the scope and limitations of the GMHealth framework. While the framework is designed to enhance user experience within mobile health applications, it is essential to acknowledge its potential constraints and areas where further refinement may be needed. By delineating the scope and limitations upfront, the study ensures transparency and clarity in its objectives and outcomes.

CHAPTER 2
LITERATURE REVIEW

2.1 Gamification

Gamification is a delightful concept that combines game design elements into everyday settings, creating fun and engaging experiences for everyone involved. This excellent approach is about tackling challenges, boosting engagement, and encouraging people to reach their aspirations (Aulia et al.,2022; Christopoulos & Mystakidis, 2023). Some popular elements that make gamification enjoyable include points, badges, leaderboards, and challenges, all thoughtfully crafted to inspire and reward users for accomplishing their tasks (Sharma et al.,2024). Gamification can be used in many areas, such as education, business, marketing, health, and commerce, where it works wonders in enhancing user experiences and fostering greater engagement (Christopoulos & Mystakidis, 2023; Sharma et al. 2024).

Gamification, the application of game elements in non-game contexts, has gained significant attention in various fields, including education, marketing, and business (Bassanelli et al.,2022; Sharma et al.,2024). It aims to enhance motivation, engagement, and learning outcomes (Kashive & Mohite, 2022; Pujolà, 2021). Recent research has explored gamification's impact on behavior change, e-learning experiences, and science education (Bassanelli et al.,2022; Kalogiannakis et al.,2021; Kashive & Mohite, 2022). Theoretical foundations of gamification include various psychological theories, with core principles focusing on goal illustration, guided paths, immediate feedback, and task simplification (Krath et al.,2021). As gamification continues to evolve, future research may include industry-specific designs, integration with emerging technologies, and applications in sustainability and smart cities (Sharma et al.,2024), including the health care context.

An effective gamified design goes beyond simply implementing game elements. It must synergistically integrate mechanics, dynamics, and aesthetics to foster autonomous motivation. By satisfying fundamental psychological needs for competence (mastery), autonomy (control), and relatedness (social connection), gamification achieves more sustainable engagement and meaningful user involvement

(Wang et al. ,2021; Zain et al.,2022). This alignment with psychological theory enhances motivation and supports long-term behavioral change, a critical goal in applications such as education, training, and health (Gkintoni et al.,2024; Hsu et al., 2025; Villasana et al.,2020).

Studies of the elements that make up gamification include points, badges, leaderboards, objectives, progress, avatars, social interaction, narratives, virtual products, and levels. Implementing each component will create a new framework for developing an engaging mobile health application. Based on the current research findings, the elements of game design that have been discovered are shown in Table 2.1, along with their respective descriptions.

Table 2.1
Gamification Element

Gamification Element	Description	Supporting studies
Points	Points frequently quantify user performance and participation, providing immediate feedback and measurable goals.	(Degraen et al. ,2021;Hallifaxet al., 2023; Mao & Lucas, 2024)
Badges	Badges serve as visual rewards for achieving specific goals or completing activities.	(Azmietal.,2021; Mao & Lucas, 2024)
Leaderboards	Leaderboards rank users based on their performance relative to peers, promoting competitiveness and social comparison.	(Hallifax et al. ,2023; Mao & Lucas, 2024; Pahlevi & Mulyati, 2024)
Goals	Goals provide users with clear objectives and challenges, guiding their activities and enhancing motivation.	(Torlakovic et al., 2022)
Progress	Progress indicators inform users about their advancement in tasks or activities, offering a sense of accomplishment and encouraging continued participation.	(Degraen et al., 2021)
Avatar	An Avatar allows users to create personalized representations of themselves, enhancing their connection to the gamified environment.	(Pahlevi & Mulyati, 2024)
Social Interaction	Social interaction elements create communities where users can communicate and support each other, fostering collaboration and a sense of belonging.	(Hallifax et al., 2023)

Narrative	A Narrative enables users to experience a sequence of events while performing an activity or task.	(Zakaria & Mahat, 2024)
Virtual goods	Virtual goods are intangible objects that can be earned. They are often implemented as an in-game currency.	(Torlakovic et al., 2022)
Levels	Levels indicate the advancement of users regarding overall performance.	(Torlakovic et al., 2022)

According to the findings of the gamification element on Table 2.1, essential features such as points, badges, leaderboards, levels, feedback, challenges, avatars, and storytelling (Al-Rayes et al.,2022; Warmelink et al,2021; Westenhaver et al.,2021)play a crucial role in this transformation. These dynamic elements are applied across various fields, including physical fitness, chronic disease management, rehabilitation, and medical education (Al-Rayes et al.,2022; Anwar, Silvani, Prayitno, et al. 2025). By infusing fun and rewarding aspects into tasks, gamification can motivate users and significantly enhance their health behaviors.

Furthermore, evidence has demonstrated that gamified health apps can boost learning, cultivate positive attitudes, and facilitate lasting behavior change (Khoshnoodifar et al.,2023; Tesi et al.,2023). For instance, users are more likely to persist with the app when they earn points for completing exercises or receive feedback upon finishing a task. In addition, features like leaderboards can foster a spirit of friendly competition, further amplifying motivation. Nonetheless, challenges remain. Sustaining user engagement over time poses a hurdle, as the initial thrill of game elements may diminish. Tailoring the experience to meet each user's unique needs is also vital.

Moreover, privacy concerns arise, particularly when collecting users' health data (Al-Rayes et al.,2022; Anwar, Silvani, & Saputra, 2025). Despite these challenges, the potential of gamification as a transformative tool for promoting healthier lifestyles is immense, particularly among young individuals adept with digital technology. With thoughtful design and a keen focus on user needs, gamified health apps can effectively inspire healthy habits and support sustained wellness (Auza-Santivafiez et al..2024; Tesi et al.,2023). Hence, all these gamification elements have been studied as potential elements for implementation in the GMHealth Framework.

2.2 Mobile Health Application

Mobile health (mHealth) is a software program specially developed for mobile devices (e.g., smartphones, tablets, and smartwatches), which have a small size and resource consumption due to the features of these devices. Meanwhile, mHealth applications are software applications related to health knowledge and research used by healthcare professionals and patients to improve health treatments and public health (Nezamdoust et al.,2022). Generally, mHealth applications are divided into two broad categories: those focused on health and wellness and those specifically designed for disease management (Chao et al.,2024; El-Sherif & Abouzid, 2022). Aside from that, nurses, doctors, and other medical partitioners use mobile devices to access patient information, databases, and resources.

The mHealth application is also helpful in collecting data related to physical activity, human body image, and other aspects related to healthcare (Jat & Grønli, 2023; Rosa et al.,2022). Health text messaging, mobile phone applications, remote monitoring, and portable sensor devices are examples of mHealth technologies. mHealth is essential because it makes healthcare practices available to the public via mobile communication technologies, such as providing healthcare news, collecting medical information, and monitoring patients and others (Junwei Cao et al.,2022; El-Sherif & Abouzid, 2022; Nezamdoust et al.,2022). In addition, mHealth helps people regulate or prevent chronic diseases such as obesity, diabetes, and cardiovascular diseases. Moreover, healthcare professionals use mobile health applications to improve and facilitate patient care (Galetsi et al.,2023).

Some mHealth applications also allow people to communicate with mobile health-related or medical software applications (Khoshnoodifar et al.,2023). According to Wall et al.,(2023), there is an increase in the use of mobile health sensors in wearable devices and smartphones. These applications use various sensors in smartwatches or smartphones to help users monitor and control their health status and progress (Jat & Grønli, 2023; Virginia Anikwe et al.,2022). In other words, mobile health applications help patients, such as dialysis patients, to self-monitor their daily food intake by providing immediate feedback. Mhealth apps also address user-to-healthcare-system communication (via call centres and appointment and exact treatment reminders), monitoring and surveillance (via patient monitoring applications and surveys), and

information access (via health records and medical diagnoses (Virginia Anikwe et al. ,2022; Yang et al.,023). Other than that, mobile health applications are also beneficial for users of different ages, regardless of their health status.

In recent years, there has been an increase in mobile health applications for physical activity, nutrition, health monitoring, and health knowledge. Virginia Anikwe et al.,(2022) state that 23,682 healthcare applications were identified based on their functionality, patient health status, and health domains. Another 7,407 applications were identified as aimed at healthcare professionals, while 6,275 were aimed at the user or patient.

Moreover, Virginia Anikwe et al.,(2022) mentioned that nearly half of the healthcare apps available with complimentary access across multiple domains are primarily focused on healthy living, with a severe lack of applications aimed at self-diagnosis, filling prescriptions, and medication compliance.

Usually, most unhealthy people are familiar with mobile health applications that monitor their health condition. However, they are not attracted to using healthcare (Chao et al.,2024). Sustainable healthcare is achieved by motivating people to care for themselves regularly through appropriate exercise.

Therefore, the GMHealth framework was developed to guide the integration of gamification elements in mobile health applications for a broad range of users. While it is not limited to individuals with health conditions, healthy users can also benefit from the gamified features. By incorporating elements such as rewards, challenges, progress tracking, and virtual guidance, the framework can encourage consistent engagement, promote positive health behaviours, and support overall well-being, ultimately fostering long-term use and a more enjoyable user experience.

2.2.1 Category of mHealth Application

mHealth applications have been categorized into several different terms, and each term has a different function for medical practitioners and users. Some apps are suitable only for medical and health experts' use, and some are focused on the general user, not only for the patients. Each category has a different function, and to develop the framework of GMHealth, this study will focus on the category of healthy life apps. The category will focus on fitness and diet apps where the user is usually a healthy

person who wants to improve their daily life routine through the mobile application to track their diet or fitness progress, track their calories per day and complete the level of their daily exercise. Table 2.2 shows some of the categories of mobile health applications, examples of the apps in the current market, and their specifications.

Table 2.2
Category of Mobile Health Application

Category	Description	Example
Clinical Assistance Apps	Clinical assistance apps have various functions, allowing doctors to check EHRs or access lab results during an appointment. These apps may also allow for image viewing and patient education, so a doctor can use them during an appointment to illustrate the information he or she is giving to a patient.	• Mobile MIM • Syngo via WebViewer • DrawMD
Monitoring apps	Monitoring apps allow a doctor to keep an eye on the behaviour or symptoms of a patient remotely. For example, a patient could use an app to take an ECG and then send the results to his/her doctor.	• American Well • InTouch Health • AirStrip-Patient Monitoring
Reminder apps	The application can remind patients of appointments or when to take medication.	• Talksoft Connect • My PillBox • OnPatient
Healthy life apps	A category that encompasses fitness and diet apps, as well as other types of apps, healthy life apps are primarily used by patients rather than by doctors.	• CarrotFit • Glow • Fitbit
References/database apps	The references app allows the doctor to look up drug dosages or symptoms. It quickly replaces old databases and takes the spot once held by giant reference tomes.	• Epocrates • AAP Red Book • UpToDate
Efficiency/ communication apps	Allowing doctors to communicate between medical facilities fosters interoperability, collaboration, and better patient care. For example, communication apps allow a doctor	• Doximity • DocbookMD • OnPage

	to securely send information about a patient to a specialist at another facility. They also allow for a more efficient workflow in the medical practice, which many doctors strive for.	
General Facility Information Apps	The apps are developed for a particular practice, usually a hospital. General facility apps give patients and family members information about the facility, its services, and its amenities. An app could include maps of the hospital and the surrounding neighbourhood or a list of available doctors at the facility, among other things.	MyWay by Boston Children's Hospital Fit4KidsCare by Miami Children's Hospital Patient by Mayo Clinic
Patient portal apps	It gives patients mobile access to their electronic medical records and allows for more accessible patient-doctor communication.	• NextGen Patient Portal • PortalConnect

Source :(Bas-Sarmiento et al. 2025; Chao et al. 2024)

Based on Table 2.2, mobile health (mHealth) applications have become increasingly diverse, catering to the needs of both healthcare professionals and patients across various health domains. These applications can be broadly classified based on their primary functionality and target users.

The first category is clinical assistance apps developed primarily for healthcare professionals, providing tools to support clinical decision-making. These may include drug interaction checkers, diagnostic aids, medical calculators, and access to clinical practice guidelines, enabling improved accuracy and efficiency in patient care, for example, using Mobile MTM apps. Furthermore, monitoring apps are designed to track health-related data, often in real-time. They are commonly used in chronic disease management, allowing users or caregivers to record vital signs such as blood pressure, glucose levels, heart rate, or physical activity. Such apps support continuous monitoring, early detection of abnormalities, and more informed clinical follow-ups.

One of the most popular reminder apps is usually for a dehydration reminder. Usually, reminder apps focus on improving adherence by sending alerts for medication intake, health appointments, or routine health tasks. These apps are especially beneficial for older adults, individuals with chronic illnesses, and those managing complex

medication regimens. The next category of health apps is Healthy lifestyle, where Healthy lifestyle apps promote general well-being by encouraging users to adopt healthier behaviors. They typically include features related to fitness tracking, nutritional advice, sleep improvement, stress reduction, and mental health support. These apps often incorporate gamification and social elements to sustain user engagement. Hence, this category is chosen as content for developing the GMHealth framework prototype to promote a healthy lifestyle among young adults and adults.

Reference or database apps provide instant access to medical literature, drug information, and clinical resources. These are primarily intended for medical students and professionals seeking reliable, evidence-based information for study or practice purposes. One example of a reference or database app is the Epocrates and UpToDate apps. The next category is Efficiency or communication apps, which aim to enhance coordination within healthcare settings. These may include internal messaging platforms, staff scheduling tools, or telemedicine systems that facilitate remote consultations and communication between healthcare providers and patients.

Next, General facility apps are developed by specific hospitals or healthcare institutions to provide users with information about services, locations, appointment booking, queue management, and check-in systems. These apps enhance patient experience and streamline administrative processes. Patient portal apps enable patients to access their electronic health records (EHR), view lab results, monitor prescriptions, and communicate with their healthcare providers. These portals encourage patient involvement in their healthcare and support continuity of care.

The classification of mHealth applications into these categories reflects the growing complexity and specialization within digital health ecosystems. Understanding these categories is essential for evaluating usability, functionality, and user engagement across different health contexts. In conclusion, the prototype of the GMHealth framework was developed by choosing the *Healthy* and *Lifestyle* category as a reference.

2.2.2 Category of Mobile Health User

Understanding the demographics of mobile health (mHealth) application users is essential for tailoring design, features, and engagement strategies to meet the specific

needs of different populations. For instance, a 2022 study in Malaysia found that most mHealth users were young adults aged 18-35, accounting for nearly 80% of respondents (Yoon et al.,2024). In addition, a 2022 population-based survey reported that mHealth app usage was more prevalent among younger individuals under 30 years of age, often associated with higher smartphone engagement and social media use (Paradis et al. ,2022).

Segmenting mHealth users by age reveals important usage trends: younger users gravitate toward proactive tracking, wellness, and fitness features, while older users in the category of baby boomers often engage mHealth tools for chronic disease management and telemedicine, albeit at lower adoption rates due to concerns over usability and privacy (Paradis et al.,2022). These distinctions help inform the design, accessibility, and engagement strategies for mHealth interventions.

Table 2.3
Range of Age with mHealth Specification

Age Range	**Primary User Category**	**Common Uses**	**Example Applications**
Adolescents (13-17)	Student and Youth Users	Fitness tracking, mental health support, reproductive health awareness	Flo, Headspace, Zombies, Run!
Young Adults (18-29)	Tech-Savvy and Wellness-Oriented Users	Preventive health, nutrition monitoring, fitness gamification, stress relief	Fitbit, MyFitnessPal, Calm
Adults (30-49)	Working Professionals and Family Caregivers	Chronic disease prevention, family health monitoring, pregnancy and parenting	Glucose Buddy, Ovia Pregnancy, Samsung Health
Middle-Aged Adults (50-64)	Chronic Condition Managers	Hypertension tracking, diabetes management, and telemedicine consultations	MySugr, Teladoc Health, Omron Connect
Older Adults (65+)	Elderly and Assisted-Living Users	Medication reminders, remote monitoring, fall detection, telehealth	Medisafe, Life Alert Mobile, KardiaMobile

Source：(Eisenhauer et al.,2021; Ferrari et al.,2022; Mazeas et al.,2022; Paradis et al.,2022)

According to the presented Table 2.3, the choice of user for the prototype of the GMHealth Framework is targeted for adults and young adults, particularly those aged 18-29 and 30-49 years old, who represent the most active demographic in mobile health (mHealth) adoption (Statista,2024). Prior studies have shown that this age group demonstrates high smartphone penetration, greater willingness to engage with digital

health solutions, and a strong inclination toward preventive health behaviours, fitness tracking, and wellness improvement (Paradis et al.,2022).

Given these factors, the *LetsGoFit* prototype adopts Health and Fitness as its primary content category, emphasizing features such as personalized workout plans, progress tracking, and motivational tools to promote consistent engagement. This aligns with recent literature highlighting that health and fitness applications are among young adults' most downloaded and regularly used subcategories of mHealth, driven by their interest in maintaining physical well-being, enhancing performance, and integrating healthy lifestyle habits into daily routines (Statista, 2024).

2.3 Gamified Mobile Health (mHealth)

In health and well-being, gamification implemented in mHealth is increasingly recognized as an essential tool to foster the sustained usage of a system or promote certain health behaviours and positively affect health-related intervention (Upadhyay et al.,2021). Based on a study by Al-Rayes et al.,(2022) and Damasevicius et al.,(2023), the health game is a digital design created specifically for health purposes that includes traditional game elements such as goals, conflicts, the ability to win and lose, and rules.

Moreover, gamification in mobile health (mHealth) applications is not solely for entertainment; it is a strategic design element intended to support users in healthcare-related activities and encourage positive behavioral changes. The provided research focuses on its application in mobile payment platforms and nutrition apps, illustrating how gamified features can enhance user engagement and assist in achieving specific goals, such as managing finances or tracking dietary intake (Chao et al.,2024; Lai & Liew, 2021).

Aside from that, gamification in health has many similarities, such as health content, health messages, theory-based behavioural design, health knowledge and information, measurable skill gains, and the ability to set targets and monitor health-related attitude changes. A previous study stated the advantages of using game mechanics in mobile health applications. The gameplay presented in mobile health interventions might positively impact users' emotional experiences and boost their pleasure and self-esteem (Eisenhauer et al.,2021; Mazeas et al.,2022). The advantage of game mechanics is that users are highly motivated to change their health behaviours

and stick with the application (Deniz-Garcia et al.,2023; Lai & Liew, 2021; Paradis et al.,2022).

However, it was discovered that gamification might fail to keep users engaged and many studies considered those game elements to assist significantly in using the application regularly (Yang et al.,2023). Moreover, the game mechanics help the user's willingness to keep using the gamified applications, where the long-term engagement requires personalization, evolving challenges and dynamic updates (Huang et al.,2024). In other words, failed gamification implementations in gamified mobile health often result from improper design, ignoring player personalities, and misaligning user goals (Wyrobek et al.,2024). Hence, to enhance user engagement, gamification should go beyond providing fun and consider various software types and platforms (Maria, 2021).

Table 2.4 summarises all the advantages of mobile health applications. The presence of the mobile application gives lots of benefits, such as increased user compliance in maintaining their health. Besides, the mHealth application makes health activities more fun and enjoyable. Other than that, social support elements in mobile health give users better social skills. Thus, it is necessary to develop mobile health applications that are more engaging by developing the GMHealth framework.

Table 2.4
The advantages of mobile health applications and supporting studies.

Advantages	Supporting studies
Sustains the user's engagement with the tool.	(Ashar et al.,2025; Rosa et al.,2022; Supramaniam et al., 2024)
Increases user compliance with health interventions and improves their ability to self-manage their conditions and adhere to treatment.	(Hsu et al.,2025; Sanchez et al., 2023; Supramaniam et al.,2024)
Provides positive emotional states and elevates the user's satisfaction and self-esteem.	(lunwei Cao et al.,2022; Yang et al.,2023)
Enhance the intrinsic and extrinsic user motivation.	(Lieder et al.,2024; Mustafa et al., 2023; Tuahetal.,2021)
It makes health activities fun, enjoyable and understandable.	(lunwei Cao et al.,2022; Epstein et al. ,2021)
Promotes healthy behaviour and reinforces the user's efforts to change their behaviour.	(Borghouts et al.,2021; Eaton et al.,2024; Saleem et al.,2021)
Social support was perceived to be appealing and crucial in increasing social skills.	(Grady et al., 2023; Saleem et al.,2021; Stutvoet et al., 2024)

2.4 Existing Gamification Application in Healthcare

In the context of health in mobile health applications, gamification is typically employed in medication adherence, medical education-related simulations, and fitness and wellness apps. According to Hsu et al.,(2025), mobile health platforms have become more advanced every day, especially with the combination of gamification, which would be considered one of the most advanced tools in the healthcare system. Table 2.5 explains some examples of the current mobile health applications that apply gamification elements and descriptions.

Table 2.5
Existing Gamification Application Related to Healthcare

Application	Description	Gamification Element
Cafe'Well 	It focuses on guiding and supporting people who want to live healthier lives. Its personalized programs focus on eating better, incorporating exercise into life, reducing stress, or walking that extra mile.	Goals, Leaderboard, Feedback, Virtual Coaches, Social Community, Library, Information Tools, Challenges, Progress, Theme Points, Reward and Level.
MangoHealth 	The apps were designed to motivate patients to take their medications on time. Users can set when medications should be taken, and the apps will remind them. It also provides medication information and warns about drug interactions and side effects. Users earn points towards gift cards or charitable donations in weekly raffles by taking the medication properly.	Reminder, Notification, Points, Reward, Logbook, Trend Alert, Autonomy, Visualization of Data, Progress Bar, Library, Information Tools, Feedback, Profile, Goals and Level

mySugr 	The apps offer gamified solutions for diabetes management in a fun way for children and adults. It helps manage their diabetes by rewarding them for consistent blood glucose testing. As points accumulate, new game levels and options unlock. There are leaderboards with the kids who collected the most points, web games, and an online community.	Badges, Points, Level, Feedback, Social Community, Logbook, Trend Alert, Leaderboard, Visualization Of Data, Challenges, Autonomy, Progress, Notification, Reminder, and Profile.
The GlassOff 	The apps were developed to eliminate dependency on reading glasses by enhancing users' brain's image processing function. The recovery process consists of several sessions that are mini visual recognition games and take about 12 minutes. It is recommended that the program be followed three times a week for three months. The apps automatically remind users when it is time for the next session.	Reminder, Notification, Goals, Autonomy, Progress, Logbook and Challenges.

Based on the existing mobile health application, most apps apply several gamification elements, such as a progress bar, to measure their success and share their progress and results with their friends and other players. Some apps also use rewards such as points, medals, stars, achievement badges, or virtual currency during each stage of progress. It creates a sense of accomplishment and increases motivation levels for the user to remain engaged in the application. Most applications also have different challenges and goals for users to achieve, depending on their objectives using that gamified mobile health application. Other than that, a few of the gamified mHealth apps implement the presence of virtual coaches to help them feel like someone is guiding them and giving support and advice throughout the health application.

2.5 User Engagement

Jansen et al. and Z.-Y. Lim et al.,(2023) define user engagement as a multifaceted concept in human-computer interaction that measures users' attraction to and involvement with products or services. According to Eaton et al.,(2024), user engagement is defined as how users interact with the intervention and the amount or 'dose' received, measured as interaction time with the intervention component. Gamification enhances engagement by encouraging behavior change through intrinsic and extrinsic rewards (Maria, 2021; Soo & Lee, 2022; Tizuka et al.,2020). As users pursue goals and receive rewards such as points, badges, or achievements, they may experience a sense of progress and accomplishment and thereby continue actions they might not otherwise perform without the presence of gamified elements.

In non-game contexts, gamification refers to using game-design elements to enhance user experience and motivation (Suryavanshi et al.,2022). By incorporating these elements into digital services, gamification creates motivational affordances that support desired behavioral outcomes (Al-Rayes et al.,2022; Sharif & Woolley, 2022). This process is particularly effective in traditionally non-gaming settings, where the addition of game-like features can significantly improve user motivation, attention, and engagement (Krath et al.,2021; Qiao et al.,2024; Suryavanshi et al.,2022).

Moreover, gamification promotes engagement by introducing game components such as rewards, challenges, and feedback loops into non-game environments to motivate actions and maintain interest. Gamified systems combine internal and extrinsic

motivators, such as competition and teamwork, to give users meaningful and entertaining experiences (Anwar, Silvani, & Saputra, 2025; Qiao et al.,2024; Six et al. ,2021). These mechanics promote emotional, cognitive, and behavioral connections, increasing user loyalty and happiness, particularly in education, healthcare, and entertainment (Qiao et al.,2024). According to research, correctly designed gamification frameworks can dramatically increase user engagement and retention by aligning with user goals and providing interesting interactions (Suryavanshi et al.,2022). However, its effectiveness depends on deliberate implementation that avoids superficiality and aligns with the targeted audience's preferences and objectives.

2.5.1 Gamified Mobile Health for User Engagement

The gamification element will also drive the users to engage with all the contexts in the mobile health application, make the experience enjoyable, and promote better health outcomes (Castiblanco Jimenez et al.,2022; Supramaniam et al., 2024). While using gamified mobile health applications, users are motivated to change their behaviour to avoid such losses, including losses in various gaming scores, items, or reputations (Alzghoul, 2024).

A study found that gamification effectively increases users' attention in engaging in mobile health applications and encourages healthy and unhealthy people to maintain their health status (Dewitz, 2022; University et al. ,2021; Yang et al.,2023). By integrating game elements such as points, badges, progress tracking, challenges, and real-time feedback, these apps transform routine health tasks into interactive and rewarding experiences. This gamified approach makes health management more appealing and encourages regular use and sustained interaction. As a result, user, regardless of whether they are healthy or living with health conditions, are more likely to adopt and maintain positive health behaviours, leading to improved health outcomes or the preservation of their current health status. These findings highlight the potential of gamification as a powerful tool in gamified mobile health design, particularly in promoting user motivation and long-term behavioral change.

According to studies by Gkintoni et al.,(2024), gamification has emerged as a promising strategy for engaging and motivating young people in health-related behaviour, effectively promoting behaviour change and improving health outcomes.

For example, gamified scenarios can help young people develop skills, knowledge, and behaviour that contribute to their overall health and well-being by providing interactive and engaging experiences, implementing elements such as points, levels, challenges, badges, leaderboards, and rewards (Gkintoni et al. ,2024). Besides, research by Gkintoni et al.,(2024) through sexual education for children and adolescents, when used appropriately, gamification can provide an engaging, interactive and less intimidating method for imparting this crucial education by integrating the use of leaderboards and badges for the quizzes related with sexual education can make the learning experience more engaging and give a better understanding in sexual health outcomes.

Health-related services are delivered using mobile devices by utilising information and communication technology (ICT) through mHealth applications. Many software, such as *Fitocracy, QUENIQ, Zamzee, Lose It,* or *7 Minutes*, can improve users' exercise routines by encouraging more effective physical activity. Additionally, mobile health applications can assist the user in documenting and recognizing the data collected from wearable devices (Cusack et al.,2024). This provides the user with a greater level of convenience. In addition, several health apps can provide services that are focused on reducing lifestyle habits that pose potential risks to someone's health, such as smoking (Rajani et al.,2021).

Furthermore, gamification is essential for those embracing mobile health (Hernandez et al.,2021). As considered from a different angle, gamification has the potential to act as a medium that may be used to promote and maintain positive behaviour, with a particular focus on the development of fun and the objectives of human behaviour. According to Xu et al.,(2022), adopting gamification approaches, including adding objectives, progress comparison, networking, social feedback, and reinforcement elements, might effectively assist changes in health behaviour activities.

These findings directly inform the development of the GMHealth framework, which integrates similar gamification elements to guide the design of mobile health applications that foster sustained engagement, motivate users, and encourage the adoption of positive health behaviours over the long term.

2.6 Framework and Theoretical Foundation

While developing the GMHealth framework, several frameworks related to gamification were identified. The elements in the framework will be studied to determine which framework is suitable to enhance and produce a new framework focused on the health sector. Each of the framework details is explained below.

2.6.1 MAKE Framework

MAKE is an acronym representing four fundamental constructs: Motivating Learning, Attitude Change, Knowledge Acquisition, and Student Engagement by Haruna et al.,(2019). These dimensions correspond with essential educational objectives of sexual health programs and have been empirically substantiated with adolescent cohorts to exhibit substantial psychometric reliability and construct validity (Haruna et al.,2019). This framework encapsulates various aspects of educational impact, encompassing cognitive, affective, and behavioral engagement, thereby providing a multi-dimensional evaluative instrument tailored to the intricate nature of sexual health liter.

Motivation, a core component, is vital to sustaining adolescent participation in gamified health education. The MAKE framework measures how effectively interventions motivate learners through intrinsically engaging game mechanics and extrinsic rewards, consistent with findings that gamification improves active user involvement and persistence (Freyer et al.,2024). Attitudinal changes toward sexual health, including beliefs about consent, contraception, and gender norms, are also central outcomes that the framework assesses, reflecting the importance of shifting perceptions to foster healthier behaviors (Nilsen et al.,2023).

Knowledge acquisition remains foundational, with recent research showing sustained improvements in understanding reproductive health, sexually transmitted infections (STIs), and safe sex practices following gamified sexual health programs (Alekseeva et al.,2023). Engagement levels measured by the framework highlight how immersive and interactive gamified methods capture and maintain adolescent attention, which is critical for learning retention and behavioral change (de Lijster et al.,2023).

Complementing the MAKE framework's constructs, broader educational and health initiatives emphasise comprehensive sexuality education (CSE) frameworks worldwide that advocate age-appropriate, evidence-based instruction to empower adolescents with sexual and reproductive health knowledge and self-efficacy (WHO, 2023; California ASH Ed Program, 2025). These programs increasingly incorporate digital and gamified elements to enhance accessibility and appeal, especially among youth disproportionately affected by inequities in sexual health outcomes (ASH Ed California, 2025).

Furthermore, gamified sexual health interventions tap into psychological constructs such as autonomy, competence, and relatedness, which underlie effective behavior change strategies and are indirectly captured by MAKE's motivational and engagement dimensions (Schuler et al.,2024). These theories help explain why gamification can be transformative in adolescent health education, as it supports sustained intrinsic motivation and social connection.

In summary, the MAKE framework offers a comprehensive, multi-faceted approach to evaluate the impact of gamified and game-based learning interventions in adolescent sexual health education. It aligns well with contemporary pedagogical and behavioral models, effectively capturing motivation, attitudes, knowledge, and engagement. This makes MAKE a valuable tool for researchers, educators, and developers aiming to enhance adolescent sexual health literacy through innovative, gamified educational technologies. Table 2.6 displays the components of the MAKE Framework.

Table 2.6
The component of the MAKE Framework

Constructs	**Components**
Motivation	Attitude Relevance Confidence Satisfaction
Attitude	Affective Cognitive
Knowledge	Importance Effectiveness Application
Engagement	Emotional Cognitive

Source：(Haruna et al. 2019)

2.6.2 Octalysis Framework

The Octalysis Framework, developed by Yu-kai Chou, (2015), is a conceptual framework that aims to facilitate the analysis of human motivation and engagement. It is based on the idea that people are motivated by specific core drivers, which Chou calls *Octalysis*, the eight aspects of human motivation. Through the Octalysis Framework, Chou aims to provide system designers with a systematic approach to understanding and leveraging motivation in various contexts, including organizational settings, marketing strategies, and product design.

One of the frameworks for gamification is called Octalysis, and it presents users with eight different core motives to push them to do certain activities. Some individuals are motivated by various reasons, and a person's core influences them differently. Different things drive different individuals. The Octalysis is configured in an octagonal shape, with the core drives positioned at each corner of the structure. Both the logical and intellectual parts are represented by the drives that are located on the left side. According to the author of Octalysis, several companies mainly explore the development of designs driven by extrinsic motivation or the desire to obtain rewards.

In the article by Chou, (2015), it is stated that the design component should be highlighted to achieve continued motivation and boost the overall happiness obtained from the activity. Intrinsic motivation, which incorporates creative and social interaction, is claimed to be the most essential part of motivation. In Figure 2.1, the Octalysis Framework is illustrated. This framework is comprised of eight cores, each of which is represented by its equivalent sub-element.

Chou , (2015) categorized the drives on the bottom side of the Octalysis as *Black Hat Gamification*, meaning negative motivation. These types of drives refer to the person being motivated to take specific actions because of the fear of losing, the curiosity of upcoming events, or striving to achieve the things he/she cannot have. The drives on the top side of Octalysis represent *White Hat Gamification*, which is considered positive motivation. These positive core drives motivate individuals through creativity, making them feel powerful due to their sense of control and the impression of a greater meaning.

One of the core drives is *Epic Meaning & Calling*, which is the human need to be a part of something bigger than us. It appeals to people's natural desire to help with

a bigger goal, like saving the world or completing an important task. Some examples are helping a good cause, protecting the earth, or participating in a movement for social change. The next drive *is Development & Accomplishment.* This core drive comes from the natural need to learn, improve, and reach goals. Users are driven by tasks, goals, and chances to improve. Levelling up, progression systems and achievement badges are all popular ways to keep users interested and give them a sense of satisfaction.

Other than that, the drive that will probably be implemented in this research project is *Unpredictability & Curiosity*, which is based on people's natural desire for change, surprise, mystery, and their desire to be unpredictable. Users are drawn to uncertain results, secret surprises, and the chance to explore what might be possible. There are many ways to keep users interested, such as random gifts, mystery boxes, and secret Easter eggs. The author also highlights that successful gamification requires considering all the core drives. Some of the elements in the Octalysis Framework will be studied as a reference when developing the GMHealth framework.

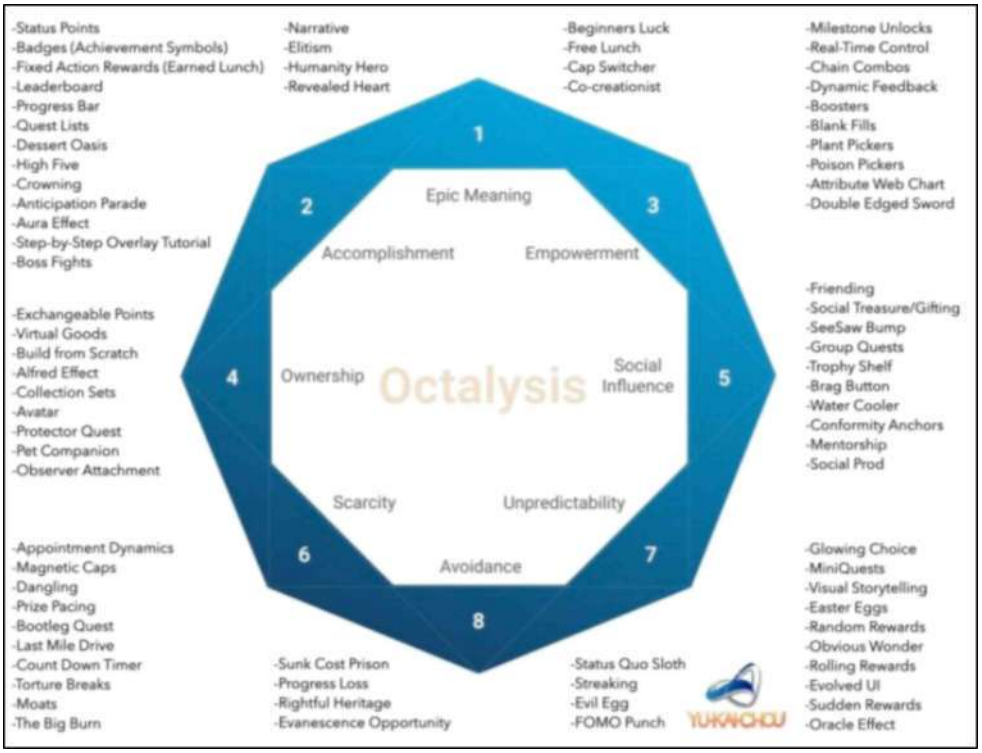


Figure 2.1 Octalysis Framework (Chou 2015)

2.6.3 Andrzej Marczewski's Framework

The framework proposed by Andrzej Marczewski,(2017) is one framework that assists designers or developers in making their gamification more adventurous. This simple framework consists of questions that the designers must ask themselves and is divided into planning and design development. This framework also offers valuable guidance for designers and developers creating engaging and effective gamified experiences. Hence, to develop the prototype of this framework, it will refer to this framework to create a more engaging application for the user.

The first phase, planning and design development, involves laying the groundwork for the gamification project. Designers ask themselves key questions and make necessary preparations before diving into the development process. It requires identifying the scope, where the designers determine what aspect of their project they want to gamify. This could be a task, process, or behaviour they aim to encourage or improve through gamification. The next step is understanding the purpose, in which the designers clarify why they are implementing gamification and what specific goals they aim to achieve. This helps align the gamification strategy with the project's overall objectives. Then, it is essential to define the target audience, such as users of the gamified experience and consider their preferences, motivations, and demographics. Understanding the target audience helps tailor the gamification elements to their needs and preferences.

Furthermore, planning the gamification element, including points, badges, levels, challenges, and rewards, is also essential in developing a good game. The design must establish analytics tools and metrics to track user engagement, behaviour, and performance within the gamified system. Lastly, user feedback is collected through testing and iteration phases before finalizing and releasing the gamified solution. User feedback provides valuable insights into usability, satisfaction, and areas for enhancement.

The second part is to remember gamification and what to consider before implementing gamification. The list consists of thinking like a game designer and trying to make it voluntary, making players much better than those forced. Next, the designer needs to plan for cheaters, which is human nature to cheat the system, especially if there is an extrinsic reward. The designer should remember that intrinsic motivation plays a

decisive role than extrinsic and should not be evil. This scenario does not offer the opportunity to use people in a designer's new gamified system. Lastly, remember that a bit of fun in the gamified system can make almost anything more bearable and socialising with other people is always better for long-term engagement.

In addition, literature study on Andrzej Marczewski's gamification framework provides valuable insights into user types, motivational drives, and engagement strategies, which are applied in the development of the GMHealth framework. These principles serve as a reference for designing the prototype of this study, ensuring that gamification elements are tailored to different user preferences and effectively enhance engagement. By aligning the GMHealth framework with established gamification theories, including Marczewski's work, the prototype is better positioned to engage users, sustain interaction, and support positive health behaviours over time. Figure 2.2 shows the framework of Marczewski's Gamification Framework.

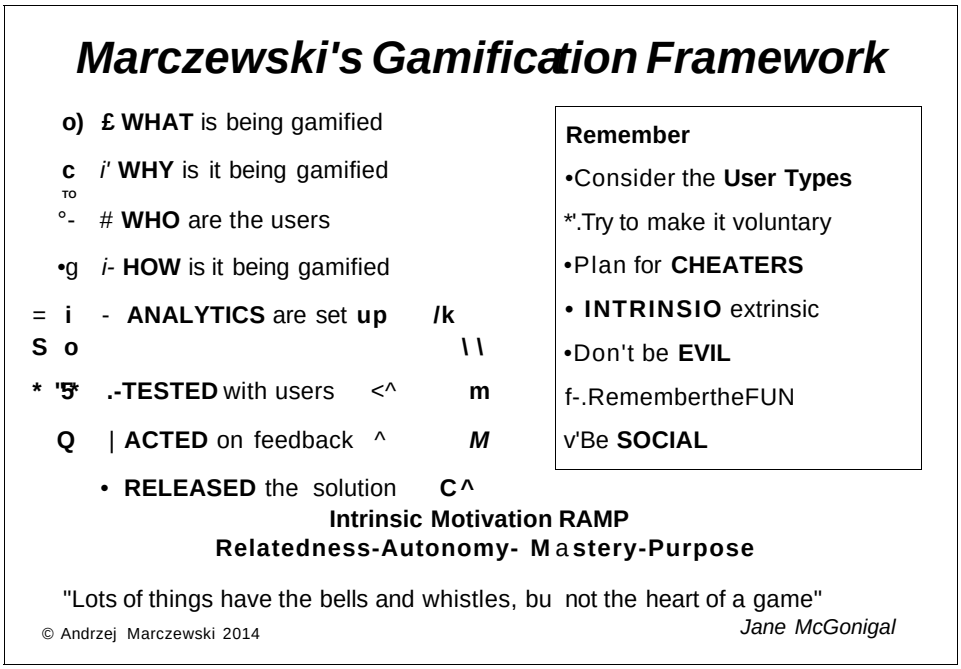


Figure 2.2 Marczewski's Gamification Framework (Marczewski, 2017)

2.7 Gamification Element in the Previous Study

Several articles and studies were analysed using content analysis techniques to develop the GMHealth framework. Based on previous research, certain gamification

elements are essential for the effective design of mobile health applications. These key elements, which will be integrated into the GMHealth framework, include Reminders/Notifications, Virtual Coaches, Rewards, Goals, Feedback, Challenges, Progress Bars, Library/Information Tools, Story/Theme, Social Support, Leaderboards and Avatars. Table 2.7 provides a detailed description of each gamification element, illustrating how they contribute to a more engaging user experience within mobile health applications. The descriptions are outlined clearly in Table 2.7, helping to explain how these elements enhance user interaction and motivation.

Table 2.7
Findings of gamification elements in the healthcare context

Element	Description	Source
Reminder/ Notification	• The mechanism that brings information to smartphone users for their attention. • The messages sent via notifications were written to be friendly, with non-judgmental language and a positive tone to avoid adverse effects on mood that may cause discontinued app use. • Just-in-time reminders and encouragement. • The reminders need to be sent once per day to avoid the annoyance.	(Gan et al.,2023; Lieder et al., 2024; Saleem et al.,2021; University et al. ,2021)
Virtual Coaches	Virtual coaches can talk and inspire the user and make them feel like someone is training them more personally. Provide motivational content to help users reach their targeted goals to engage with applications. It must be in real-time support and synchronous feedback to avoid user frustration.	(Bassi et al. ,2022; Lithoxoidou et al.,2022; Mitchell et al. ,2021)
Reward	The system provides an incentive for a certain action. It can be represented in several forms: trophies, badges, points, medals, and scores. The reward must be presented in an automatic, real-time feedback system and various collectable virtual rewards. The reward can be numerical (e.g., points and score). The trophies can only be given to a specific award to the player upon accomplishing a particular activity. Badges should be meaningful and awarded for meeting objectives.	(Sharif & Woolley, 2022; Six et al.,2021; Tesi et al., 2023)

Goals	The goal is the end of a game where the objective is achieved.	(Albers et al. ,2023 ;Damasevicius et al.,2023)
Feedback	A helpful mechanism informs the user's progress and alerts them to changes in outcome status. Providing instant feedback is a helpful mechanism for informing users about their progress and alerting them to changes in their status. Feedback was mainly represented in visual popups (e.g., textual measures, informative messages) or audible notifications (sound effects). Feedback must be in real-time.	(Ashar etal. ,2025; Cusack et al. ,2024; Lieder et al. ,2024; Nwaimo et al. ,2024)
Challenge	It is defined as an element with increasing difficulties at different levels. It needs to be carefully designed as overly easy tasks make the players bored, while overly difficult tasks make them leave. Challenges are regularly updated to provide users with sufficient options to motivate them to use the application.	(Bas-Sarmiento et al.,2025; Trinidad etal.,2021; Warmelink et al, 2021)
Progress Bar	• Progress bars help users visualize their performance and keep track of their progress. • A progress bar at the top of the page showed the encouragement's scoring process. • The progress bar element is a graphical element in the user interface that shows the user's progression and how close he/she is to completing tasks. • It could be in a percentage, visual form, or textual representation.	(Rajani etal.,2021; Xu et al.,2022)
Library/ Information	• To inspire in line with user feedback. The expert must validate the information provided	(Borghouts et al.,2021;Dewitz,

Tools	and trust it to avoid misinformation in health facts. The information represented is designed to be easy to understand. The information must be related to the application.	2022)
Story/Theme	• A story or theme in a gamified application brings a gameful experience. • Immersion in a story makes users perceive it as realistic, and story characters that the users can identify with increase the probability of a narrative-driven belief change. • The theme is the background that the user might connect to at the beginning. • The storyline controls the user's progress and arc through the experience. • They create a journey that makes the user part of it and increases engagement.	(Huang et al.,2024; Torlakovic et al., 2022; Westenhaver etal.,2021)
Social Support	Players can communicate and support each other to generate competition and stimulate prosocial behaviour. It must be in real-time, personalized, and promote interaction, creating a community of reciprocal support. Create a community where users can share their experiences and learn coping strategies from each other. Allow users to link their profiles to their social media profiles. They can share their achievements and rewards with their family and friends, not in the community.	(Grady etal., 2023; Haque & Rubya, 2023; Huang et al.,2024)
Leaderboards	Dynamically rank individual user progress and achievements as compared to their peers.	(Anwar, Silvani, & Saputra, 2025; Warmelink et al, 2021; Westenhaver

	Users should be able to see their position in the context of others, as facilitated through a numbered ranking system. It should be carefully designed to encourage users to do well rather than discourage them from doing poorly. Instantly and regularly update so users can monitor their rank and current position.	et al.,2021)
Avatar	An avatar can be identified as the player's virtual identity or self-representation in the application. Allowing users to express themselves freely, for example, allows them to upload profile images, offers predesigned images for them to choose from, or personalizes their profiles.	(Taylor et al.,2022; Tuah etal, 2021; Warmelink et al.,2021)
Self-Monitoring	• Establish a method for the person to monitor and record their behaviour. • Real-time self-monitoring. • Create a logbook where users can enter all the data they need to save from their daily test results. • The visualization of data in a graph or chart is based on the data user in the logbook. • Alert the user of any trends or malicious symptoms in their daily progress.	(Alharthi, 2025; Eisenhauer et al. ,2021; Lithoxoidou et al., 2022)

According to the in-depth studies in several articles, one of the potential elements that can be implemented in this research framework is Notification/Reminder. Notifications/Reminders are a mechanism to bring information to smartphone users for their attention (Gan et al.,2023). Implementing this aspect is crucial in developing mobile health apps due to the efficacy of alerts in encouraging user engagement (Gan et al.,2023; Lieder et al.,2024). Moreover, the information delivered by notifications should be friendly, neutral, and encouraging (Iii & Lock, 2023). The message of notification could be presented in positive words, for example, "You're doing a great

job!", "Think back why you started?" and "You haven't make any moves or tasks today, keep going!".

Furthermore, limiting the frequency of alerts to a maximum of one per day is recommended to minimise user inconvenience and avoid disruptions to daily routines (Iii & Lock, 2023). The presence of notifications and reminders proves to be very helpful for users of mobile health applications. For instance, encouraging individuals to record their consumption of vegetables, informing them about their advancement (Gan et al., 2023), notifying the user about their medicine intake (Sanchez et al.,2023), and enhancing adherence to treatment in chronic illnesses (Eisenhauer et al., 2021). Thus, features such as notifications and reminders are very helpful to users and should be implemented in the GMHealth framework to engage users with their applications.

The next element that has been identified is Virtual Coaches. Virtual coaches can communicate and motivate users using the health application, creating a sense of personalised training (Bassi et al. ,2022). Virtual coaches improve the user's long-term involvement (Mitchell et al. 2021) and generate a more immersive experience, enabling the user to concentrate on establishing and attaining more significant objectives (Bassi et al. ,2022) on their tasks and exercises. Virtual coaches can be presented in several formats, including Chatboxes, Virtual Agents, Virtual Conversational Agents, Automated Physical Activity, and Virtual avatars (Jafar et al.,2023; Lieder et al. 2024; Taylor et al., 2022). The specific criteria of virtual coaches should be specifically built to provide immediate assistance and helpful feedback (Haque & Rubya, 2023). In addition, it is essential to provide motivating content for virtual coaches to effectively assist users towards achieving their desired objectives and maintaining their active involvement in their activities (Eisenhauer et al., 2021). The presence of virtual coaches in mobile health applications will motivate users to perform better and give them a sense of guidance, like someone helping them throughout the tasks and health activities (Taylor et al., 2022).

Furthermore, it is crucial to apply Rewards in a gamified health framework. The reward, the system, motivates a specific behaviour (Suryavanshi et al., 2022). Providing rewards in various forms, such as points, badges, medals, trophies, and scores, is a core gamification approach for users who have completed the assigned tasks (Sharma et al. , 2024). Creating rewards involves the implementation of an automated real-time feedback mechanism, which may be expressed in numerical form as scores or points

(Lieder et al., 2024). Furthermore, the reward system is a widely utilised strategic component of actual goods that players acquire through gameplay(Soo & Lee, 2022). The player is awarded prizes to achieve a specific goal or activity (Tuah et al., 2021).

In contrast to Points and Badges, prizes often refer to achieving specific behaviours (Tuah et al., 2021). On the other hand, the user can collect badges when reaching a specific numerical level and receive recognition for accomplishing objectives in their health-related tasks (Warmelink et al., 2021), which is expected to mean they have already done the challenges and have been awarded with the unlocked badges (Rao et al. n.d.). Hence, the reward element is needed to keep users engaged, motivated to perform better, and to stick with the m-Health application.

Feedback is also considered an essential element in mobile health. Feedback is a valuable technique for informing users about their progress and notification of any alterations in their outcome status (Lieder et al., 2024). Moreover, feedback tends to be given by visual popups, such as textual measures and informational messages, or through audio notifications, such as sound effects (Ashar et al.,2025; Lieder et al., 2024; Xu et al.,2022). The presence of feedback inside mobile health applications can enhance users' engagement and foster positive feelings towards the completion of suggested actions (Khoshnoodifar et al., 2023). In order to prevent user annoyance, this element must be promptly and efficiently addressed (Iii & Lock, 2023; Tuah et al. 2021). In other words, responses are another name for feedback. The presence of feedback in a gamified health framework helps make the user aware of their specific actions and performance.

The following gamification elements are Challenges. The concept of challenges within applications is pivotal for engaging users and enhancing their experience. Challenges are dynamic elements that escalate in difficulty across various levels, contributing significantly to user immersion and enjoyment. Challenges, also referred to as quests, offer users a structured journey through a series of gameplay actions, providing direction and purpose for their interactions within the application (Anwar, Silvani, & Saputra, 2025; Khoshnoodifar et al., 2023). To effectively engage users, it is crucial for challenges to be regularly updated, ensuring that users are presented with fresh and diverse options. This constant evolution helps sustain user motivation and interest in the application over time. However, designing challenges that balance

difficulty and engagement is essential to prevent users from feeling bored and leaving the application. Creating too easy challenges can lead to user boredom and disinterest(Bayo, 2024; Krath et al.,2021). When tasks are overly simplistic, users may lose interest as they fail to find stimulation or a sense of accomplishment.

Conversely, tough challenges can frustrate users and drive them away from the application altogether. Users may feel overwhelmed or discouraged if they perceive tasks as unattainable, leading to a negative experience and decreased engagement (Tuah et al., 2021). Hence, the challenge element had to be implemented in the GMHealth Framework.

The next one is the Progress Bar. In the realm of mHealth apps, the progress bar stands out as a standard feature that aids users in visualizing their performance and monitoring their health journey (Xu et al., 2022). Traditionally, this bar has been positioned at the top of the page, as a visual indicator of the scoring process. Its primary function is to offer encouragement, signalling the user's proximity to achieving a new level or reaching a significant milestone (Zolfaghari et al., 2021). As Rajani et al., (2021) pointed out, the progress bar should be seamlessly integrated into the graphical elements of the user interface, providing users with a clear representation of their progression and how close they are to completing their tasks. This progress bar can manifest in various forms, either visually or through textual representation, depending on the design and user preferences. Regardless of its format, the progress bar is crucial in promoting positive behavior and averting discouragement among users (Zolfaghari et al., 2021). It is a motivational tool, driving users forward in their health endeavours by visually showcasing their advancements and accomplishments. Through its presence, users are encouraged to stay committed to their goals and maintain a proactive approach towards their well-being.

The other finding for gamification elements is library or information tools. The purpose of library/information tools is to inspire based on user feedback. In a previous study, Quitter was used to educate individuals on how to quit smoking. Users reported that the educational content in the information toolbox helped them quit smoking (Bindoff et al., 2020). When designing library/information tools, keep the rule that follows in mind: the information provided must be verified and evaluated by an expert to avoid misinterpretation (Cyr, 2021; Dennis et al., 2023). Lastly, the information provided must be directly relevant to the application's purpose and objectives,

enhancing its utility and effectiveness (Zolfaghari et al., 2021). As a result, library/information tool capabilities will be integrated into the GMHealth Framework as a platform for users to obtain and develop their knowledge about the health applications that they are using.

Next, one of the most powerful gamification approaches is Storytelling. A story or theme in a gamified application creates a game-like experience (Aktas. Reyhan, 2025). According to Tuah et al., (2021), stories play a crucial part in gamified applications, generating an enjoyable environment when the stories fit the player's interests (Huang et al., 2024). The story is also known as narrative, context, or storytelling, whereas theme refers to the background the user may connect to at the start. When creating a compelling story or theme, ensure that the flow of the journey is relevant to the consumer and can boost engagement (Westenhaver et al., 2021). Next, the storyline's context is analogous to a real-world situation (Tuah et al., 2021). Some mobile health applications that integrate the story or theme aspect reported that users get inspired to complete their medication journal and help support efficacy by relating their character to the story (Ehrler et al., 2018).

Users are said to provide social support when they communicate with one another and offer advice to foster competitiveness and stimulate positive behaviour (Meyer et al., 2022). One of the social supports and tools that can improve user motivation is social media, which includes platforms such as Facebook and Twitter. It establishes a connection between users or patients and the community, giving them the impression that they are supported and not alone (Supramaniam et al., 2024). Social support must be provided in real-time, to be personalised, and to encourage interaction that results in community formation (Eisenhauer et al., 2021). In one of the applications, titled "Milkman: Gamifying Breastfeeding for Fathers," it was reported that the fathers used the conversation that took place in the forum in order to provide and seek social support, source connection and knowledge, and share their experiences about their baby's progress and growth (Aktas. Reyhan, 2025). Thus, social support in gamified mobile health applications can be considered an effective tool to boost user motivation and engagement.

Within mobile health applications, leaderboards are a gamification component encouraging user interactions and participation. A typical function of leaderboards is to offer users ranks that are determined by their scores or levels of performance. In

addition, these leaderboards are frequently updated in real-time, which enables users to monitor their progress and the current ranks of their competitors (Anwar, Silvani, & Saputra, 2025; Warmelink et al., 2021; Westenhaver et al., 2021).

Regarding health applications, it is of the highest priority to build leaderboards in a way that encourages users to perform at a higher level rather than one that discourages them from doing so (Westenhaver et al., 2021). In addition, leaderboards provide users with a sense of accomplishment and comparison by presenting information regarding their usage of the mobile health application compared to their peers (Tesi et al., 2023).

The next element is Avatar. Avatars function as a virtual identity or self-representation for users, playing a key role in defining their roles and enhancing the immersive experience within digital environments. These avatar elements also provide visual feedback or responses to an individual's health condition, contributing to a more personalized interaction (Tuah et al., 2021). Avatars are widely recognized as a tool for self-representation, allowing users to express their virtual identities (Tuah et al., 2021). In addition, users can customise their avatars in various ways, such as uploading personal profile images, choosing from pre-designed images (Taylor et al., 2022), or selecting in-game usernames freely (Warmelink et al., 2021). This flexibility makes users feel more connected to the application, fostering a sense of ownership and personalization.

Lastly is the Self-Monitoring component. Self-monitoring is a critical component of gamified mobile health applications, allowing users to track and record their health-related behaviors and data. Effective self-monitoring systems allow individuals to manage their health actively by tracking essential metrics. To optimize user engagement and accuracy, the self-monitoring feature should be designed to operate in real-time (Hsu et al., 2025). This enables immediate feedback and encourages users to log data as they go about their daily routines, enhancing the accuracy and relevance of the information collected. An essential self-monitoring feature is the logbook, which allows users to input specific data such as daily glucose levels, activity, or diet (Eaton et al., 2024). The logbook should be user-friendly and easily accessible, enabling users to record their health information quickly without disruptions (Lithoxoidou et al., 2022).

Additionally, data visualization plays a crucial role in helping users understand their health trends. The data can be presented through graphs, charts, or dashboards, allowing users to track their progress easily. Visual representation makes it simpler to spot trends, such as health improvements or deteriorations, and empowers users to take action based on the insights (Yoon et al., 2024). Another critical aspect of self-monitoring is alert systems. If the data entered or tracked by the application indicates unusual or potentially harmful symptoms, such as a dangerously high or low glucose level, the system should trigger a pop-up alert to notify the user (University et al., 2021). Integrating these elements, real-time tracking, logbook entries, data visualization, and alerts, a gamified mobile health application can provide users with comprehensive self-monitoring tools that enhance user engagement and support effective health management.

2.8 Theoretical Framework

To guide the development of the framework and analysis of this study, a well-established theoretical framework is essential for ensuring that the research is grounded in proven concepts and principles. A theoretical framework serves as the foundation that connects the research problem with relevant theories, providing a structured lens through which the study's variables, relationships, and expected outcomes can be examined. Adopting a framework that aligns with this research's objectives makes it possible to systematically interpret findings, justify design decisions, and ensure that the developed intervention is theoretically sound and practical. Hence, the details of the GMHealth Framework's core foundation were discussed in this section.

2.8.1 The Wheel of Sukr

The Wheel of Sukr: A Framework for Gamifying Diabetes Self-Management in Saudi Arabia was developed by Al Marshedi et al., (2015). It is a theoretical framework that aims to guide developers to create apps or systems to help individuals manage their chronic illnesses effectively. The framework emphasizes the link between gamification and behaviour change methods. The Wheel of Sukr provides a guideline for designing a gamified diabetes self-management system and the authors validated the framework using a mixed-method study (AlMarshedi et al.,2017). The Wheel of Sukr consists of eight themes: fun, esteem, growth, motivation, sustainability, socializing, self-representation, and self-management. Each element includes several sub-elements, as shown in Figure 2.3.

Since the framework was focused on chronic diseases such as diabetic patients, the themes *of fun* and *self-management* are essential. The Wheel of Sukr's fun theme focuses on incorporating enjoyment and entertainment elements into self-management apps for chronic illnesses. It aims to make managing chronic illnesses more engaging and enjoyable for users. Developers are encouraged to include gamification in their apps within a fun theme. This means incorporating game-like elements such as points, rewards, badges, and levels to motivate and engage users. By implementing these elements, users can feel a sense of accomplishment and progress as they manage their chronic illnesses. The fun theme also emphasizes creating a positive and enjoyable user

experience. This framework also encouraged the developers to design the application visually appealing and intuitive, providing users with seamless and enjoyable interaction. This can include using vibrant colours, interactive features, and engaging animations to enhance the overall experience. Overall, the fun theme in the Wheel of Sukr provides guidelines for developers to create self-management apps that are effective in helping individuals manage their chronic illnesses and are enjoyable and engaging to use. By incorporating fun elements, developers can motivate users to stay committed to their self-management practices and make the experience more positive and rewarding.

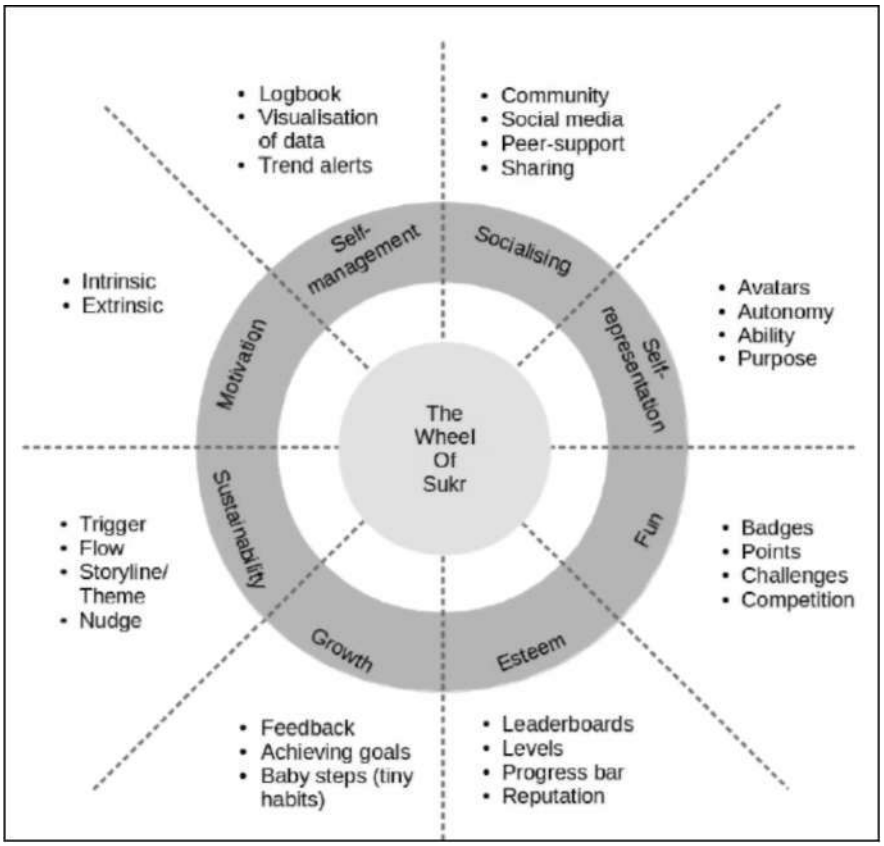


Figure 2.3 The Wheel of Sukr Framework

On the other hand, *self-management* is a key theme in the Wheel of Sukr framework for gamifying the management of chronic illnesses. It refers to individuals' strategies and techniques to effectively control their health and manage their chronic conditions. The self-management theme in the Wheel of Sukr emphasizes empowering individuals to participate actively in their care. It encourages users to become

knowledgeable about their condition, understand their treatment plans, and make informed decisions regarding their health. Within the self-management theme, the guidelines suggest incorporating elements such as alerts and reminders to help users stay on track with their self-management practices. This can include reminders to take medications, track symptoms, engage in physical activity, or follow a specific diet. By providing these reminders, individuals are better equipped to adhere to their treatment plans and maintain their overall health. The guidelines also highlight the significance of peer support in self-management. Connecting individuals with others going through similar experiences can provide a sense of understanding, empathy, and motivation. Peer support can be facilitated through the app by incorporating features such as discussion forums, chat groups, or social media integration.

Furthermore, the self-management theme emphasizes the importance of user autonomy. Giving individuals control over their choices and activities within the app can lead to empowerment and ownership over their health journey. This can include goal setting, progress tracking, and personalized action plans. In addition, within the esteem theme, the framework suggests incorporating elements such as leaderboards, progress tracking, and badges to provide users with a visual representation of their achievements and progress. By displaying their accomplishments, users can gain a sense of pride and motivation to continue their self-management efforts. The Wheel of Sukr also emphasizes creating a supportive and encouraging community within the app. This can be achieved by enabling users to be recognized and appreciated by community members for their efforts and progress. By allowing users to become role models and inspire others, the esteem theme promotes a sense of belonging and positive social interaction.

Overall, the gamification element in the Wheel of Sukr framework provides guidelines for developers to incorporate game elements and techniques into self-management apps for chronic illnesses. By doing so, developers can enhance user engagement, promote behavioural change, and increase motivation, ultimately improving the overall self-management experience for individuals with chronic illnesses. Hence, the Wheel of Sukr will be enhanced for gamification in this research's general health context.

Based on the identified gamification frameworks and potential elements from the literature review, the GMHealth framework will be developed based on the

enhancement of Wheel of Sukr. The primary purpose of the Wheel of Sukr framework by Al Marshedi et al., (2015) is to focus on chronic diseases such as diabetes to allow the patient to self-manage their disease and make daily progress. Hence, all the elements in The Wheel of Sukr will be studied and analysed to produce a new gamification framework focusing on health and well-being. Moreover, identified gamification elements in healthcare were determined to be developed by the GMHealth framework by the enhancement of The Wheel of Sukr.

2.9 Comparison between Framework and Theoretical Foundation

In designing the GMHealth Framework, evaluating existing gamification frameworks to identify their strengths, limitations, and suitability for mobile health applications is essential. Several established frameworks, namely the MAKE framework, Octalysis framework, Andrzej Marczewski's framework, and the Wheel of Sukr, provide and offer different perspectives on motivation, engagement, and behaviour change. Each framework has been applied in varying contexts, ranging from education to marketing and healthcare, but their applicability to general health and well-being differs significantly. By systematically comparing these frameworks, it becomes possible to determine the most suitable foundation for enhancement into a more comprehensive and domain-specific gamification model for health.

Table 2.8

Comparison Between Comparison of MAKE, Octalysis, Andrzej Marczewski's, and Wheel of Sukr Frameworks

Framework	Purpose & Focus	Strengths	Limitations	Relevance to GMHealth
MAKE Framework (Haruna et al. 2019)	Evaluates educational impact in sexual health programs through Motivation, Attitude, Knowledge, and Engagement.	Comprehensive multidimensional evaluation; proven reliability in adolescent learning contexts; integrates cognitive, affective, and behavioural outcomes.	Focused on educational settings; not designed for ongoing self-management; limited general health applicability.	Helpful in assessing engagement and motivation, but insufficient for long-term health behaviour change in mHealth.
Octalysis Framework (Chou, 2015)	Analyses human motivation using eight core drives (intrinsic and extrinsic) for gamification design.	Strong psychological foundation; flexible across industries; balances short- and long-term engagement.	It is not healthcare-specific, lacks self-management or patient care guidance, and requires adaptation for health contexts.	It provides motivational insight for game element selection but needs integration with health-specific strategies.
Andrzej Marczewski's Framework (2017)	Guides gamification design through planning, user types, and intrinsic/extrinsic motivator balance.	Practical and adaptable; considers player types; emphasises user feedback and iteration.	The generalist framework lacks a clinical or health focus and has no direct link to behaviour change models.	It offers planning and audience-tailoring guidance for GMHealth but is not health-specific.
Wheel of Sukr (Al Marshedi et al. 2015)	Gamification for chronic disease self-management with eight themes: fun, esteem, growth, motivation, sustainability, socializing, self-representation, and self-management.	Health-specific; integrates gamification with behaviour change; validated in chronic illness management; emphasises long-term engagement, autonomy, and community support.	Focused initially on diabetes; requires adaptation for broader health contexts.	Strong foundation for GMHealth due to health-domain alignment and proven behavioural impact; can be expanded for general well-being.

Referring to Table 2.8, gamification frameworks have seen a growing application to boost user involvement and motivation in health-related initiatives. Among the chosen frameworks, the MAKE, Octalysis, and Wheel of Sukr exhibit distinct conceptual and practical focuses, impacting their suitability within health and wellness sectors.

The MAKE Framework, created by Haruna et al., (2019), primarily concentrates on sexual health education, highlighting the importance of motivating learning, changing attitudes, acquiring knowledge, and engaging students. Its multidimensional approach combines cognitive, affective, and behavioral aspects to promote holistic sexual health literacy, mainly aimed at adolescent demographics. This framework incorporates intrinsic and extrinsic motivators, seeking to inspire changes in attitudes and behaviors through gamified educational strategies.

On the other hand, the Octalysis Framework (Chou, 2015) presents a comprehensive motivational structure centred around eight core drives featuring positive "White Hat" (e.g., empowerment, social influence) and negative "Black Hat" motivators (e.g., fear of loss, scarcity). Its broad applicability across various sectors allows designers to customize gamification features such as badges, points, achievements, and social elements to maintain user engagement and support goal attainment. While it offers an in-depth motivational analysis, it focuses less on health issues. However, the gamification element in Octalysis is still considered valid when developing the GMHealth Framework.

The Wheel of Sukr, developed by Al Marshedi etal.,(2015), distinctively targets chronic disease self-management, particularly for diabetes. Its central themes revolve around enjoyment ('fun'), visual attractiveness, and intuitive gamification features (e.g., points, levels, badges), specifically crafted to promote ongoing adherence to self-care. This framework highlights the importance of embedding engaging, game-like characteristics within mobile health applications to motivate patients in their daily disease management routines.

The choice of the Wheel of Sukr as the foundational framework for the GMHealth framework is driven by multiple significant factors. Firstly, its clear focus on chronic disease self-management closely aligns with GMHealth's aim to empower patients in the proactive daily handling of their health. In contrast to MAKE, which is focused on sexual health education, or Octalysis, which adopts a more general approach,

the Wheel of Sukr's specific health orientation guarantees relevance and contextually appropriate design principles.

Secondly, the framework's focus on 'fun' highlights an often-neglected motivational aspect in health interventions, utilizing enjoyment as a powerful driver for long-term commitment and behavioral consistency. This integration of game mechanics, such as rewards and progression systems, nurtures intrinsic motivation and sustained user engagement, which are crucial for effective chronic illness management.

Thirdly, the Wheel of Sukr promotes visually appealing and user-friendly interfaces, a crucial aspect for health applications aimed at varied patient groups, including those with limited technological proficiency. Its focus on intuitive design enhances accessibility and ongoing interaction, thereby increasing the chances of achieving successful health outcomes.

Finally, the framework is supported by empirical evidence in healthcare environments. Its application in chronic disease scenarios has demonstrated effectiveness, reinforcing its credibility and dependability as a theoretical basis. The GMHealth framework builds upon this foundation by incorporating additional gamification elements, such as reminders, virtual coaching, challenges, storytelling, leaderboards, and self-monitoring, identified in existing literature to amplify engagement and comprehensive health management.

2.10 Summary

Chapter two describes the literature review of related studies through the findings from the selected articles and journals. Existing literature from the previous research was identified, along with the findings of existing frameworks related to gamification. The chapter starts by explaining a few essential main points of this study, such as gamification, mobile health applications and gamified mobile applications. Besides, the current mobile application was presented to identify the current gamification elements involved. Next, the theoretical foundation related to this study is clearly explained, and the chosen framework, The Wheel of Sukr (WoS), will be pointed out when developing the GMHealth framework focused on the healthy life apps category. The gamification element in health in previous applications was also extracted to identify which elements are suitable for GMHealth implementation.

CHAPTER 3
METHODOLOGY

3.1 Introduction

This chapter identifies the methodology for developing the gamification framework for mobile health (mHealth) applications.The methodology for developing the GMHealth framework was adapted from the Design Science Research process Peffers et al., (2006), which is widely applied in studies involving the development of artefacts such as models and frameworks (Purao, 2002). Similar to approaches used in previous gamification and mHealth studies, the process was structured into four stages: problem investigation, framework development, framework evaluation, and documentation. In the problem investigation stage, a comprehensive literature review was conducted alongside a preliminary study of the top 10 gamified mHealth applications 2022, focusing on the integration of Wheel of Sukr (WoS) elements. This step ensured that both theoretical insights and practical applications informed the study. The framework development stage drew upon WoS as the foundational framework, which was then refined and extended through the mapping of gamification elements identified in the literature. As in other framework-oriented research, expert validation was carried out, involving face validation for clarity and content validation to ensure conceptual accuracy and comprehensiveness. Following this, the validated framework was implemented in a health and fitness prototype, *LetsGoFit*, designed for adults above 18 years. The evaluation stage then assessed user engagement with the prototype, a method consistent with prior gamification research that emphasizes user experience and behavioural outcomes. Finally, the documentation stage compiled all processes and findings, thereby presenting a structured and transparent account of the GMHealth framework development.Table 3.1 shows the summarised activities that were carried out in this study.

Table 3.1
The process of developing the GmHealth Framework

Phase	Activity	Method of Data Collection	Sampling Frame	Procedure	Outcomes
	Literature Review	Content Analysis	Topic through LR from journal and proceedings articles with the keywords related to the research, such as: • Gamification • mHealth • Gamified-Mobile Health Application • Mobile Health Application • Health Framework • Gamification Framework	1. Define the objectives of the studies. 2. Gather data from existing studies and articles. 3. Analyze data from existing studies and articles to identify gaps or unresolved issues. 4. Investigate the problem with an answer to this question: • What is the problem? • Why is it a problem? • Where is the problem occurring? • Who is experiencing the problem? • When is the problem occurring? • How was the problem observed? • How often was the problem observed?	• Problem Statement • Research Question • Research Objective • Research Gaps • Significance of research

Preliminary Study	1. Secondary data i. App features ii. Popularity Metrics	The top 10 most popular gamified mHealth applications in the App Store in 2022 incorporated gamification elements.	1. Define gamification elements from the Wheel of Sukr (WoS) gamification element. 2. Searching for the top 10 most popular gamified mHealth applications in the App Store in 2022. 3. Review and analyze the mHealth application based on data collected from app features and popularity metrics. 4. Analyze how gamification elements are implemented. 5. Mapping app features with gamification elements WoS.	• Potential Element, theme and framework.

Comprehensive Literature Review	Content Analysis	The Wheel of Sukr (WoS) was selected as the foundational framework to be enhanced and adapted into a new framework. The WoS was selected as the core framework because, based on the preliminary study findings, almost all the top 10 most popular gamified mHealth applications used WoS elements.	Explore gamification elements, user engagement metrics, and existing health app frameworks. Mapping gamification elements from the Wheel of Sukr with insights from the literature review.	Potential Element Potential Theme Framework gaps
Expert Review	1. Face Validation	Face validation aims to determine whether the instrument makes sense and appears relevant to the topic.	Define objectives of the face validation. Ensure respondents are familiar with the subject but do not require expert-level knowledge. Prepare the instrument and face validation	• Initial draft of GMHealth Framework

			feedback form 4. Ask respondents to complete the feedback form based on their perceptions 5. Collect and analyze feedback	
2. Content Validation i. Content Validity Ratio (CVR) ii. Item Content Validity Index (I-CVI) iii. Scale Content Validity Index (S-CVI)	Content validation aims to validate whether the proposed framework is relevant and whether clarity represents the domain it is intended to measure. The experts consist of an academician and a panel of experts from industry. Inclusion criteria for academician: o Be a full-time lecturer.	Define objectives of the content validation. Prepare the inclusion and exclusion of experts' criteria Prepare the instrument and validation form Ask experts to validate the instrument in terms of relevance and clarity. Collect and analyze feedback Revise the instrument	Draft of The GMHealth Framework	

- Have at least a minimum of five years of teaching experience.
- Have at least one year of experience in designing and developing games.
- Have a qualification that the Ministry of Higher Education recognizes.

based on experts comments.

- The expert among the medical practitioners was required to fulfil these criteria:
  - Have at least three years of experience in the health and medical sectors.
  - Qualify by The Ministry of Health Malaysia.
- The experts from the industry

were required to fulfil these criteria:

- Have at least three years of experience in Computer Science or Information Technology fields, such as game design, mobile health applications, web development, and technology design.

- Exclusion Criteria:
  - The incomplete data from the participants will be excluded from the research procedure.
  - The participant does not have a consent/survey form. He/she does not have the right to be involved in this research.

	Development prototype	Implement validated GMHealth Framework elements into the prototype	This prototype's target users are young adults above 18 who intend to use gamified mHealth applications.	The development of the prototype implements the RAD Model: 1. Requirement Planning Phase 2. User Design Phase 3. Construction Phase 4. Cutover Phase 5. Documentation Phase	• *LetsGoFit* application with the implementation of the GMHealth Framework
	Evaluation of the prototype	Evaluate the prototype that implements the GMHealth framework to contribute to an engaging experience.	Target users: young adults ages 18 and above. Prototype content: Stretching and fitness apps. Evaluate the engaging experience through the GMHealth instrument.	1. The validation of the GMHealth framework will be implemented in the prototype. 2. Target users using the application related to stretching and fitness. 3. The GMHealth instrument used to evaluate engaging experience using the *LetsGoFit* mHealth	• Evaluated the GMHealth framework through a prototype

o « e S s u o O	Writing findings in report form	Organize all the data and findings.	N/A	Documentation of data in the report form.	Complete overall report for the study

3.2 Phase 1: Problem Investigation

In the first step of the investigation, a comprehensive literature review was conducted to identify the problem. The issue statement was established based on these actions and a few aspects that prompted the investigation. The construction of research questions, objectives, and scopes is the result of these studies, which result in their construction. In addition, a thorough literature analysis was carried out to identify the initial elements taken from the framework for gamifying mHealth applications.

Steps to take to explore the issue and provide an answer to this query are as follows: 1) What is the problem? 2) Why is it a problem? 3) Where is the problem occurring? 4) Who is experiencing the problem? 5) When is the problem occurring? 6) How was the problem observed? and 7) How often was the problem observe? This study identifies a critical issue: a lack of understanding regarding the application of gamification in real-world mHealth apps, as noted by Mustafa et al., (2023). Additionally, Gan et al., (2023) highlight that the absence of standardized guidelines for mobile health apps results in poor user engagement and usability. These challenges are prevalent in the mobile healthcare industry, impacting users' ability to effectively manage their health and leading to unsatisfactory experiences.

Developers also face difficulties due to limited knowledge of how gamification can be successfully implemented in mHealth applications. The issue was identified through an extensive literature review and a preliminary analysis of current mHealth apps in the market that incorporate gamification elements. In conclusion, the problem with the mHealth application was investigated during this phase using the journal, the article, and any other associated procedures.

3.2.1 Preliminary Study

A preliminary study was conducted to identify the top 10 most popular gamified mHealth applications in the App Store in 2022, as used by Apple users in 2022 (Store, 2022). The objective of this preliminary study is to identify the current gamification elements that have been implemented in current mobile health applications that map with the Wheel of Sukr (WoS) Framework.

The study focused on the top 10 most downloaded mHealth applications, identified using keywords such as health, gamified mobile health, m-health and health fitness. Each mHealth was downloaded and carefully analyzed to determine which gamification features most effectively engage users, mainly because these top 10 mHealth apps have successfully maintained user attention over extended periods. All the data with the application's name based on rank have been tabulated in the table with the gamification elements based on the WoS framework. If the application has the gamification element from the WoS, a mark will be ticked on the table. An in-depth discussion of the preliminary study findings is presented in Chapter 4.

Table 3.2
The most popular application in the App Store with the implementation of a gamification element

	Application / Element																											
1	My Sejahtera	-	-	-	-	-	-	-	-	-	-	-	-	/	/	-	-	/	/	-	/	/	/	/	-	-	-	
2	Flo-Period & Ovulation Tracker	-	-	-	-	-	/	-	/	-	/	/	-	/	/	-	/	/	/	/	/	/	/	/	/	/	/	
3	Period Tracker	-	-	-	-	-	-	-	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
4	HUAWEI Health	/	-	/	/		/	-	-	-	-	-	-	/	/	-	/	/	/	/	/	/	/	/	-	-	-	
5	Strava: Run, Ride & Swim	/	-	/	/	/	/	/	/	/	/	/	-	/	/	-	/	/	/	/	/	/	/	/	-	-	-	
6	Alpha Face: Facial Exercises	-	/	/	-	-	/	/	-	-	-	-	-	/	/	-	/	/	/	/	/	/	/	/	-	-	/	
7	MyFitnessPal	-	-	/	-	-	/	/	/	-	/	/	-	/	/	-	/	/	/	/	/	/	/	/	-	/	-	
8	FitnessCoach and Diet: FitCoach	-	-	/	-	-	/	/	-	-	-	/	-	/	/	-	/	/	/	/	/	/	/	/	-	-	/	
9	Mi Fitness	-	-	-	-	-	/	-	-	-	-	-	-	-	/	-	-	/	/	/	-	/	/	/	-	-	-	
10	Mood Balance	-	-	/	-	-	/	/	-	-	/	-	/	-	-	/	/	/	/	/	/	/	/	/	/			/

3.3 Phase 2: Framework Development

The development of the framework commences following the thorough completion of the problem investigation phase. During this phase, a comprehensive understanding of the issues and requirements is established, forming a solid foundation for the framework's design. Once the problem investigation is complete, a content analysis technique will be employed to systematically extract and identify the elements of the GMHealth framework. The framework development requires two steps: 1) Extracting elements from the current literature review and 2) Validation through an expert reviewer.

3.3.1 Comprehensive Literature Review

A comprehensive literature review involves meticulously examining relevant literature, documents, and frameworks to uncover key elements and themes. This technique ensures the identified elements are relevant, comprehensive, and representative of the addressed construct. This method scrutinises each potential component for its relevance, applicability, and contribution to the framework.

3.3.1.1 Content Analysis

The elements of the GMHealth framework were developed through a thorough review of previous studies, employing a rigorous content analysis technique. This multifaceted process began with identifying existing frameworks pertinent to the research questions. Specifically, a collection of frameworks related to gamification was compiled and meticulously analyzed to identify potential elements for the GMHealth framework.

The search for relevant articles used targeted keywords such as gamification, gamified mobile health, engagement, game element, motivation, m-health, health-framework, gamification framework, game, and health. This search selected only articles with assertive, pertinent abstracts for further examination.

Once the relevant articles were selected, the gaps within these frameworks were scrutinized and identified. The WoS framework emerged as having the most promising gamification elements for application in the health sector. However, its primary focus

on chronic disease management posed a limitation. Therefore, an in-depth analysis of the WoS framework was performed to identify gaps and opportunities for enhancement.

In the next phase, all potential elements identified from the selected frameworks and literature were systematically documented into separate tables, with each table representing a different source. These tables were then arranged side by side to enable comparison and analysis, allowing similarities and differences among the elements to be easily identified before mapping. The mapping process combined overlapping elements and selected the most relevant ones for integration into the GMHealth framework, ensuring its robustness and relevance.

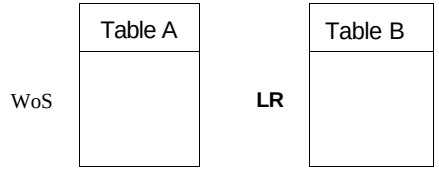
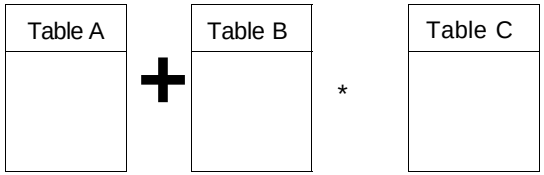
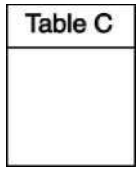
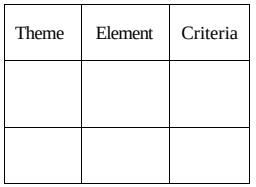
Following this, operational definitions were developed for each theme and element to clearly describe their roles and functions. The characteristics and criteria of each element were then tabulated, providing specific attributes to guide their application. These criteria were later used to construct questionnaires, ensuring alignment with the defined themes and elements for evaluation purposes.

Finally, the GMHealth framework was constructed as an enhancement of the WoS framework, strengthened with insights from the literature review. This resulted in a comprehensive framework for gamified mobile health applications. Table 3.3 outlines the steps involved in developing the initial draft of the GM Health Framework. A detailed explanation of the process involved is provided immediately after Table 3.3.

Table 3.3

Steps required in constructing the GMHealth Framework

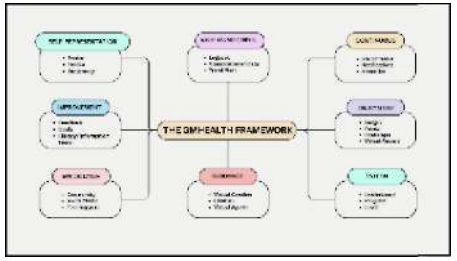
Process	Activities	Output
Process 1 : Identify the gamification mHealth framework for core reference.	Identify the primary theoretical foundation or framework that aligns with the objectives. Identify the gaps and limitations of the previous potential gamified framework. Understand the core components, assumptions, and limitations of the framework. Based on the preliminary study findings, the Wheel of Sukr (WoS) Framework was selected as the core reference for the gamification mHealth framework.	The Wheel of Sukr (WoS) Framework 
Process 2: Identify the previous literature review related to gamification elements that are applied to the mHealth area	Tabulate the elements and themes of the WoS in Table A. Identify potential elements from relevant empirical studies, models, and frameworks in the literature review. Tabulate the potential element in Table B.	Table A WoS Table B LR

Process 3: Rearrange the elements of the potential GMHealth Framework	Rearrange the elements from Table A and Table B. Place both tables side by side to facilitate easy comparison and analysis. This layout will help quickly identify table similarities, differences, and trends.	
Process 4: Conducting a mapping process on both tables to produce a GMHealth Framework	Mapping the relationship between elements of the WoS framework (Table A) and elements from empirical findings (Table B) Highlight areas where empirical findings align with core components. Combine the elements that meet the same criteria from Table A and Table B into a new Table C. The analysis and synthesis of the mapping data provide deeper insights and identify significant patterns or correlations.	
Process 5: Define operational definition and criteria for each theme and element	Operational definitions for each theme, element, and criterion were stated	 Produce operational definition, theme, element and criterion.
Process 6: Develop a conceptual framework to represent the theme, element, criteria and their relationship.	Define relationship theme, elements, and criteria by specifying how components interact or influence each other.	

Process 7:

The initial draft of the GMHealth Framework was developed

An initial draft of a conceptual framework named The GMHealth Framework was developed.



Process 1: Identify the related gamification and health framework

After an extensive literature review, the Wheel of Sukr (WoS) by Almarshedi (2016) was identified as the most suitable framework to enhance in developing the GMHealth framework. Besides, the preliminary study also confirmed WoS as the core reference. Originally designed for diabetic patients in Saudi Arabia, WoS supported self-management, reinforced positive behaviours, and provided an interactive platform. While its focus was diabetes care, its structure makes it relevant for wider healthcare applications. The GMHealth framework builds on this by extending its use across diverse health domains, offering a more flexible approach to user engagement and behaviour change.

WoS consists of eight core themes and 27 elements, centred on two pillars: *fun* and *self-management*. The *fun* aspect includes gamification elements such as badges, points, challenges, and competitions to enhance motivation and enjoyment. The *self-management* aspect provides tools like logbooks, data visualisations, and trend alerts, enabling patients to track health information (e.g., glucose readings, diet logs), identify trends, and take proactive steps in managing their condition.

While WoS effectively supports diabetes self-management, GMHealth adapts these principles for broader use. All eight themes and 27 elements of WoS were analysed to identify gaps and limitations, which guided the development of GMHealth. This new framework is designed to be adaptable across various health contexts, ensuring sustained user engagement and effective health management through gamification.

Process 2: Identify the previous literature review on gamification elements applied to the health area.

The next step involves identifying and reviewing relevant literature on gamification elements to comprehensively understand how these elements have been applied across various contexts. This process includes examining studies, frameworks, and theoretical models that explore game mechanics such as points, badges, leaderboards, challenges, rewards, and feedback loops within healthcare for chronic disease, wellness and lifestyle, health monitoring apps, or women's health apps. By

analyzing the successes and limitations of gamification in these areas, key insights can be drawn to inform the design of a more effective and engaging GMHealth framework. The description of WoS's theme and elements is tabulated in Table 3.4 (Table A). In contrast, the findings based on the literature review related to 'health',' gamification', and 'gamified mobile health' have been tabulated in Table 3.5 (Table B).

Table 3.4
The Wheel of Sukr's Theme, Element and Description (Table A)

Theme	Element	Description
Fun	Badges	The badge element indicates the special designs that can be awarded to users as a sign of membership and achievement. Users can receive badges once they use the application, accumulate several points, or complete a level.
	Points	The points element indicates the points awarded to users when entering test results, completing the minimum required tests daily, completing a week of entering test results, completing a challenge, and communicating with other users.
	Challenges	The challenges element indicates the motivators created in the gamified system to get users to engage in difficult but obtainable tasks. These could be completing a week of entering test results or maintaining a certain glucose level.
	Competition	The competition element indicates the competitive environment that can be created using the elements in this theme and other themes (such as levels and leaderboards) to increase user engagement. The competitive environment should be exclusive to the activities completed (i.e. the number of times the user logged in, the user's involvement in the community, completing tasks, etc.) and not regarding their test results. Users can compete with each other in the community and with themselves.
Esteem	Leaderboards	The leaderboard element indicates the leaderboards that

		are used in video games. Similar to video games, in gamification, leaderboards are social features used to increase engagement, motivation, and competition between players. This is done by ranking them in several ways, such as according to the number of points or badges collected, the levels achieved, etc.
	Levels	The levels element indicates the part of the application that users need to complete to meet specific goals to advance to the next level. The difficulty of every level increases as the user completes new levels.
	Progress bar	The progress bar element is a graphical element in the user interface that shows the user's progression and how close he/she is to completing tasks. It could be expressed as a percentage, in visual form or a textual representation.
	Reputation	The reputation element indicates the user's status, rank and expertise in the community. It is how users showcase their points and badges. Reputation mechanics must be designed and updated based on the community.
Growth	Feedback	The feedback element indicates the comments users receive regarding their test results entries and their overall performance in the application (their self-management habits)
	Goals	The achieving goals element indicates outlining clear goals and rules in the system. Goals could also be set by the user with the help of caregivers.
	Baby Steps	The baby steps/tiny habits element indicates the breakdown of activities into smaller tasks easily incorporated into the users' daily routine. This is believed to result in adopting the new "tiny habits" to reach a desired behaviour. This helps in changing behaviour in self-management
Motivation	Intrinsic	The intrinsic motivation element indicates the innate desire to perform an activity for the love and joy that it brings. Intrinsic motivators include health, social

		satisfaction, status, mastery, purpose, acceptance, and curiosity.
	Extrinsic	The extrinsic motivation element indicates the performance of an activity solely for the external rewards, which could include points, rewards, and gaining status.
Sustainability	Trigger	The trigger element indicates the visual or audio messages or cues that could trigger behaviour. In the context of the self-management of diabetes, a trigger could be a message to the user to remind him/her to enter test results, or communicate with others, etc.
	Flow	The flow element represents the mental state of absorption and engagement in an activity or a game. In the flow state, the user is intrinsically motivated and wholly immersed in what they are doing. The gamified activities in the self-management application should be designed according to users' skill level, thus gradually increasing the difficulty as the users' skills increase.
	Story & Theme	The storyline and theme elements indicate the importance of creating a link between the user and the application. The theme is the background the user might connect to at the beginning, whereas the storyline is about controlling the progress and the arc the user takes through the experience. These elements also give more meaning to gamification features, creating a journey that makes the user part of it and increases engagement.
	Nudge	The nudge element is based on one of the theories known to drive behaviour - the nudge theory. A nudge uses positive reinforcement and indirect signals to lead to a non-forced action by creating the most straightforward path to specific behaviour.
Self-Representation	Avatar	The avatar element allows the user to express themselves by allowing them to upload profile images, offering predesigned images for them to choose from, or allowing them to personalise their profiles.

	Autonomy	The autonomy element occurs when the users fully control their choices and activities.
	Ability	The ability element suggests that developers should consider the varied abilities of users and simplify the tasks required.
	Purpose	The purpose element indicates that the goal and purpose of self-management are transparent to the user.
Socializing	Community	The community element means creating a network held together by the shared experience of having a chronic illness and the common goal of living a healthy life.
	Social Media	The social media element means allowing the user to link his/her self-management profile or activities with their other social media accounts, such as Facebook or Twitter.
	Peer-Support	The peer-support element indicates the support provided through the community (other users in the app), the social media (if the app is linked to social media such as Twitter and Facebook), and the gamified features such as feedback and rewards.
	Sharing	The sharing elements involve allowing users to share their test results, progress, etc., with others in the community.
Self-Management	Logbook	The logbook is a space that allows the user to keep logs of their test results, date/time, food intake, exercise, how they are feeling, and other relevant information.
	Visualization of data	The visualization of data elements involves turning the data in the user's logbook into visual representations. In this way, the user can benefit from the accumulated information. For example, users can see how well they did in the past week or month using a table or a specific graph. Moreover, this would enable them to spot patterns more easily.

Trend Alerts	The trend alert element indicates using the logged data to alert the user of any sudden changes or worrying results, such as extreme lows/highs in their blood glucose, etc.

Source : (AlMarshedi et al. 2017)

Table 3.5
Findings on Literature Review related to the Gamified mHealth Application, Gamification and mHealth Application (Table B)

Elements	References
Reminder/Notification	(Camacho-Rivera et al., 2020; Gan et al.,2023; Lieder et al., 2024;Saleemetal.,2021)
Virtual Coaches	(Bassi et al.,2022; Jafar et al.,2023; Meyer et al.,2022; Mitchell etal.,2021)
Virtual Reward	(Saleem et al., 2021; Sharif & Woolley, 2022; Six et al., 2021; Tuah et al.,2021; Westenhaver et al., 2021; Xu et al.,2022)
Points	(Lieder et al., 2024; Rajani et al., 2021; Sanchez et al.,2023; Tuah etal.,2021)
Goals	(Albers et al., 2023; Krath et al., 2021; Sharif & Woolley, 2022)
Feedback	(Ashar et al., 2025; Epstein et al., 2021; Khoshnoodifar et al., 2023; Lieder etal., 2024)
Challenge	(Ahluwalia et al., 2016; Khoshnoodifar et al., 2023; Warmelinket al.,2021)
Progress	(Eisenhauer et al., 2021; Hallifax et al., 2023; Tuah et al.,2021; Xu et al.,2022)
Social Support/ Social Media	(Alzghoul, 2024; Nwaimo et al., 2024; Stutvoet et al., 2024)
Library/ Information Toolbox	(Aktas. Reyhan, 2025; Borghouts et al., 2021; Jianfei Cao et al., 2021; Zolfaghari et al., 2021)
Leaderboards	(Anwar, Silvani, & Saputra, 2025; Warmelink et al., 2021; Westenhaver et al., 2021)
Avatar	(Taylor et al., 2022; Tuah et al., 2021; Warmelink et al., 2021)
Badges	(Sharma et al., 2024; Warmelink et al.,2021; Wyrobek et al., 2024)
Story/Theme	(Aktas. Reyhan, 2025; Huang et al., 2024; Westenhaver et al., 2021)
Self-monitoring	(Bassi et al., 2022; Camacho-Rivera et al., 2020; Cusack et al., 2024; Kaplan et al., 2023)
Level	(Al-Rayes et al., 2022; Ferrari et al., 2022; Lim et al., 2023)
Community	(Nwaimo et al., 2024; Stutvoet et al., 2024)
Chatbox	(Haque & Rubya, 2023; Lieder et al., 2024; Mitchell et al.

	,2021)
Virtual Agents	(Bassi et al., 2022; Taylor et al., 2022)
Trend Alert	(Kanai et al.,2025; Mazeas et al.,2022; Yang et al., 2023)
Visualization of data	(Kanai et al.,2025; Mazeas et al.,2022; Yang et al., 2023)
Autonomy	(Wang et al., 2021; Zain et al., 2022)
Interface	(Nezamdoust et al., 2022; Roslan & Salim, 2023)
Language	(Ashar et al.,2025; Pujolà, 2021; Tesi et al., 2023)

Process 3: Rearrange the elements of the potential GMHealth Framework

Once Table A and Table B were arranged side by side, the elements within each table were meticulously analyzed. This analysis aimed to enhance the theme elements as we transitioned from the WoS to the GMHealth Framework. Themes and elements with identical criteria and operational definitions were either maintained or combined. Furthermore, any new improvements and enhancements were incorporated into the GMHealth Framework. Table 3.6 shows the detailed, comprehensive mapping of each element within the framework, ensuring a robust and well-rounded structure.

Table 3.6
Mapping process from Table A and Table B for Theme in the GMHealth Framework

Table A (The Wheel of Sukr)	**Table B (Findings on literature review)**	**Table C (The GMHealth Framework)**
Fun	Theme X1	Engagement
Esteem	Theme X2	Esteem
Growth	Theme X3	Improvement
Motivation	Theme X4	Eliminate, replace with Guidance
Sustainability	Theme X5	Continuous
Self-Representation	Theme X6	Self-Representation
Socializing	Theme X7	Socializing
Self-Management	Theme X8	Self-Management

Table 3.7
Mapping process from Table A and Table B for elements in GMHealth

Table A (The Wheel of Sukr)	**Table B** (Findings on literature review)	**Table C** (The GMHealth Framework)
Badges	Element X1	Badges
Points	Element X2	Points
Challenges	Element X3	Challenges
Competition	Element X4	Eliminated
Leaderboards	Element X5	Leaderboard
Levels	Element X6	Levels
Progress bar	Element X7	Progress
Reputation	Element X8	Eliminated
Feedback	Element X9	Feedback
Achieving Goals	Element X10	Goals
Baby Steps	Element X11	Eliminated
Intrinsic	Element X12	Eliminated
Extrinsic	Element X13	Eliminated
Trigger	Element X14	Notifications
Flow	Element X15	Eliminated
Story & Theme	Element X16	Story & Theme
Nudge	Element X17	Reminders
Avatar	Element X18	Avatar
Autonomy	Element X19	Autonomy
Ability	Element X20	Eliminated
Purpose	Element X21	Eliminated
Community	Element X22	Community
Social Media	Element X23	Social Media
Peer-Support	Element X24	Peer-support
Sharing	Element X25	Eliminated
Logbook	Element X26	Logbook
Visualization of data	Element X27	Visualization of data
Trend Alerts	Element X28	Trend Alerts

Process 4: Conducting a mind mapping process on both tables to produce a GMHealth Framework

The mind mapping process was carried out using data from Table A and Table B, leading to the development of the GMHealth Framework. This process also resulted in creating a diagram representing the initial draft of the framework, which is illustrated below.

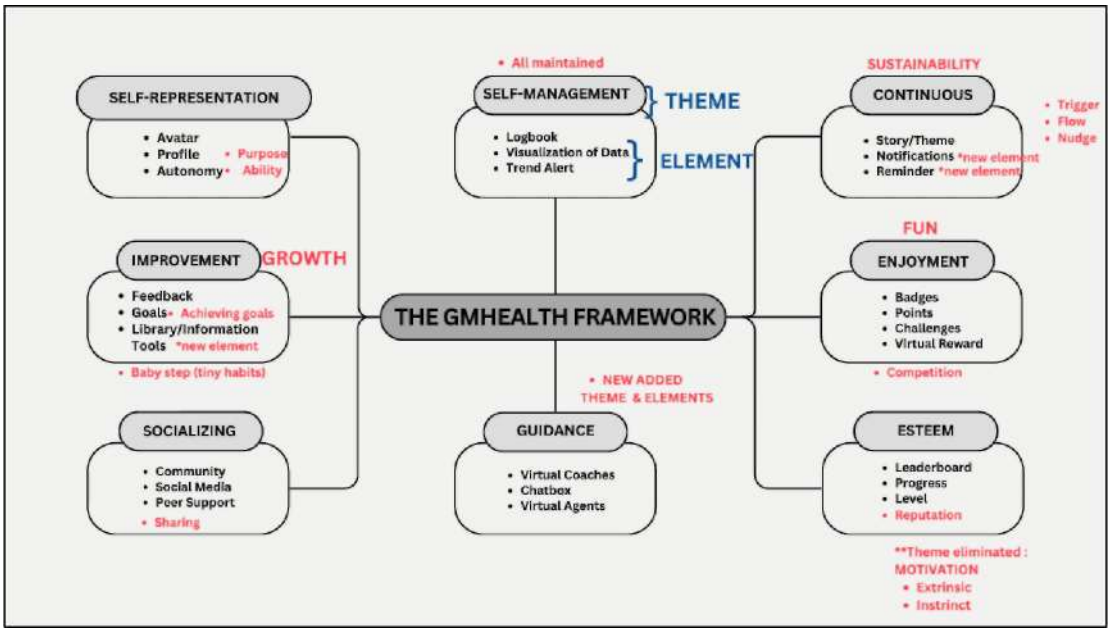


Figure 3.1 The Initial Draft Version 1 Of The Gmhealth Framework, Which Is Undergoing A Development Process

Based on Figure 3.2, the development of the GMHealth framework was adapted from the WoS framework, with several themes and elements modified through a detailed mapping process. According to the diagram, red writing means changing, eliminating, and modifying the theme and elements. The most significant alteration was removing the '*Motivation*' theme, which initially included *extrinsic* and *intrinsic* motivational elements. This decision was informed by studies from Zolfaghari et al. ,(2021), Zain et al., (2022) and Trinidad et al., (2021), which highlight that gamification elements such as points, badges, reward systems, social community features, and notifications are sufficient to foster user motivation in gamified health applications. These elements inherently motivate users, encouraging engagement and promoting

behavioral change. By eliminating this theme, the GMHealth framework simplifies the development process for developers and provides a more precise structure for future research. This adjustment avoids redundancy and potential confusion, ensuring a more streamlined approach to incorporating motivational aspects into gamified health applications.

Next, a new theme introduced in the GMHealth framework is the '*Guidance'* theme, which includes three key elements: 1) *Virtual Coaches*, 2) *Chatbots*, and 3) *Virtual Agents*. The '*Guidance*' theme enhances the user's engagement by creating a more immersive environment, helping them focus on setting and achieving their goals (Freyer et al., 2024). According to Bassi et al., (2022) and Jafar et al., (2023), virtual coaches play a pivotal role in this process by providing users with motivational content tailored to their personal goals, as set during health interventions. These virtual coaches assist in maintaining engagement by encouraging users to adhere to active exercise schedules and promoting behavioral and lifestyle changes, particularly regarding healthier dietary habits. The result is increased user adherence and commitment to long-term health improvements. The inclusion of virtual coaches is further supported by research from Bassi et al., (2022), which highlights their effectiveness as a promising tool for fostering long-term engagement in gamified mobile health applications. These virtual coaches, chatbots, and virtual agents help sustain user motivation and engagement by offering personalised guidance and consistent interaction. Hence, the *Guidance* theme was added in GMHealth for better user engagement in gamified mobile health applications and to make the user feel more immersive and guided by the presence of coaches.

Next, the most significant modifications within the GMHealth framework were made to the '*Improvement'* theme, which was revised from the '*Growth'* theme found in the WoS framework. One significant change was eliminating the *'Baby Steps'* element, as no relevant findings were identified in the comprehensive literature review to support its continued inclusion. Additionally, the *'Goals'* element was revised from the original *'Achieving Goals'* element in the WoS framework, reflecting a more focused approach to goal setting. A new element, ' Library and Information Tools', was introduced to enhance the' Improvement' theme further. This element recognizes the widespread use of mobile health and gamified health applications globally, with over 500 million people

utilizing health-related smartphone apps. These apps commonly incorporate simple performance-tracking features alongside practical tips and encouraging information, as highlighted by Zolfaghari et al., (2021). Including this element ensures that users have access to relevant and positive content related to their health goals and apps that support their personal growth and improvement.

No significant modifications were made in the 'Socializing' theme, with one critical adjustment being the removal of the *'Sharing'* element. This decision was made after a careful analysis, which revealed that the remaining elements,' *Community,' 'SocialMedia,'* and *'Peer-Support, '* already incorporated sharing functionalities. These elements allow users to connect with others, share their experiences, and receive feedback or support from peers, effectively fulfilling the role that the *'Sharing'* element initially intended to address. For instance, through *'Community'* features, users can engage in group discussions, share progress, and build a sense of belonging (Huang et , al. 2024). Similarly, the integration of *'Social Media'* allows users to share their achievements, milestones, and experiences with a broader audience, further enhancing social connectivity (Haque & Rubya, 2023). The *'Peer-Support'* element also encourages sharing by fostering mutual encouragement and guidance among users working towards similar health goals (Alzghoul, 2024). By consolidating these overlapping functions, the *'Sharing'* features were removed. This simplifies the development process for app designers and ensures a more cohesive user experience where social engagement remains a core focus.

In addition, the *'Self-Management'* theme remained unchanged, as no amendments were deemed necessary. All three elements,' *Logbook,' 'Visualization of Data'* and *'Trend Alert, '* are essential to any effective gamified mobile health application. The *Logbook'* element allows users to track their daily activities, health metrics, and progress, providing a structured way to monitor their behaviors over time (Eisenhauer et al., 2021). *'Visualization of Data'* plays a crucial role in translating this raw data into user-friendly formats, such as charts or graphs, enabling users to easily interpret their progress and identify patterns (Tuah et al., 2021). Finally, the *'Trend Alert'* element offers proactive feedback by notifying users of significant changes or trends in their data, helping them make informed decisions and adjust their health routines (Supramaniam et al., 2024). These three elements work together to empower

users with real-time insights, fostering a sense of accountability and motivation. Since *Self-Management* is a cornerstone of behavior change in health interventions, retaining these elements ensures the GMHealth framework remains comprehensive and aligned with the best practices in mobile health applications.

Another significant modification in the GMHealth framework was made to the *'Continuous'* theme, which was previously referred to as *'Sustainability.'* This change reflects a more precise approach to capturing the ongoing engagement required for health-related behavior change. Two significant elements, *'Trigger'* and *'Nudge,'* were replaced with *'Notifications'* and *Reminders,' &s* their functions and purposes are closely aligned. The *'Trigger'* element was initially defined as visual or audio cues that prompt users to perform a specific behavior (AlMarshedi et al., 2017). However, this concept strongly overlaps with the role of *Notifications,'* which serve as alerts or messages that draw the user's attention to specific actions or behaviors, such as progress tracking or health updates (Lieder et al., 2024).

Similarly, the *Nudge'* element, which refers to using positive reinforcement and subtle cues to guide users toward desired behaviors without forcing them (AlMarshedi et al., 2017), closely resembles the function of *'Reminders'* Daily notifications and reminders in mobile health applications can serve as nudges, prompting users to check their progress and remain engaged with the app (Gan et al., 2023). By replacing *'Trigger'* and *Nudge'* with *Notifications'* and *'Reminders'* the framework becomes more intuitive and more accessible for developers and researchers to implement. These changes ensure the elements reflect their purpose while focusing on user engagement through consistent, subtle reinforcement.

The next theme in the GMHealth framework is *'Enjoyment'*, which encompasses several key gamification elements, including badges, challenges, points, and virtual rewards. This theme was renamed from the *'Fun'* theme in the WoS framework to better capture its purpose of fostering active participation and sustained interest in health-related activities. Notably, the *'Competition'* element was excluded from the GMHealth framework. While competition can drive user engagement and motivation, research indicates it may also lead to negative emotional responses, such as defeat or frustration (Qiao et al., 2024). These adverse effects are particularly concerning in health-related contexts, where users may already be grappling with physical or mental health

challenges. The framework aims to create a more supportive and inclusive environment by eliminating the' Competition' element. The focus on engagement through positive reinforcement, such as *badges* and *virtual rewards*, allows users to experience a sense of accomplishment and progress without the potential stressors associated with competition. This approach promotes healthier behaviours and encourages sustained participation, making the gamified health experience more enjoyable and beneficial for users.

In the *'Esteem*' theme, no significant changes were made. The elements of *leaderboard, progress tracking, and levels* remain integral components of the GMHealth framework, as they are recognized as effective tools for enhancing user engagement in gamified mobile health applications (Hallifax et al., 2023; Pahlevi & Mulyati, 2024; Warmelink et al., 2021). These features foster a sense of achievement and motivate users to participate actively in their health journeys. However, the '*Reputation'* element was removed from the framework. This element refers to the user's status, rank, and expertise within the community (AlMarshedi et al.,2017). The decision to eliminate '*Reputation*' stemmed from its similarity to the '*Competition*' element, which can evoke negative emotional responses, such as anxiety or decreased self-esteem, particularly in individuals who may already be dealing with health challenges (Qiao et al., 2024). The GMHealth framework aims to prioritize a supportive and positive user experience by removing the' Reputation' element. Focusing on personal progress and engagement rather than social comparison helps users feel valued and encouraged, ultimately promoting healthier behaviors and sustained participation in their health management.

The final theme in the GMHealth framework is the *'Self-Representation'* theme, which focuses on tailoring the user experience to foster a deeper connection between the application and its users (AlMarshedi et al., 2017). By personalizing interactions and allowing users to express themselves within the app, this theme aims to enhance user engagement and create a more meaningful and rewarding experience (AlMarshedi et al. 2017). As part of this refinement, the *'Purpose'* element was removed. This element initially highlighted the necessity of clearly conveying the objectives of self-management to users. However, its core function closely aligns with the 'Goals' element, which aims to clarify the users' objectives in their health management journey. The

decision was made to eliminate the *'Purpose'* element to prevent redundancy and ensure clarity.

Additionally, the *'Ability'* element was also excluded from the framework. This element addressed the importance of recognizing the diverse abilities of users and advocating for the simplification of tasks to accommodate varying skill levels. While this is a crucial consideration for developers, it primarily focuses on the technical aspects of app design rather than directly enhancing user engagement. By streamlining the framework and concentrating on elements that significantly contribute to user interaction and satisfaction, the GMHealth framework can better fulfil its mission of facilitating effective health management.

In conclusion, the GMHealth framework represents an enhancement of the WoS Framework, maintaining the original structure of eight themes while incorporating thoughtful modifications to improve user engagement. These changes align the framework with contemporary practices in gamified mobile health applications. By carefully analyzing and adapting the elements within each theme, the GMHealth framework seeks to create a more engaging and supportive environment for users. The revisions reflect a deeper understanding of user needs and preferences, ensuring the framework remains relevant and effective in promoting positive health behaviors. Ultimately, the GMHealth framework not only preserves the foundational principles of the Wheel of Sukr Framework but also evolves to meet the dynamic demands of today's health technology landscape. This adaptability is crucial for fostering sustained user interaction and enhancing the overall effectiveness of gamified health interventions.

Process 5: Define the Operational Definition and criteria for each theme and element.

After identifying the potential themes and elements of The GMHealth Framework, the next step was establishing precise operational definitions for each theme and element. This was done to ensure a comprehensive understanding and clarity, allowing for consistent interpretation and application throughout the study. Table 3.8 and Table 3.9 represent the definitions of the theme and elements for the GMHealth Framework.

Table 3.8
Operational Definition of Theme in GMHealth's Framework

Themes	Definition
Self-Representation	Tailoring the experience to create a bond with the user, thus increasing engagement and creating a meaningful experience.
Improvement	The ability of the system to maintain the same level of engagement to sustain the desired effect.
Socializing	Being a part of a group of people that shares the same situation, which offers social and emotional support and adds to the value of rewards
Esteem	Create a feeling of admiration and respect for the user.
Enjoyment	Creating a game-like experience
Guidance	It helps create a more immersive experience, which makes users more focused on setting and achieving higher goals.
Self-Monitoring	Basic elements needed to self-monitor users' daily activities include tracking their progress, food intake, and other related information; getting feedback based on the entries; and being notified of their progress.
Continuous	Creating a fruitful experience for the user, where gamification in a social and psychological context can result in personal growth in managing the activities, learning new habits, and better understanding their health condition.

Table 3.9
Operational Definition of Element in GMHealth's Framework

Elements	Description
Reminder/Notification	A mechanism to bring information to smartphone users for their attention
Virtual Coaches	Virtual coaches can talk and inspire the user and make them feel like someone is training them in a more personal way.
Virtual Reward	The system provides an incentive for a certain action.
Points	The heart of any gaming system, which quantifies users' participation and performance. A gamified application can adopt several types of points depending on the purpose the points serve

Goals	The goal is the end of a game where the objective is achieved.
Feedback	A helpful mechanism as regards informing users about their current progress and alerting them to changes in their status of outcome
Challenge	An element with increasing difficulties at different levels.
Progress	Progress bars that help users visualize their performance and keep track of their progress
Social Support/ Social Media	Player can communicate and support each other to generate competition between them and stimulate a prosocial behaviour
Library/ Information Toolbox	To provide inspiration in line with user feedback.
Leaderboards	Leaderboards dynamically rank individual user progress and achievements as compared to their peers.
Avatar	Avatar can be identified as the player's virtual identity or self - self-representation in gameplay.
Badges	Badges are a symbol of status. They symbolize a specific achievement in a gamified application and are collected after earning a particular number of points.
Story/Theme	A story or theme in a gamified application brings a gameful experience.
Self-monitoring	Establish the method for the person to monitor and record their behavior
Level	The term levels is commonly used to refer to advancing progress, as in levelling up; it is also used to refer to new, more difficult environments.
Community	A group of individuals who develop relationships and interact with each other online, which can include platforms beyond traditional websites, such as bulletin boards, online games, and virtual worlds
Chatbox	A chatbot is a system that can converse and interact with human users using spoken, written, and visual languages.
Virtual Agents	Virtual agents represent animated embodiments that respond to users through verbal and non-verbal communication.

Logbook	The logbook is a space that allows the user to keep logs of their test results, date/time, food intake, exercise, how they are feeling, and other relevant information.
Visualization of data	The visualization of data elements indicates turning the data in the user's logbook into visual representations.
Trend Alert	The trend alert element indicates the use of the logged data to alert the user of any sudden changes or worrying results.
Autonomy	It comes from the user's basic desire to control what happens and make decisions that affect the outcome.

Process 6: Extracted the Criteria and characteristics of each element to create the GMHealth Instrument.

Following identifying the operational definition for each element and theme, the criteria for each element were meticulously extracted. These criteria were then used to develop the instrument for the GMHealth Framework. This instrument underwent a rigorous validation through expert review, allowing necessary amendments and corrections. Table 3.10 shows the draft of instrument of the GMHealth framework version 1 before it was sent to the expert reviewer.

Table 3.10
Draft of Instrument of The GMHealth Framework version 1

Theme & Element	**Instrument**
Self-Representation	**I** am freely to make my own choice
• **Avatar**	I can customize my profile based on my interest
• **Profile**	The choice provided in gamified application grabs my attention
• **Autonomy**	
Improvement	**I** received instant feedback on my progress while using gamified application.
• **Feedback**	I received intermediate feedback based on my actions
• **Goals**	I received information on my status eg.score, level
• **Library**	I can freely set my own goals
• **Information tools box**	I understand the content provided in the Gamified Application.

	The information presented in gamified application increases my knowledge.
	I catch the basic idea of the knowledge in gamified Application.
	The Gamified Application motivates me to integrate the knowledge sharing.
Socializing	**I** can share my health progress with other members.
• **Community**	I love to interact and support each other in gamified
• **Social Media**	Applications.
• **Peer-Support**	My motivation increases while sharing my achievement.
	I can link my Gamified Application with my social media platform.
	I love to receive real-time feedback while communicating with the community.
	I feel involved while using gamified application
	I am freely sharing my opinion with others.
Esteem	**I** can trace my current ranking while using gamified
• **Leaderboards**	application.
• **Progress**	I can monitor my progress easily
• **Level**	I can track my current achievement while using gamified application
	I can know my position immediately.
	The progress indicator are presented clearly.
	I know what to do in the next stage.
Enjoyment	**I** enjoy using this Gamified Application without
• **Badges**	feeling bored or anxious
• **Challenge**	The challenges provided are moderate, not too
• **Points**	difficult or easy.
	The Gamified Application provides audio or indicator that help me to complete the challenge.
	I prefer gamified mobile health application that contains entertainment (and encouragement) features.

Guidance • **Virtual Coaches** • **Chatbox** • **Virtual Agents**	**I** am highly motivated to use gamified application with the presence of the coaches. I received real-time support from the coaches. The virtual coaches were very helpful I feel a sense of guidance
Self-Monitoring • **Logbook** • **Trend Alert** • **Visualization of Data**	**I** can freely insert my daily progress in Gamified Mobile Health applications I can trace my health condition easily I am aware my health condition by looking at the data visualization presented.
Continuous • **Story/Theme** • **Notifications** • **Reminder**	The interface of gamified application grabs my interest I become more immerse in the gamified health application The notification makes me become more aware The gamified mobile application give positive reminders as an encouragement to do better.

Process 7: The initial draft of the GMHealth framework was developed

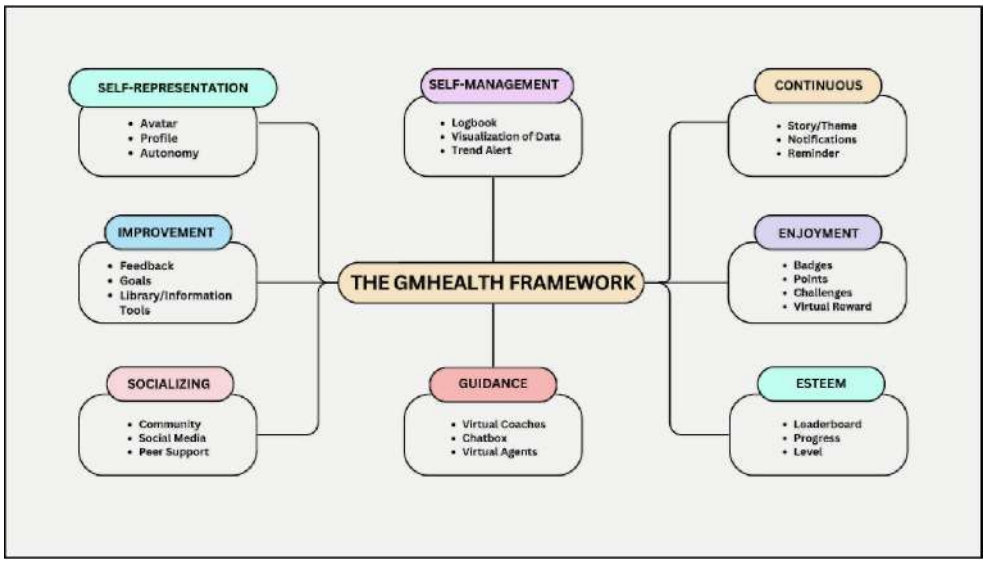


Figure 3.2 The Initial Draft Version 2 Of The Gmhealth Framework

The diagram illustrates the initial draft of the GMHealth Framework, which has undergone several processes. The GMHealth Framework retains eight themes derived from the enhancement of the WoS framework. Notably, it removes the 'Motivation' theme from the WoS framework and introduces a new theme, 'Guidance.' This new theme incorporates improvements by revising theme names and adding new elements such as *library and information tools, virtual coaches, chatbots, virtual agents, notifications, and reminders*. These additions enhance user engagement and user experience using gamified mobile health applications. Next, all the themes, elements, and instruments of the GMHealth will be sent to the expert reviewer for validation.

3.3.1.2 Expert Review

After the initial draft of the GMHealth framework, it will be sent to potential experts for face validation and content validation. The face validation aims to determine whether the instrument makes sense and appears relevant to the topic. At the same time, expert validation aims to ensure that the elements accurately and comprehensively represent the framework. The study will implement a quantitative approach by distributing a survey to the research domain experts, including academicians, game experts, industry professionals, and health experts. Figure 3.3 shows the steps required to assess expert validations for Face Validation and Content Validity to evaluate the GMHealth Framework.

Figure 3.3 Steps Required To Assess Expert Validations

The first step to getting the expert's validation is identifying the inclusion and exclusion criteria of the expert based on relevant experience, position, field of expertise, and other qualifications pertinent to the study's objectives.

Inclusion Criteria include:

The expert among academicians was required to fulfil these criteria:

- A full-time lecturer
- Have at least a minimum of ten years of teaching experience
- Have at least a minimum of one year of experience in mobile health applications or developing games.
- Have a qualification from The Ministry of Higher Education recognised.

The expert among the medical practitioners was required to fulfil these criteria:

- Have at least three years and above experience in the health and medical sectors.
- Qualify by The Ministry of Health Malaysia.

The experts from the industry were required to fulfil these criteria:

- Have at least three years of experience in Computer Science or Information Technology fields, such as game design, mobile health applications, web development, and technology design.

Exclusion Criteria:

- The incomplete data from the participants will be excluded from the research procedure.
- The participant does not have a consent/survey form. He/she does not have the right to be involved in this research.

Following this, a thorough search was conducted using reputable sources such as academic databases, professional networks, and institutional websites such as *mmu.edu.my* and *ukm.edu.my* to gather detailed information about potential experts who meet the requirements of the inclusion criteria.

Once suitable experts were identified, a personalized email invitation was drafted, outlining the study's purpose, the role they were expected to play, and providing a link to the necessary evaluation materials. A deadline, typically within two weeks, was set for their response or task completion. In cases where responses were not

received by the initial deadline, a follow-up email was sent, reiterating the importance of their participation and offering an extended deadline.

Table 3.11:
Elements of an invitation email for an expert's content

Paragraph	Sample Text
State the purpose of the study.	**I** am reaching out to request your valuable opinions, suggestions, or recommendations regarding the Conceptual Framework for Gamifying Mobile Health Application (GmHealth Framework).
Briefly describe the instrument.	As an expert in the field, I would greatly appreciate your feedback on validating this framework. I would be grateful for your assessment of each item's relevance and clarity to improve the proposed framework.
Describe how to contribute to a study.	**I** am eagerly awaiting your feedback. Kindly provide your feedback using the Expert Review link within two weeks, preferably by September 19, 2023. To begin the review process, please confirm your participation in this study by clicking on this link: Expert Review Form
Contact Information and thank you.	Thank you for your cooperation, time, and assistance. Please find attached a letter of appointment as an expert reviewer for your reference. Once again, thank you in advance for your time and effort in making this research successful. If you have any questions, please do not hesitate to contact me at khairinayahizan.work@gmail.com (016 - 208 9500).

Source : (Hidayah Mat Zain et al., 2016)

Once the expert agrees to contribute, they must complete the evaluation form provided in the email. The expert's role involves critically assessing the initial draft of the GMHealth framework based on the specified criteria for each element involved. They are expected to review the content thoroughly, offering revisions or suggestions for improved wording where necessary. The expert needs to evaluate each theme and criterion of the GMHealth framework based on clarity and relevance. Additionally, the

expert evaluates whether the elements and criteria are essential and relevant to the GMHealth framework. Details of the questionnaire administered for expert validation are presented in Appendix 12.

After completing their review, the expert submits the final draft of the GMHealth framework, including any amendments they have made. The expert provides detailed feedback on the evaluation form, outlining their rationale for the changes and offering insights into the overall structure and content. If the expert identifies any significant issues or believes that further major changes are required, the expert contacts the researcher directly through the provided number and email. This ongoing dialogue ensures the framework is refined and validated effectively, incorporating the expert's valuable input.

An e-certificate was provided to acknowledge their contribution as a formal token of appreciation. Finally, a thank-you email was sent upon completion of their involvement, which included information regarding an honorarium and an overview of the collaborative efforts of other experts, if applicable. This structured approach ensured the efficient and respectful engagement of experts in the study. All further details about the forms, email content and experts' certificates are attached in the Appendix.

a) Face Validation for GMHealth Framework Instrument

Face validity of the instrument was conducted to provide an overall impression and assess the accuracy of the items in representing a single test item (Bornstein et al., 1994) as well as its subjective nature (Elangovan & Sundaravel, 2021). Face validity evaluates the extent to which a construct appears clear and relevant for its intended purpose. Furthermore, face validity is a crucial method to confirm the overall validity of the prepared research tool (Yusoff, 2019). According to Oluwatayo, (2012), face validity can be established either through expert review in the relevant field or by obtaining input from individuals with no psychometric experience, as their perspectives can offer insight into the appropriateness of the instrument for its intended use. This process is essential when reporting validity procedures. However, some previous researchers do not regard face validity as a legitimate component of content validity. In fact, face validity is often seen as the most minimal and basic indicator of content validity (Zhang & Garcia, 2023). Hence, face validity was conducted for GMHealth instruments to evaluate their relevance and understanding before proceeding to an

expert reviewer for the overall evaluations of the instrument and items of the GMHealth framework.

As noted by Lynn, (1986) and Zamanzadeh et al., (2015), face validity is an unstandardized and inherently unquantifiable approach. Therefore, the author recommends quantifying the responses by calculating the percentage of agreement, as shown in Table 3.12. The percentage for individual questions and overall agreement will be calculated using equations 1 and 2.

Table 3.12
Calculation for Face Validation Agreement

Equations	Equation 1	$\frac{\textbf{No. of agreed raters per question}}{\textbf{Total number of rates per question}} \times \textbf{100\%}$
	Equation 2	$\frac{\text{Sum \% of all questions}}{\text{Total number of questions}}$

Source : (Patel & Desai, 2020)

Table 3.13 is proposed as a guide for retaining, redefining, or restructuring the areas covered by each question and the overall instrument. All the calculations for face validation will be documented in more detail in Chapter 5.

Table 3.13
Guidelines for Defining the Face Validity Agreement

Percentage (%) of agreement	**Strength of Agreement per question or overall**	**Action for each question/ entire**
<80	Poor	Restructure
80-90	Substantial	Revise
90-100	Full	Retain

Source : (Patel & Desai, 2020)

i) Face Validation Procedures

The experts for face validity are two total experts identified and invited to examine the research instrument for face validity, Lynn, (1986), as shown in the table. Two inclusion criteria were used in choosing the expert as follows:

1. A full-time lecturer.
2. Academic experts who have experience of 10 years and above in the Computer Science field (>10 years).
3. Have a qualification recognised by The Ministry of Higher Education.

Table 3.14 shows the number of appointed expert panel members, their areas of expertise, and their years in their respective fields. All the appointed experts are academics, specifically lecturers, who specialize in education.

Table 3.14
Expert for Face Validation

Expert	Expertise	Experiences (Years)
1	Computer Technology & Networking	More than 20 years
2	Multimedia, Information Technology, Game-Based Learning, Digital Storytelling	26 years

Each expert panel member will receive an official email appointment letter and a link to the evaluation form. The instrument will also be emailed with a cover letter, a summary of the GMhealth research, and the evaluation form. Clear instructions on completing the evaluation will be provided to ensure the process is smooth and straightforward. Once the evaluation is complete, the panel members will submit their responses via Google Forms. This process ensures consistency, transparency, and ease of communication between the research team and the expert panels.

The instrument collects the demographic details of each expert, including their name, institution, position, field of expertise, and years of experience. This information helps contextualize their feedback and ensures their evaluations are relevant to their professional background.

In the face validation sections of the instrument, experts are provided with comprehensive instructions to assess the suitability and effectiveness of the GMHealth questionnaires for their intended use. The validation process follows specific criteria outlined by Oluwatayo (2012), which include:

1. Use of correct and appropriate grammar.
2. Adjusted use of appropriate language.
3. Use of correct spelling.
4. Correct sentence structure
5. Appropriate writing size
6. Appropriate format.
7. Appropriate content.

The feedback from the panel of experts was categorized into two responses: 'Agree' (Yes) and 'Disagree' (No). An 'Agree' response signifies that the item is structured according to empirical standards and aligns with the thematic categories outlined by Sangoseni et al., (2013). This indicates that the item meets the established criteria for organization and relevance within the specified themes.

Furthermore, the expert panel was encouraged to provide additional comments and suggestions to refine and enhance the GMHealth instrument. These insights are valuable for making necessary adjustments or any amendments to improve the clarity, effectiveness, and overall quality of the GMhealth instrument. The next chapter will discuss all the details about the face validation calculation.

b) Content Validity

After getting the data and evaluation from the expert, the content validity of the GMHealth Framework will be carried out, and the analysis will be based on the results of the expert review. Content validity is a process to measure whether the framework component is precise and valid (Rodrigues et al., 2017).

Table 3.15 summarizes the demographic and professional characteristics of the expert panel, detailing their quantity, specialized knowledge, and accumulated professional experience. All the details about the expert being discussed at Chapter 4.

Table 3.15
Expert for Content Validation

Category of Experts	Number of Experts
Industry Expert	8
Academicians	8
Health Practitioners	6
Total	22

The Content Validity Ratio (CVR), Item Content Validity Index (I-CVI), and Scale Content Validity Index (S-CVI) were examined by implementing the mean value and inter-rater agreement approach. According to Rodrigues et al.,(2017), the content validity index is mainly used by researchers because it is simple to calculate and easy to understand, and it provides information on each item, which can be used for modifying or deleting instrument items. Item Content Validity (I-CVI) is the proportion of content experts giving the item a relevance rating of 3 or 4. Next, the Scale Content Validity Index (S-CVI) is the average of the ICVI scores for all items on the scale or the average of the proportion relevance judged by all experts. The proportion relevant is the average relevance rating by individual experts (Rodrigues et al.,2017). Table 3.16 states the formula for calculating the content validity. The next chapter can refer to all the details and results of the expert's validation feedback.

Table 3.16
The formula for calculating content validity

Item	Formula
N	Total number of experts
Ne	Number of experts agreeing on a rating of 3 or 4
Content Validity Ratio (CVR)	***=(Ne--)/(-)***
Content Validity (CVI)	= (-)
I-CVI (Item-content validity for individual item)	= (number of experts providing a rating 3 or 4)/ (number of experts)
S-CVI/Ave (Scale-level content validity index based on the average method)	= (sum of I — CVI scores)/ (number of Item)
Pc (Probability of chance agreement)	= r i „. Q §N *Ne\{N-A)*
Kappa (K)	**(I-CVI-Pc) / (I-Pc)**

Source : (Rodrigues et al., 2017;Zain et al., 2022)

Table 3.17
The Lawshe table for minimum values of CVR

No of expert	5	6	7	8	9	10	11	12	13	14	15	20	25
Min Value	0.99	0.99	0.99	0.75	0.78	0.62	0.59	0.56	0.54	0.51	0.49	0.42	0.37

Source : (Lawshe, 1975)

After gathering the feedback and evaluation data from the expert validation process, the final revisions were made to the GMHealth Framework. This paved the way for the next phase: user evaluation. The GMHealth Framework will be implemented in the *LetsGoFit:* A Stretching Fitness App prototype in this phase. The user will evaluate the application using the finalized GMHealth instrument.

3.4 Phase 3: Framework Evaluation

The framework will be validated through a prototype demonstration involving the user using the prototype implemented with the validated GMHealth Framework. The details of the evaluation process are broken down below.

3.4.1 Rapid Application Development (RAD) for the Methodology of Prototype Development

Rapid Application Development (RAD) is one of the methodologies designed by Martin,(1991) to give faster development and higher-quality systems than the traditional life cycle. RAD has compressed the step-by-step development of standard methods to an iterative process (*What Is RAD Model? Phases, Advantages and Disadvantages*, n.d.). User requirements are refined, a solution is designed, and a prototype is the initial view of the product. The prototype is a review, the user input is provided, and the process repeats.

The RAD methodology will be implemented in the prototype development of the GMHealth framework because RAD provides more quality products in less time to meet the requirements. RAD will be implemented to develop the prototype of the GMHealth framework. RAD comprises several phases: requirement planning, user design, construction, and cutover. Figure 3.4 shows the phases of the RAD methodology.

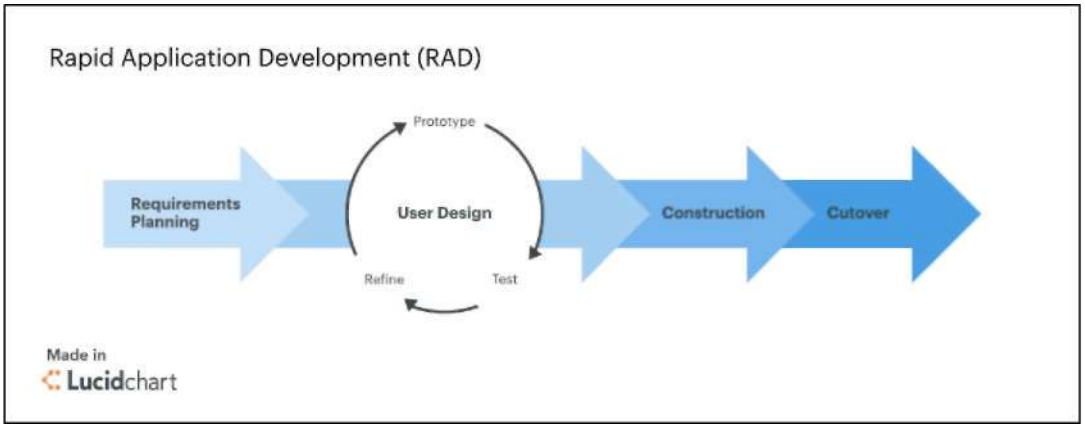


Figure 3.4 Rapid Application Development (RAD)

3.4.1.1 Requirement Planning Phase

The requirement phase collected all the data and information related to the prototype content. The title, objective, target user, language use, and content of the mobile health application will be identified. Various and different types of resources, such as surveys, internet resources, journals, articles, newspapers, and e-books, will be analyzed to get some ideas about the outcome of the prototype. The concept and design of the mobile health application had been identified in this phase. In addition, the software for designing the content, game engine, and audio will be decided. Although the preliminary study focused on gamified mobile health applications in the Apple App Store, the prototype was developed on the Android platform. This choice was made because Android allows greater flexibility in development, avoids certain safety and privacy restrictions, and provides accessible tools for testing and refinement. The gamification principles and user engagement strategies identified in the Apple-based study remain applicable, ensuring that insights are transferable across platforms.

Consequently, the Android prototype serves as an effective medium for evaluating the GMHealth framework and assessing user engagement in a controlled and practical environment.The strengths and weaknesses of the existing mobile health application will be pointed out to improve and produce a better prototype of GMHealth. Lastly, all the information gained will be adequately documented for the following development process.

3.4.1.2 User Design Phase

The user design phase will involve developing the prototype, including designing a flowchart and storyboard. The flowchart's use defines how a process is performed from start to finish, typically in sequential order. The step-by-step process of the GMHealth prototype will be sketched as initial references to how the prototype will look. Next, the storyboard is designed to visualize the flow of the application. The initial view of the prototype interface design will be helpful as a guideline, and all the multimedia elements will be identified, for example, audio, video, buttons, and text. Figure 3.5 represents the flowchart of the *LetsGoFit* application.

i) Flowchart

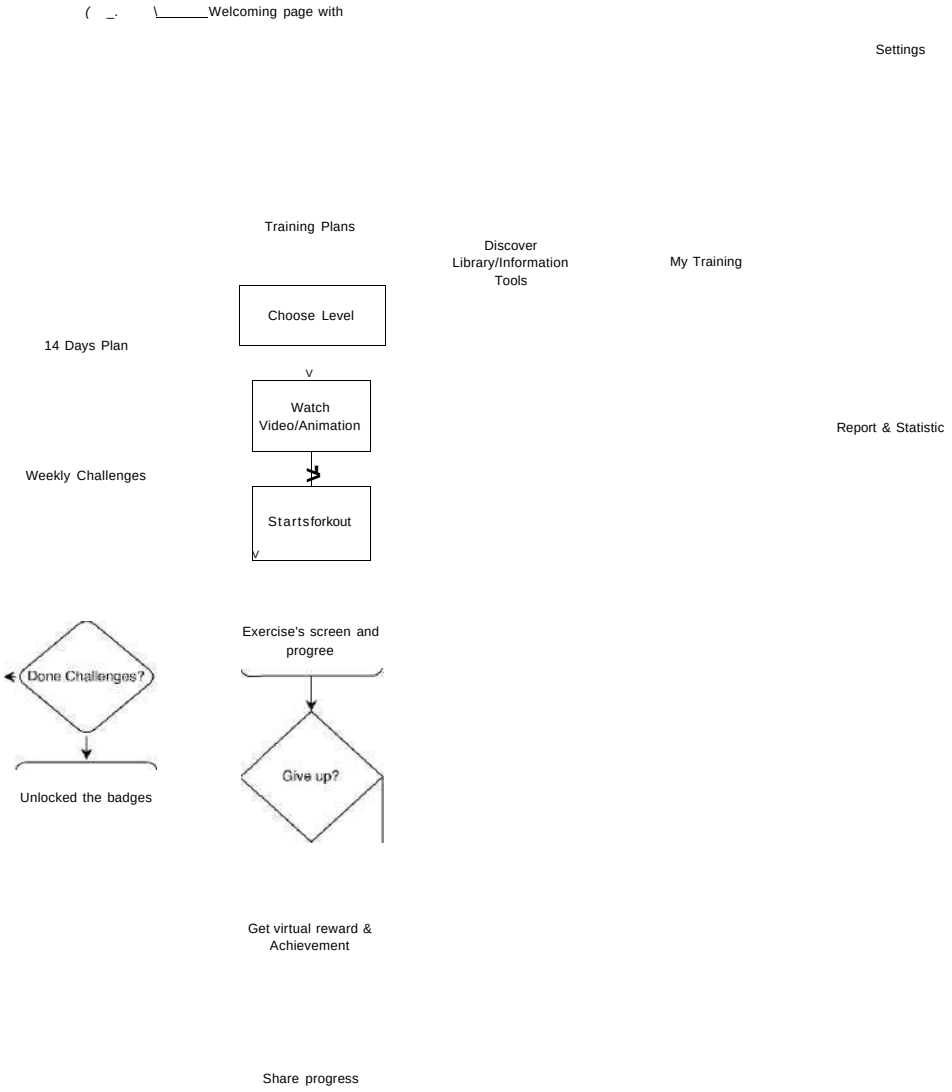


Figure 3.5 Flowchart Of *Letsgofit* Application.

The *LetsGoFit* application opens with a welcoming page that prominently displays the app's logo, creating an inviting start for users. Upon entry, users are prompted to define their fitness goals by selecting options such as Warm-up, Cool-down, Pain Relief, Body Relaxation, or Posture Correction. This goal-oriented approach immediately tailors the experience to each user's needs and preferences. Once a goal is selected, users are directed to the Homepage to explore the app's main features,

including a Training Plan, Discover Library/Information Tools, My Training section, User Profile and Settings.

In the 'Training Plan' section, users engage in a 14-day structured program incorporating weekly challenges to motivate progress and unlock virtual badges. The program is designed to cater to various fitness level,beginner, intermediate, and advanced,allowing users to tailor their workouts to their current fitness and personal goals. Before beginning a workout, users can access instructional videos and animated coaches for clear guidance, ensuring exercises are performed safely and effectively. While working out, a progress bar visually tracks completion, providing real-time feedback on their current status and remaining tasks. Integrated music and calming audio enhance the workout experience, offering users a holistic and enjoyable routine. If users choose to stop a workout prematurely, a prompt confirms their decision, and if confirmed, they are smoothly redirected to the Homepage. If the user completes workout tasks, they will receive award points and trophies, and users can choose to share their accomplishments on social media, fostering a sense of achievement and community.

The 'Discover Library/Information Tools' section acts as a knowledge hub, offering articles, tips, and resources on various health topics, such as menstrual pain relief and wellness strategies. The 'My Training' section is a personal health journal, enabling users to document their progress, set goals, and track their journey. Users can monitor their performance on leaderboards through the' Profile' feature, access detailed progress reports, and visualize their fitness journey. Finally, the 'Setting' menu allows users to personalize their experience with options to adjust notifications, reminders, and other preferences to suit their routine. This flowchart provides a comprehensive overview and framework for developing the *LetsGoFit* application, ensuring a user-friendly and goal-oriented experience.

ii) Low Fidelity Storyboard

According to Snyder, (2003), low-fidelity storyboards help communicate basic ideas and concepts to team members and stakeholders without requiring comprehensive images. They prioritise utility and user flow over aesthetics. Other than that, testing concepts with low-fidelity storyboards minimizes investment in development, allowing teams to validate ideas before committing to higher-fidelity prototypes or production (Chang et al.,2008). Hence, the low-fidelity storyboard had been developed for GMHealth's prototype named, *LetsGoFit* as a basic idea and to visualise the concept, the content, and flow of the application. Figures 3.6-3.8 show examples of low-fidelity storyboards for the *LetsGoFit* apps, with the basic concept and initial view, as well as the title and identified element applied in the prototype.

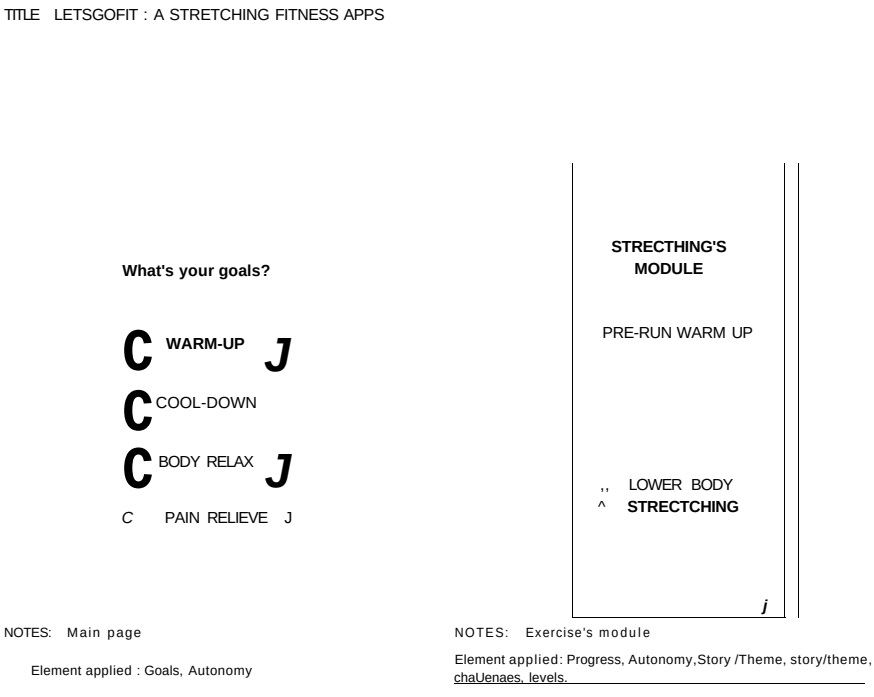


Figure 3.6 Low-Fidelity Storyboard For Scenes 1 And 2

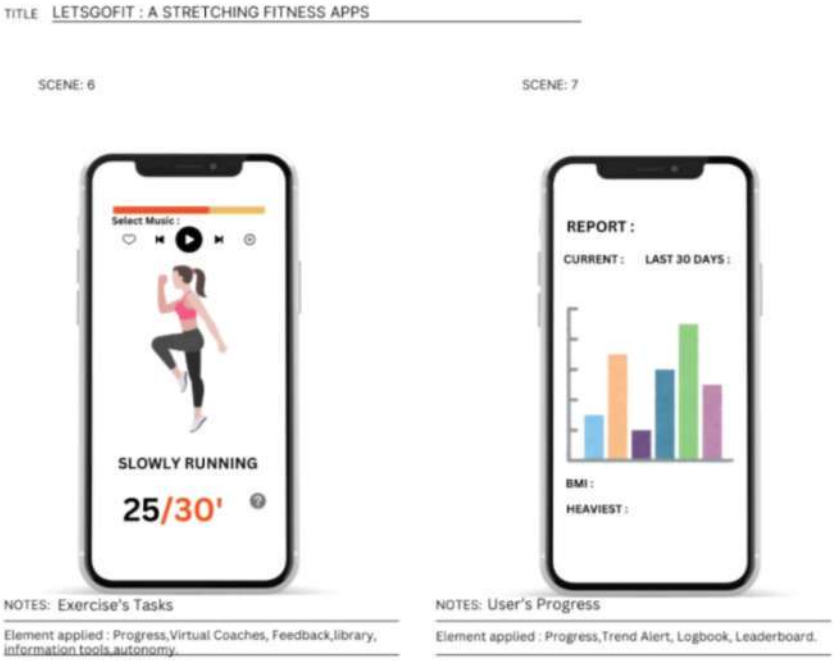


Figure 3.7 Low-Fidelity Storyboard For Scenes 6 And 7

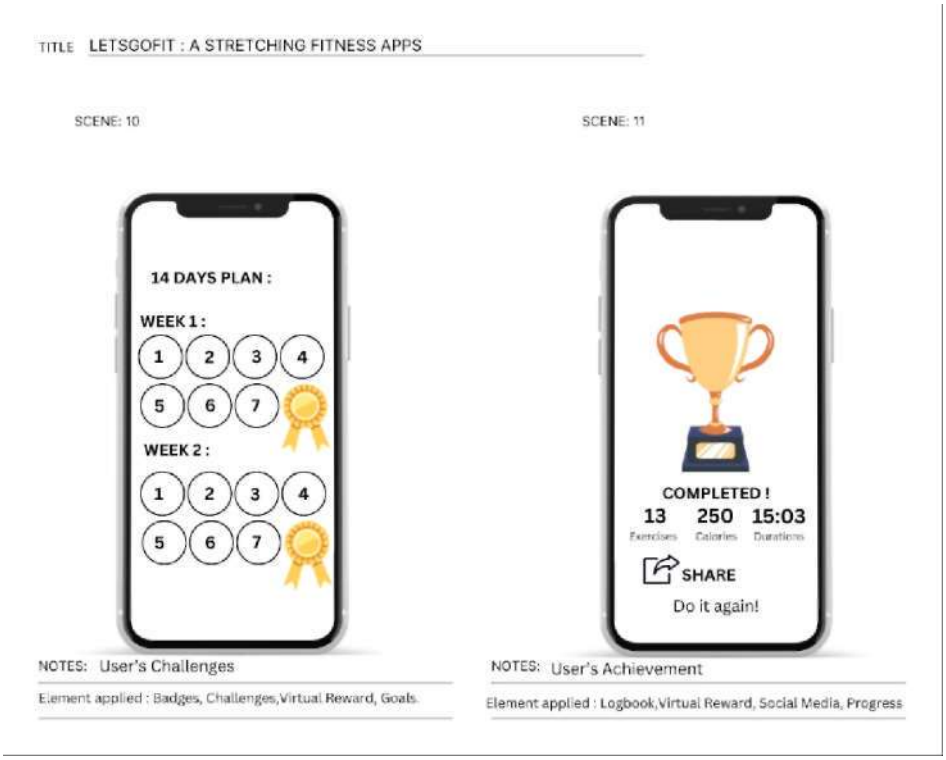


Figure 3.8 Low-Fidelity Storyboard For Scenes 10 And 11

3.4.1.3 Construction Phase

The third phase of RAD is the construction phase, where all the remaining elements and application features are developed and integrated into the product. The development of the components, such as interface, character, button, and graphic, is based on the user design phase. It involves scripting, recording the audio, language, modelling, and animation for the prototype content. The prototype implementation applies to the information gained from the requirement and user design phases. The software development prototype content includes Adobe Photoshop, Illustrator, Android Studio, and Audacity.

Table 3.18

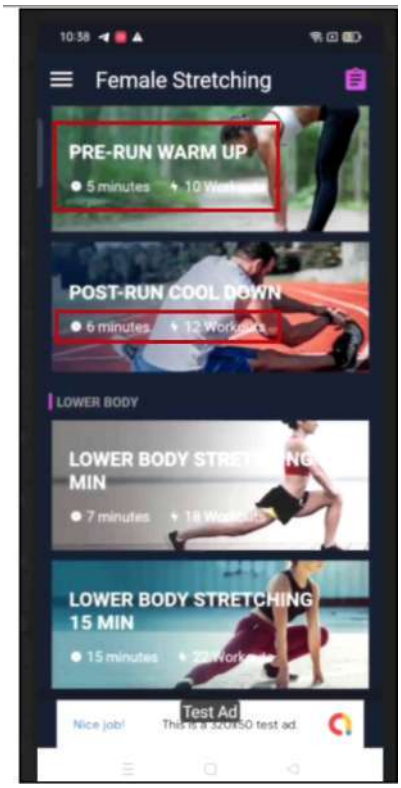
Example Of Initial Storyboard Of GMHealth's Framework Implementation

Interface	Features	Element applied
	The user can establish personalized goals within the application, aligning them with their preferences and capabilities. Whether aiming for weight loss, strength building, endurance improvement, or any other fitness objective, users can define meaningful and relevant targets to their aspirations.	• Goal • Autonomy

The application offers personalized recommendations to assist users in achieving their targets and goals.

These recommendations are tailored to each individual's needs and aspirations based on user input, performance data, and established fitness elements.

- Goals
- Autonomy



The application offers a comprehensive array of tasks and exercises, each accompanied by detailed information, guidelines, and varying challenges and difficulty levels.

For each exercise, users receive clear, step-by-step instructions to ensure proper form and technique, minimizing the risk of injury and maximizing effectiveness. The guidelines also include tips for optimizing performance and achieving the best results.

The story and theme of this application are represented as 'Fitness apps for females', in which all the content and tasks are more likely related to females, with blue, black, and pink as the color themes.

Library
Information
Tools
Challenges
Level
Story/Theme

h^

INTRODUCTION

In this training, we will guide you to get your full splits step by step.

BEGINNER

INTERMEDIATE

ADVANCED

Users can freely choose their level of exercise based on their performance and fitness level.

The application offers a variety of exercises, each designed with different levels of difficulty and unique challenges.

This allows users to select exercises that match their current abilities and progressively increase the intensity as they improve.

Level Challenges

<r SPLIT TRAINING BEGINNER

17MINS • 16 WORKOUT ;

JUMPING JACKS
00:30

STANDING KNEE TO CHEST

SKIPPING WITHOUT ROPE

QUAD STRETCH
01:00

LYING LEG ABDUCTION
00:30

SINGLE LEG SWINGS

Nice job! Th SfffffO test ad. £\

The gamified application offers an early review of the exercises through the assistance of virtual coaches and provides an estimated time for the user to complete each task.

Virtual coaches guide users through their exercises, offering tips, encouragement, and feedback in real-time.

Challenges Virtual Coaches Library/Information tools

| Female Stretch

S Discover

4-¥ My Training

, | | Report

O Reminder

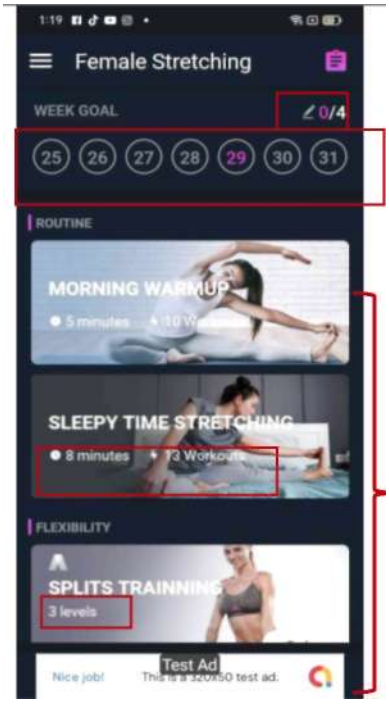
O Settings

3 Exit

The user can control the flow of the application based on their preferences, allowing for a highly personalized experience.

Users can tailor the app to meet their needs and preferences by adjusting settings and customising features.

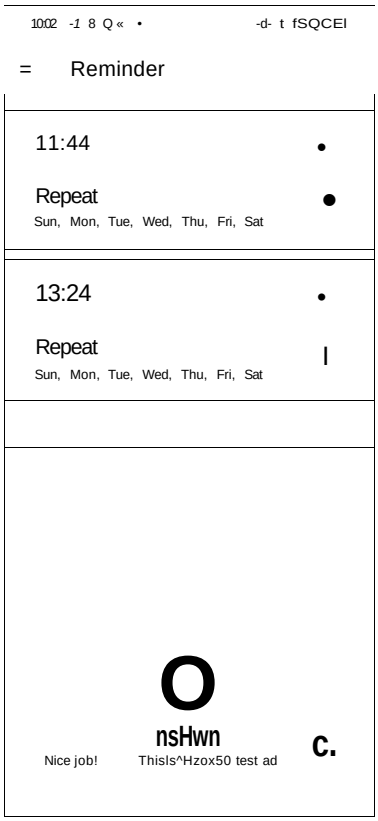
Autonomy



D O

The user can easily monitor their progress towards their goals through badges within the application. Other than that, the tasks

Progress
Challenges
Level
Goal
Badges

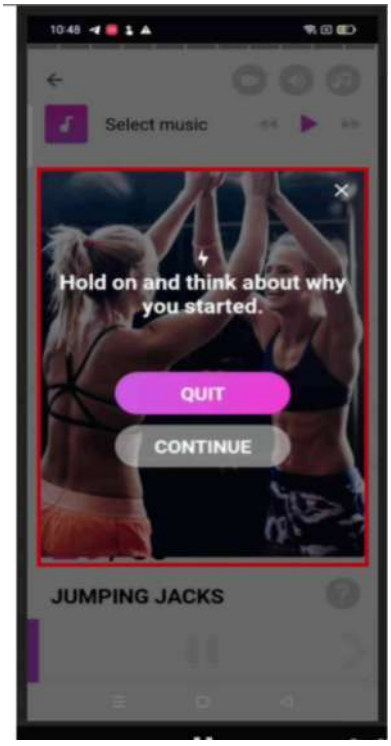


To avoid the annoyance of constant notifications, the user can customize the timing of reminder alerts according to their preferences.

This feature allows users to set specific times for reminders, ensuring that notifications are received at convenient moments and do not disrupt their daily activities.

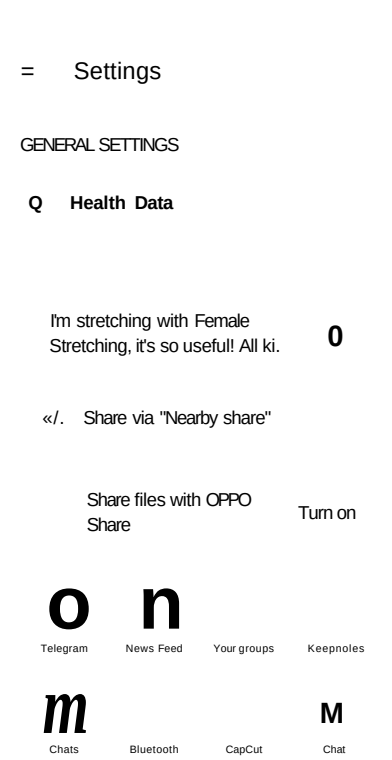
Users can maintain focus and productivity by personalising reminder times without interruptions.

- Reminder
- Notification



Positive words motivate users to stay committed to their goals and exercises, especially during moments of doubt, by offering encouragement and support.

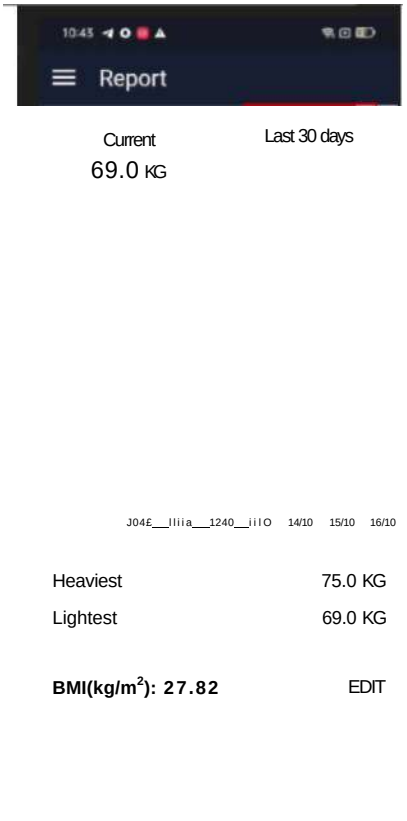
Feedback
Notifications



Users can share their exercise achievements and completed tasks on social media platforms and within their social communities.

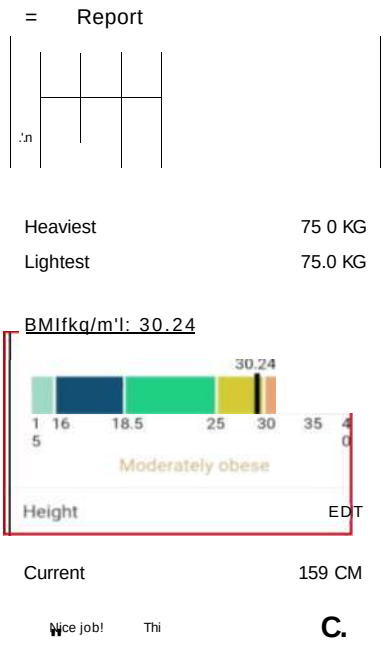
This allows them to celebrate their progress, receive encouragement, and inspire others.

- Social Media
- Social Community
- Peers-sharing



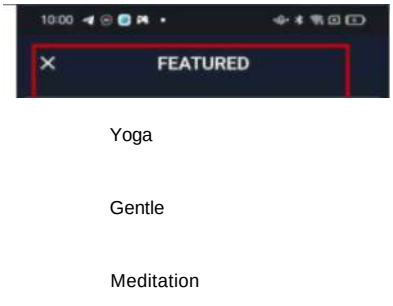
The application allows users to input their body weight and view a visual display of their progress. This feature helps users track changes, identify trends, and make informed decisions about their fitness and wellness.

- Trend alert
- Visualization of data
- Progress
- Logbook
- Leaderboard



Users can track their health progress and update their weight in the app, allowing real-time feedback on their efforts and achievements.

- Progress
- Logbook



Users can choose their preferred music during workouts, helping them stay calm, focused, and enjoy a more immersive exercise experience.

Autonomy

Select music

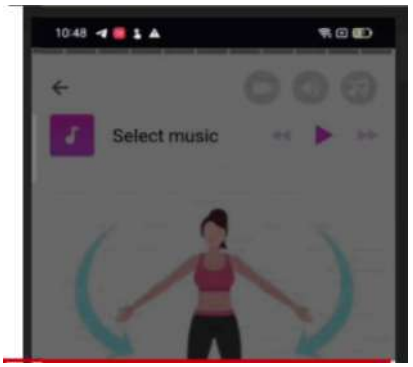
Virtual coaches guide users in reaching their goals by showing progress through a progress bar and timer. Users can also view detailed exercise steps by accessing the tools box.

Virtual Coaches
Library
Information tools
Autonomy
Progress

X J

30"/30'

CAMEL



Users have the option to either mute the voice guide and coach tips or enhance their experience with the presence of virtual coaches by adjusting the sound settings accordingly.

Autonomy
Virtual coaches

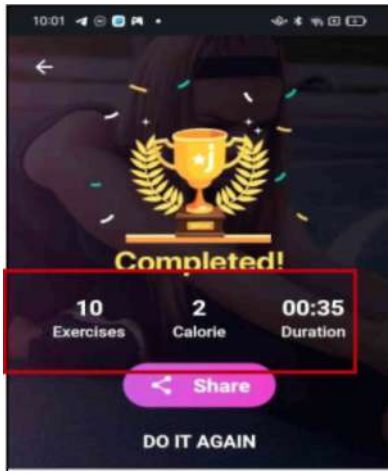
Sound options

Mute

Voice guide
&) Know your next workout and how many times you need to doit.

Coach tips
• >) Follow coach tips to make sure you use the right from during each exercise.

-



Reminder:

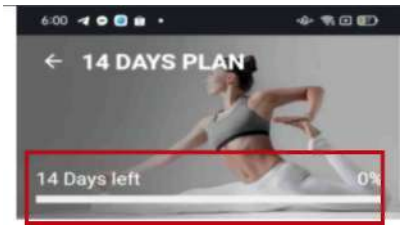
:

Weight 75.0

W<60testad. £#

Upon finishing the tasks and exercises, users will receive their score and points, determined by the completed tasks and calories burned.

Virtual reward
Points
Score
Progress
Feedback



I INTRODUCTION

Splits Trainning is designed for all levels to get full splits step by step, even if you are a beginner. With just 10 min a day. you'll get cl..

WEEK 1 0

0 > © * © * ©

©>©>©> f

O WEEK 2 0/ '

> C n 1 •> (Q 1 > C7\

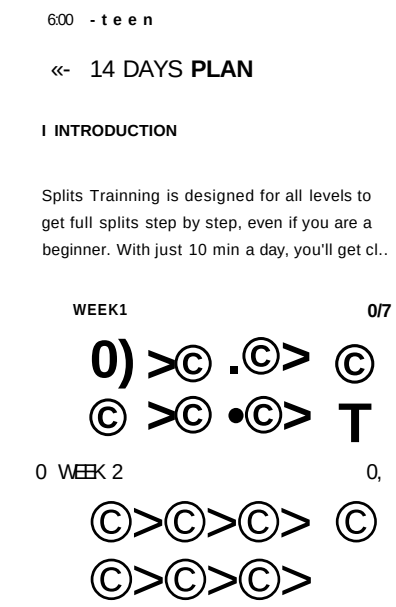
^M ^A

Nice job! ET-T^

ThCT^ffTTOxbO test ad

Users must complete weekly challenges within 14 days to earn badges and level up, with a progress bar at the top of the page motivating them to reach their goals.

- Challenge
- Badges
- Progress
- Trophies



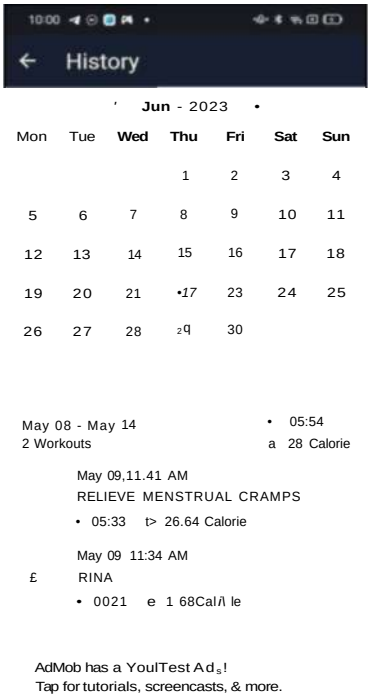
Users must complete each step of the challenge to earn badges.

Pop-up messages will remind users of any previous challenges that have been skipped.

Feedback

In this gamified app, animated virtual coaches guide each task with instructions and sounds to enhance immersion. Users can also reset and save their exercise times.

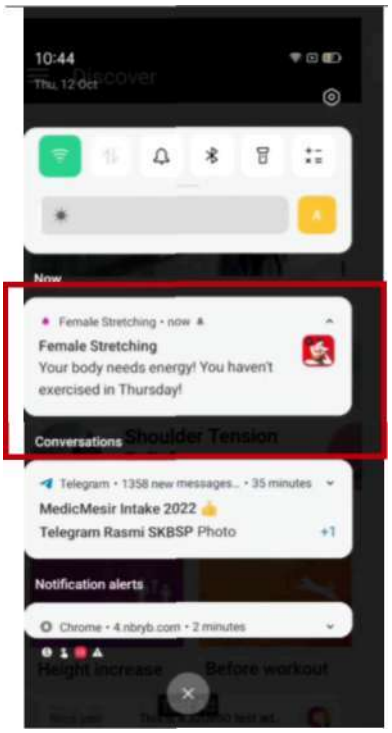
Virtual coaches
Information tool
Autonomy



Users can review and track their historical health and fitness data within the designated history section of the application.

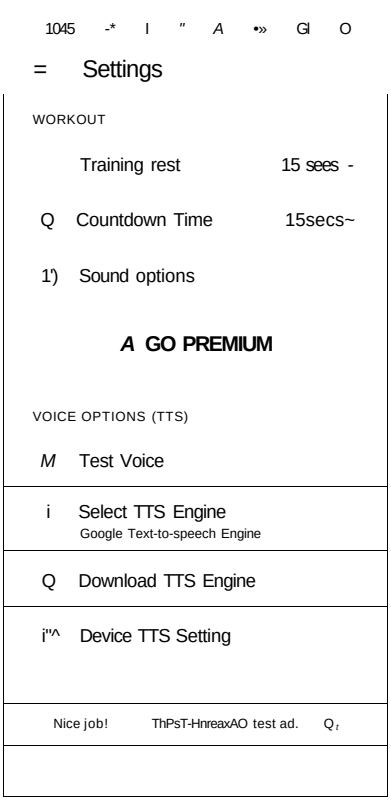
This feature lets users access detailed records of past activities, progress, and achievements.

- Logbook
- Progress



Users receive personalized notifications based on their settings, reminding them to exercise and stay consistent with their fitness goals.

Notification Reminder



Users can customize their workout settings and adjust the application's voice through the settings option.

This feature empowers users to tailor their workout experience to their preferences and needs.

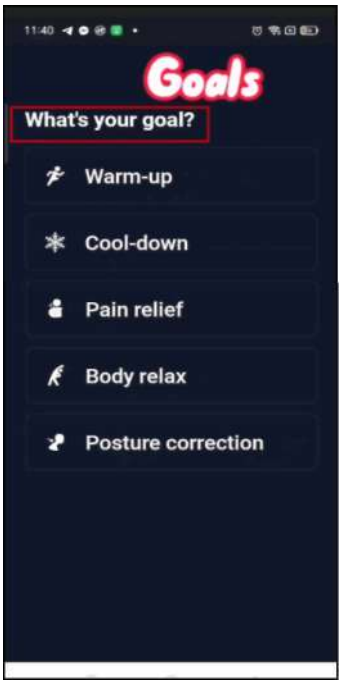
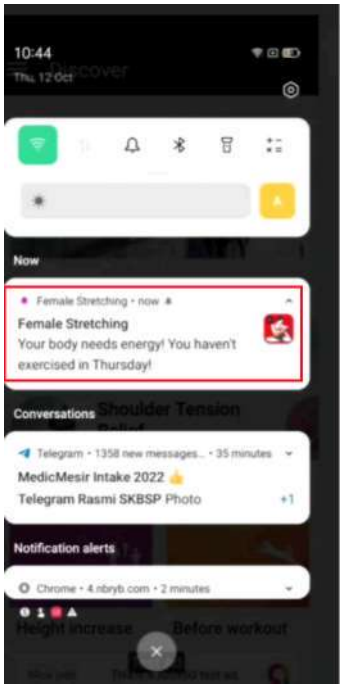
- Autonomy

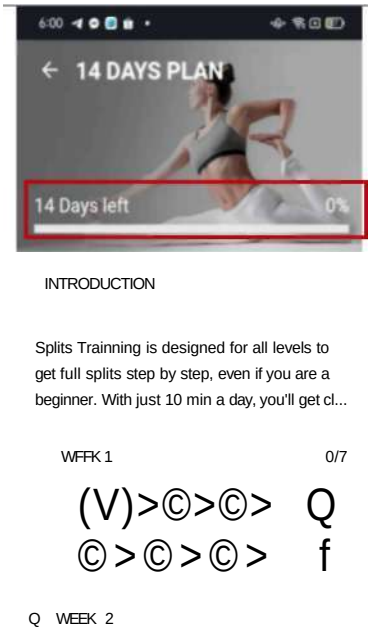
3.4.1.4 *CutoverPhase*

The cutover phase is the final phase in the RAD methodology. The final prototype will be tested for any changeover and functionality, stability, usability, and maintainability before being delivered to the user. For the GMHealth prototype, the evaluation will involve adults aged 18 and above to validate the gamified mobile health. The questionnaires are adapted from the GMHealth instrument and will be distributed to the user after the prototype is used. Table 3.19 shows the prototype development that had undergone the cutover phases with the element applied to each prototype scene.

Table 3.19

Prototype's status is that it is undergoing the cutover phases.

Interface	Features	Element applied	Status
	The user can establish personalized goals within the application, aligning them with their preferences and capabilities. Whether aiming for weight loss, strength building, endurance improvement, or any other fitness objective, users can define meaningful and relevant targets to their aspirations.	Goal Autonomy	• No bugs • Tested
	Users will receive notifications according to their reminder settings, serving as reminders to engage in their exercises and maintain their fitness regimen. These notifications are tailored to the user's preferences, ensuring they stay on track with their fitness goals and remain consistent with their workout routines.	Notifications Reminder	No bugs Tested Notifications received at the right time



Users must fulfil the weekly challenges to earn badges and progress to the next level.

All fitness activities within these challenges must be completed within a 14-day timeframe.

The progress bar located at the top of the pages serves as an indicator, motivating users to reach their goals.

Challenge Badges Progress Trophies	• No bugs • Tested • Progress bar running • The badges are disabled after completing the levels.

Engagement Evaluation

The GMHealth framework research project seeks to evaluate the GMHealth framework by utilising a gamified mobile health (mHealth) application named *"LetsGoFit: A Stretching Fitness App"* This prototype implements gamification elements to amplify user engagement, including points, badges, progress bars, levels, and challenges. The evaluation centres on themes such as socializing, guidance, self-monitoring, improvement, enjoyment, continuous, esteem and self-representation, each comprising distinct parts for analysis. To carry out the assessment, participants will utilize the *LetsGoFit* application and submit feedback via distributed questionnaires, providing valuable insights into the framework's efficacy and the application's influence on user engagement and health-related behaviours.

i) Participants

The user evaluation for the GMHEALTH Framework prototype involved young adults (18-35 years) and adults (36-60 years) because they represent the primary users

of mobile health applications. These age groups frequently use smartphones for health monitoring, fitness, and lifestyle management, making them the most suitable participants to assess the prototype's usability, engagement, and overall effectiveness.

ii) Procedures

To evaluate user engagement with the *LetsGoFit* prototype with the implementation of the validated GMHealth Framework, several procedures are followed to ensure a comprehensive assessment and reliable results. Figure 3.9 illustrates the necessary steps for the user's evaluation through TheGMHealth's prototype evaluation process.

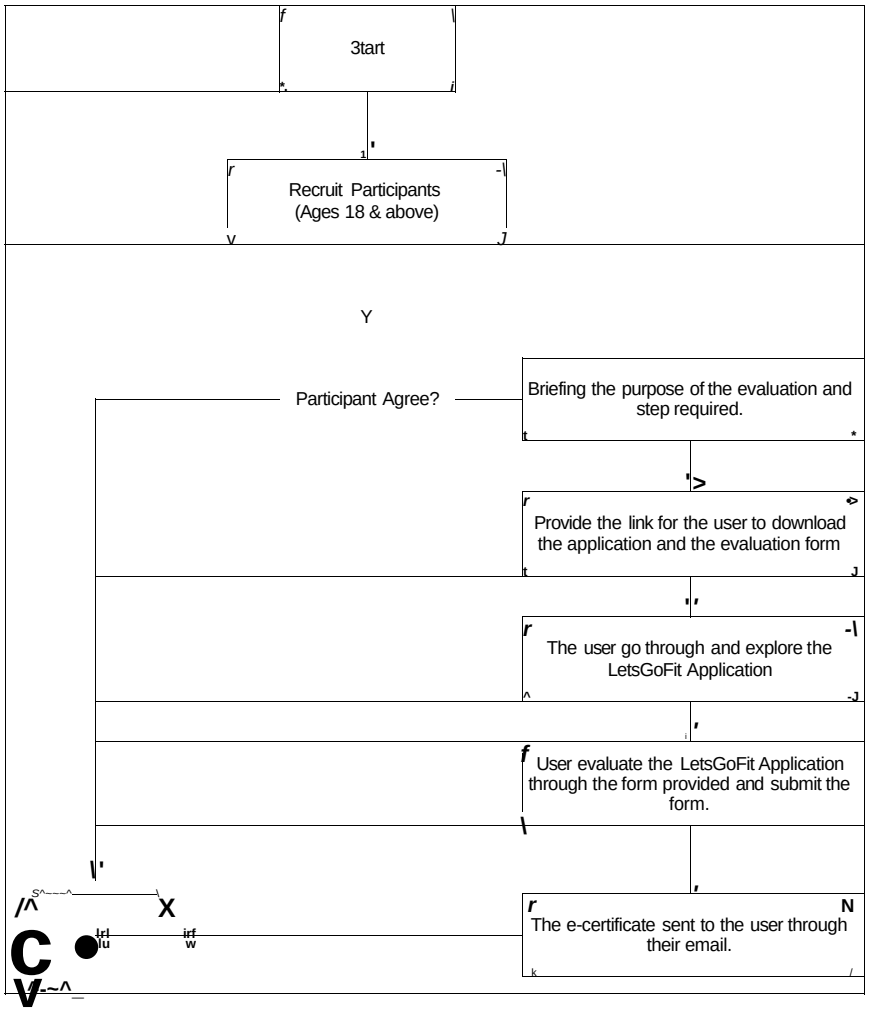


Figure 3.9 The Process Of Prototype Demonstration

The prototype demonstration begins by recruiting participants aged 18 and above, as they can legally provide consent and meet ethical research requirements. After obtaining consent, a briefing session is scheduled to explain the evaluation process, application features, and installation steps. This session, conducted via an online platform such as Google Meet, Microsoft Teams, or WhatsApp, ensures participants understand how to install and use the LetsGoFit application.

During the briefing, participants are introduced to the main features and gamification elements of LetsGoFit, including points, challenges, levels, progress bars, virtual coaches, profiles, autonomy, data visualisation, and logbook. Clear instructions for downloading and installing the .apk file are provided, along with technical support contacts to resolve any issues. Participants also receive a link to the evaluation form to record feedback on usability, engagement, and overall experience.

Once the app is installed, participants are asked to explore and interact with all modules for one week. LetsGoFit functions as a stretching fitness app, incorporating gamification through exercise routines, challenges, points, badges, and progress tracking to encourage motivation and regular use. After the evaluation, participants submit feedback via the provided form.

As appreciation, all participants receive an e-certificate acknowledging their contributions. This recognition highlights the importance of their feedback in improving the GMHealth prototype and demonstrates the potential of gamification in sustaining user engagement with mobile health applications.

iii) Instruments

The evaluation of the GMHealth framework within the LetsGoFit prototype was carried out using questionnaires derived directly from the framework after being validated by the expert from previous phase. These questionnaires encompassed eight theme,Self-Monitoring, Esteem, Self-Representation, Enjoyment, Continuous, Guidance, Improvement, and Socializing, which collectively reflect the multidimensional nature of user engagement in gamified health applications. Similar to prior studies that employed structured instruments for usability and engagement assessment, the use of Google Forms proved effective in streamlining distribution, data collection, and automated analysis, thereby enhancing the accuracy and efficiency of

result interpretation. The questionnaire incorporated both demographic questions (gender, age, education level, and previous experience with gamified mobile health applications) and thematic sections aligned with the framework, with each section containing between three and seven items, resulting in a total of 36 questions distributed across 24 elements. Responses were collected using a five-point Likert scale ranging from *strongly agree* to *strongly disagree*, ensuring a systematic capture of participant perceptions. In addition, an open-ended section was provided to allow users to share suggestions or general feedback, which offered qualitative insights into the usability and overall user experience of the LetsGoFit prototype.The detailed breakdown of these questions, including their corresponding themes and elements, is presented in Table 3.20.

Table 3.20:
The prototype evaluation's questionnaire is based on the validated GMHealth Framework

	Theme	Element	Criteria
1.	Self-Representation	• Avatar • Profile Autonomy	SRI -1 have the freedom to choose how I represent myself SR2-1 can personalize my profile based on my interests SR3 - Gamified applications with options catch my attention
2.	Improvement	• Feedback • Goals • Library • Information Tools	II - The application provided me with instant feedback on my progress. 12- The application provided me with information on my status, such as my score and level. 13-1 was able to set my own goals freely. 14-1 was able to understand the content presented in the application. 15- The information presented in the application increased my knowledge. 16- The gamified application motivated me to share knowledge about health
3.	Socializing	• Community • Social Media, • Peer-Support	S1-1 am able to share my health progress with other members. S2-1 enjoy supporting each other in gamified applications. S3- My motivation increases when I share my achievements. S4-1 can link my gamified application with my social media platform. S5-I appreciate receiving real-time feedback while communicating with the community. S6-I feel involved while using gamified applications S7-I am comfortable sharing my opinions with others.
	Esteem	• Leaderboard	E1-1 am able to keep track of my rank in the gamified application,

		Progress Level	E2-I am able to monitor my progress easily. E3-1 am able to keep track of my accomplishments within the gamified application. E4- The application provides clear progress indicators, allowing me to know my position immediately. E5-1 am able to understand what is expected of me in the next stage.
5.	Enjoyment	• Badges • Challenges • Virtual Reward	EJ1-I find this gamified application enjoyable to use without getting bored. EJ2- The challenges provided are moderate in difficulty, making them neither too easy nor too difficult. EJ3- The gamified application provides audio/visual indicators to help me complete the challenges. EJ4-I prefer gamified mobile health applications that have enjoyable features.
6.	Guidance	• Virtual Coaches • Chatbox • Virtual Agents	Gl-I am motivated by the presence of virtual coaches. G2-1 received real-time support from the virtual coaches. G3-The virtual coaches were very helpful G4-1 feel a sense of guidance
7.	Self-Monitoring	• Logbook • Trend Alert • Visualization of Data	SM1-I can easily log my daily progress in Gamified Mobile Health applications. SM2-1 can effortlessly track my health condition. SM3-1 am able to understand my health condition through clear data visualisation.
8.	Continuous	• Story/Theme • Notifications • Reminder	CI- The interface of the gamified application captures my attention. C2- The notifications increase my awareness C3-1 find myself becoming more immersed in the gamified health application. C4- The gamified mobile application's positive reminders motivate me to improve.

3.5 Phase 4: Documentation

The final phase of this study is documentation, during which all tasks, activities, and findings from the previous phases are systematically compiled into a comprehensive final report. This report serves as the complete record of the research process, ensuring that every stage, from problem investigation, framework development, and prototype evaluation is thoroughly detailed and clearly presented.

The documentation phase includes a structured presentation of the research methodology, data collection procedures, analysis, and results. It also highlights how the GMHealth framework was conceptualized, validated, and applied in the prototype, providing a clear linkage between theoretical foundations, practical implementation, and observed outcomes. By systematically organizing the study's processes and findings, this phase ensures transparency, reproducibility, and clarity, allowing future researchers and practitioners to understand the rationale behind design decisions and to build upon this work. Ultimately, the documentation phase consolidates the study's contributions, providing a complete reference that supports the conclusions, recommendations, and potential directions for further research.

3.6 Summary

This chapter outlines the methodology employed in the research on the GMHealth framework. The first step is problem investigation, where the issues are identified through an extensive literature review. This process addresses key questions such as, 'What is the problem?', 'Why is it a problem?' and 'How frequently has this problem been observed?'. These questions provide a structured approach to understanding the challenges within the context of gamification in healthcare. The second phase involves the development of the GMHealth framework using a content analysis technique. In this phase, various existing gamification frameworks are reviewed, and a mapping process is conducted, drawing from the Wheel of Sukr model and insights gathered from the literature. This process led to the creation of the GMHealth framework, which was designed to be more engaging and suitable for implementation in general healthcare contexts, building upon elements of pre-existing frameworks. Furthermore, a prototype named *LetsGoFit* was developed as part of this

research, incorporating all aspects of the GMHealth framework into a practical application to be tested by the user. The final phase involves evaluating the framework, which includes validation by experts from relevant fields, followed by a prototype evaluation by user to identify user engagement from the GMHealth framework.

CHAPTER 4
RESULT AND DISCUSSION

4.1 Introduction

This chapter presents the findings and calculations for the overall research study of the GMHealth Framework from the Phase 1: Problem Investigation, Phase 2 : Framework Development, Phase 3 : Framework Evaluation, and Phase 4 : Documentation.

4.2 Findings of Phase 1: Problem Investigation

In this phase, a comprehensive investigation of the research problem was undertaken through an extensive literature review and a preliminary study. The literature review systematically analysed various scholarly articles, journals, and conference proceedings. Utilizing keywords such as "gamification," "mobile health application," "mHealth," "gamified mHealth," and other terms relevant to the study, this review aimed to identify prevailing challenges and gaps within the healthcare context. The findings from this process provided critical insights into the current state of gamification in mHealth applications, highlighting key areas requiring further exploration and development.

This phase also facilitated the formulation of essential research components, including the problem statement, research objectives, research questions, the significance of the study, and its limitations. These foundational elements were instrumental in defining the study's scope and purpose. Furthermore, a preliminary study examined existing mobile health applications employing gamification techniques. This examination identified current practices and limitations, offering a contextual understanding that informed subsequent phases of the research.

4.2.1 Preliminary Findings

A preliminary study was conducted to identify the top 10 most popular gamified mHealth applications available on the App Store in 2022, as utilized by Apple users (Store, 2022). The primary objective of this study was to examine the current

gamification elements implemented in these mobile health applications and map them against the Wheel of Sukr (WoS) Framework.

This investigation focused on the top 10 most downloaded mHealth applications, identified using keywords such as "health," "gamified mobile health," "mHealth," and "health fitness." Each application was downloaded and meticulously analyzed to identify the gamification features that effectively engage users. The focus on these top-ranking applications was based on their demonstrated ability to sustain user attention over extended periods, signifying successful engagement strategies.

The findings were systematically recorded, with the names of the applications ranked by popularity and the corresponding gamification elements based on the WoS framework presented in a table. For each application, a tick mark was used to indicate the presence of specific gamification elements from the WoS framework, providing a clear and structured comparison of the features utilized by the selected mHealth apps. Table 4.1 presents the findings of the preliminary study.

Table 4.1
Findings of Preliminary Study

Application / Element																													
My Sejahtera	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	1	1	1	1	0	0	0	8	31
FlowPeriod & Ovulation Tracker	0	0	0	0	0	1	0	1	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	17	65
Period Tracker	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	19	73
HUAWEI Health	1	0	1	1	0		1	0	0	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1	0	0	14	54
Strava: Run, Ride & Swim	1	0	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	1	0	0	0	20	77
Alpha Face: Facial Exercises	0	1	1	0	0	1	1	0	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1	0	0	1	15	58
MyFitnessPal	0	0	1	0	0	1	1	1	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	0	1	0	17	65
FitnessCoach and Diet: FitCoach	0	0	1	0	0	1	1	0	0	0	1	0	1	1	0	1	1	1	1	1	1	1	1	0	0	1	15	58
Mi Fitness	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	1	0	1	1	1	0	0	0	8	31
Mood Balance: Daily Tracker	0	0	1	0	0	1	1	0	0	1	0	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	15	58

Total Score	2	1	6	2	1	7	6	4	2	5	5	2	7	9	3	7	10	10	9	9	10	10	10	3	3	5
Total Score (%)																										
Highest Element			/			/	/			/	/		/	/		/	/	/	/	/	/	/	/			/

According to Table 4.1, the most common gamification elements in mobile health apps are profile creation, feedback systems, logbooks, trend alerts, and data visualization. These features are key in sustaining engagement, motivating users to interact with the app, and supporting their daily health tracking (Al Marshedi et al., 2015). Among the top 10 apps, *Strava: Run, Ride & Swim* shows the most comprehensive use of gamification based on the WoS framework, integrating badges, challenges, leaderboards, social communities, and real-time tracking through smartwatch syncing (Xu et al.,2022; Couture, 2020).

However, points and badges,common motivators in digital platforms,are less used in top health apps. Only *Alpha Face: Facial Exercises* includes a points system, while badges appear in *HUAWEI Health* and *Strava*. Points provide immediate feedback and a sense of achievement (Lieder et al., 2024), while badges reward milestones and foster competition (Wyrobek et al., 2024). Virtual rewards, such as unlocking features or trophies, are also limited, appearing in just two apps despite their potential to boost motivation and user satisfaction (Qiao et al., 2024; Tizuka et al. 2020).

Overall, the most widely adopted elements include challenges, progress tracking, levels, peer support, sharing, notifications, reminders, autonomy, profile, feedback, goals, information tools, logbooks, trend alerts, data visualization, and virtual agents where each scoring above 50% usage. Less common elements were reviewed against the literature and excluded if unnecessary, ensuring the GMHealth Framework focuses on impactful features. Importantly, nearly 60% of the identified elements align with the Wheel of Sukr, confirming its relevance and validity as the foundation for GMHealth development.

4.3 Findings of Phase 2: Framework Development

Phase 2 Framework Development encompasses two findings: *Face Validation* and *Content Validation.* Face validity of the instrument was evaluated to provide an overall impression and assess the accuracy of the items in describing specific test components (Bornstein et al., 1994) and subjective aspects (Elangovan & Sundaravel, 2021). It involves determining the clarity and purpose of a construct used for evaluation. According to Oluwatayo, (2012), face validity can be established by involving experts in the relevant field or individuals without psychometric expertise who assess the instrument's appropriateness for its intended purpose quantitatively. This process is a critical step in documenting validity procedures. Thus, by establishing face validity, the GMHealth instrument gains credibility and acceptance, confirming that the items are well-aligned with the instrument's objectives and are understandable to both users and stakeholders. This step is essential for enhancing the instrument's reliability and usability in measuring health-related outcomes.

The next is validation through content validity. Content validity involves evaluating whether the items in the GMHealth instrument are relevant, accurate, and appropriately worded. This study asked experts to complete a questionnaire to assess the instrument independently. Each item was rated using a four-point scale to measure two aspects: Relevance (1 = not relevant, 2 = needs revision, 3 = relevant but requires minor revision, 4 = very relevant) and Clarity (1 = not clear, 2 = needs revision, 3 = clear but requires minor revision, 4 = very clear) (Lynn, 1986; Zain et al. 2022). This process ensures the GM Health instrument's content aligns with its intended purpose. The findings from each phase have been systematically tabulated, providing clear, quantitative and qualitative evidence of the overall GMHealth instrument, including each theme and item.

4.3.1 Face Validation Findings

The final phase of this study is documentation, where the entire task will be accumulated in a final report. The final report systematically outlines each progress stage's research methodology and procedures.

Regarding face validity, Oluwatayo,(2012) outlined five key criteria that must be met in research. As shown in Table 4.2, all the experts unanimously agreed with the

first criterion: *Correct and appropriate grammar*. This emphasized the need for sentences in the GMHealth framework to be written in the present tense. Additionally, none of the instruments within the GMHealth framework were found to contain any grammatical errors, further supporting the validity and professionalism of the instrument's language.

Next, under the Adjusted use of appropriate language criterion, both experts agreed that all GMHealth instruments utilize proper English, ensuring clarity and comprehension before being distributed to the target audience. The experts also confirmed that the GMHealth questionnaire adheres to the criterion of *Correct Spelling*, noting that there were no typographical errors or confusing sentences that would require further clarification. Additionally, in the *Correct sentence structure* category, both experts strongly agreed that the sentence structures used in the GMHealth questionnaire were accurate, clear, and well-constructed, contributing to the overall professionalism and readability of the instrument.

Furthermore, the experts strongly agreed that all 36 questions in the GMHealth instrument were presented using an appropriate font style and size. Specifically, the instrument uses the *Verdana* font, with size 12 for the main body text, size 14 for subheadings, and size 16 for headings, ensuring clear readability. In addition, both experts confirmed that the formatting applied in the instrument was correct and did not require any adjustments or corrections. Lastly, when evaluating the overall content of the GMHealth instrument, both experts agreed that the material was appropriate and aligned with the tool's intended purpose.

In conclusion, both experts achieved a perfect score, with a unanimous agreement (seven out of seven) on all criteria for face validity. The agreement percentage and average percentage agreement also recorded a 100% result. This confirms that the GMHealth instrument has been exceptionally well-designed and is fully comprehensible to the intended audience. Table 4.2 shows the criteria that were evaluated based on results from the two experts.

Table 4.2
Result for Face Validation

No.	Evaluation Criteria	Expert 1	Expert 2
1	Use of correct and appropriate grammar	/	/
2	Adjusted use of appropriate language	/	/
3	Use of correct spelling	/	/
4	Correct sentence structure	/	/
5	Appropriate writing size	/	/
6	Appropriate format	/	/
7	Appropriate content	/	/
8	Total of Agreement	7/7	7/7
	Percentage of Agreement	100%	100%
	Average Percentage of Agreement	100%	

4.3.2 Content Validity Findings

Content validity refers to the degree to which the items or components of an instrument adequately represent the construct or domain that it is intended to measure. In other words, it assesses whether the content of a tool, questionnaire, or framework is relevant, comprehensive, and appropriate for capturing the concept under investigation. (Patel & Desai, 2020). Experts in the relevant field review the instrument to determine whether the items are clear, representative, and aligned with the study's objectives. This process ensures that important aspects of the construct are covered while excluding irrelevant or overlapping elements (Lynn, 1986; Zain et al., 2022).

4.3.2.1 Content Validity's Expert

A total of 22 experts participated in this study to evaluate the content validity of the GMHealth Framework, representing a broad range of professional backgrounds across academia, healthcare practice, and industry. The academic experts brought substantial experience in Mixed Reality, Mobile Application Development, Instructional Design, Multimedia Learning, Bioinformatics, Game Design, Machine Learning, Android Applications, Human-Computer Interaction (HCI), and Medical Laboratory Technology, with experience ranging from 5 to 20 years. Meanwhile, Health practitioners contributed clinical expertise from Emergency and Trauma services,

Nursing, Public Health, Family Medicine, and general medical practice, with 2 to 20 years of professional experience. Next, industry experts further enhanced the evaluation by providing applied perspectives in Information Technology, UX Design, Mobile and Web Development, Graphic Design, and ICT Governance, with 4 to 15 years of experience. This multidisciplinary panel ensured a comprehensive and rigorous assessment of the GMHealth Framework's content validity, strengthening its relevance, clarity, and applicability for gamified mobile health design.Table 4.3 show the details of the Expert's demography.

Table 4.3
Expert's Demographic

Expert ID	**Category of Expert**	**Area of Expertise**	**Year of Experience**	**Designation**
Expert 1	Academicians	Mixed Reality, Mobile Application, Image Recognition	**6**	Senior Lecturer
Expert 2	Academicians	Instructional Design, Multimedia Learning	**20**	IT Teacher
Expert 3	Health Practitioner	Emergency and Trauma Department	**3**	Medical Assistant
Expert 4	Academicians	Bioinformatics / Big data analytics	**17**	Senior Lecturer
Expert 5	Academicians	Game design	**17**	Ts. Dr.
Expert 6	Health Practitioner	Nursing	**2**	Nursing
Expert 7	Health Practitioner	Medical	**8**	Resident Doctor
Expert 8	Health Practitioner	Family Medicine Specialist	**15**	Medical Officer
Expert 9	Health Practitioner	Putrajaya	**20**	Community Nurse
Expert 10	Academicians	Medical	**10**	Academcians
Expert 11	Health Practitioner	Public health	**2**	Public health Physician
Expert 12	Academicians	Machine Learning, Android Application	**20**	Senior Lecturer
Expert 13	Industry	Information Technology	**5**	IT Resident Engineer
Expert 14	Industry	Graphic Design	**4**	Graphic designer
Expert 15	Industry	UX Design & Operational ICT Strategic Governance	**8**	Mobile Developer
Expert 16	Industry	Information Technology	**15**	Information Technology Officer
Expert 17	Industry	Mobile Developer	**4**	Executive

Expert 18	Academicians	HCI	**20**	Senior Lecturer
Expert 19	Academicians	Medical Laboratory Technology	5	Lecturer
Expert 20	Industry	Web and Mobile development	5	Software Engineer
Expert 21	Industry	Infomation Technology	4	Business Analyst
Expert 22	Industry	Front-End Development	5	Application developer

The initial draft of the GMHealth Framework was sent to the experts for their opinions, suggestions, and comments on all the instruments of the GMHealth, including the theme, operational definitions, criteria, and elements. The experts need to rate and evaluate the instrument on a four-point rating scale of each item, which is for Relevant elements (1 = not relevant, 2 = item needs some revision, 3= relevant but needs some minor revision, 4 = very relevant) and for Clarity (1= not clear, 2= item needs some revision, 3= clear but needs some minor revision, and 4= very clear) (Zain et al., 2022; Zamanzadeh et al., 2015). In this expert validation, 22 experts agreed to participate in validating the GMHealth instrument.

After that, all the data and evaluation of the expert will be calculated using this formula to ensure the validity of each content. The formula for the expert's evaluation is shown in Table 4.4.

Table 4.4
The formula for content validity

Item	Formula
N	Total number of experts
Ne	Number of experts agreeing on a rating of 3 or 4
Content Validity Ratio (CVR)	*N* *N*
Content Validity (CVI)	= (-)
Item-content validity for individual items (I-CVI)	= (number of experts providing a rating of 3 or 4) / (number of experts)
Scale-level content validity index based on the average method (S-CVI/Av)	= (sum of I-CVI scores) / (number of Items)
Probability of chance agreement (Pc)	-[*m* **1*0.5"**
Kappa(K)	(I-CVI-Pc) / (I-Pc)

Source : (Zain et al.,2022)

The Lawshe Table is a widely used statistical method for evaluating the content validity of items in an instrument or test, ensuring that each item aligns with the measured construct (Lawshe, 1975). Developed by C. H. Lawshe in 1975, this method employs the Content Validity Ratio (CVR) to determine the degree to which experts consider an item essential. Experts independently assess each item, categorizing it as "essential," "useful but not essential," or "not necessary". The CVR for each item is calculated using the formula:

$$_{CV}R = (JVe-f)/(f) \quad (4.1)$$

Where *Ne* is the number of experts rating the item as essential, and *N* is the total number of experts. The resulting CVR value ranges from -1 (no experts find the item essential) to +1 (all experts find the item essential), with zero indicating that half the experts consider the item essential.

The Lawshe Table provides critical CVR values that vary based on the number of experts involved. For an item to be deemed valid, its CVR must meet or exceed the threshold critical value corresponding to the number of experts. For instance, with five experts, the critical CVR value is 0.99, while for 10 experts, it is 0.62. Items failing to meet the threshold are flagged for revision or removal, as they lack sufficient relevance to the construct (Lawshe, 1975).

This method systematically quantifies expert consensus, ensuring the inclusion of only the most relevant and essential items in the instrument. By focusing on content validity, the Lawshe Table enhances the quality, reliability, and applicability of measurement tools in the GMHealth framework and instruments. Table 4.5 shows Lawshe's Table value, which was used to calculate the validity of the GMHealth instrument.

Table 4.5
The Lawshe table for minimum values of CVR

No of expert	5	6	7	8	9	10	11	12	13	14	15	20
Min Value	0.99	0.99	0.99	0.75	0.78	0.62	0.59	0.56	0.54	0.51	0.49	0.42

Source : (Lawshe, 1975)

4.3.2.2 Theme Relevancy

Relevance is a critical component of content validity, ensuring that each item within an assessment instrument accurately reflects the construct it aims to measure. The degree to which an instrument's content is pertinent and representative of the targeted construct determines its content validity (Yusoff, 2019; Zamanzadeh et al., 2015). Content validity is essential and closely linked to reliability in the GM Health instrument development process. Establishing content validity involves evaluating whether the items are directly relevant to the measured underlying concept. Ensuring relevance in content validity provides reliable and meaningful results of the GMHealth instruments. Table 4.6 shows the elements of the GMHealth framework presented as code for the following findings.

Table 4.6
Code of each element

Code	Elements
SRI	Avatar
SR2	Profile
SR3	Autonomy
11	Feedback
12	Goals
13	Library/Information tools
SI	Community
S2	Social Media
S3	Peer-Support
El	Leaderboards
E2	Progress
E3	Level
EJ1	Badges
EJ2	Challenge
EJ3	Points
Gl	Virtual Coaches
G2	Chatbox
G3	Virtual Agents
SMI	Logbook
SM2	Trend Alert
SM3	Visualization of Data
CI	Story/Theme
C2	Notification
C3	Reminder

a) Self-Representation Theme

Table 4.7 presents the findings regarding the content validity of the Self-Representation theme. According to the expert panel, the elements SRI, SR2, and SR3 demonstrated excellent validity and were highly relevant, with I-CVI values ranging from 0.9 to 1.00. The S-CVI value for the self-representation theme is 0.97, further indicating an outstanding level of validity. All experts unanimously agreed that SRI and SR2 exhibited excellent validity and were highly relevant, achieving an I-CVI of 1.00. SR3 also received strong validity ratings, with an I-CVI of 0.9. Consequently, all items within the Self-Representation theme were retained based on the experts' evaluations and the score values.

Table 4.7
Content validity of the *Self-Representation* theme

Code	N	*N*[e]	*CVR*[a]	/ - *CVI*[b]	*PC*[C]	*Kappa*[d]	*Evaluation*[6]
SRI	**22**	22	1	1	0.000000238	1	****
SR2	**22**	22	1	1	0.000000238	1	****
SR3	**22**	20	0.81	0.9	0.00005507	0.9	****
						SCVI/Av	0.97

Content Validity Ratio (CVR) = (Ne- -)/(-)

Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts

[c] *Probability of chance occurrence (PC)= [————-] * 0. 5*

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

b) Improvement Theme

Table 4.8 shows that all items within the *Improvement* theme were deemed highly relevant, reflecting excellent validity, with Kappa value scores ranging from 0.90 to 1.00. Additionally, the S-CVI for this theme achieved an exceptional value of 0.99, indicating overall strong validity. The expert panel unanimously agreed that items II and 12 were particularly relevant, each receiving perfect scores 1.00 across CVR, I-CVI and Kappa value. As a result, none of the three items required any modifications or revisions.

Table 4.8
Content validity of the *Improvement* theme

Code	N	N^e	CVR^a	/ - CVI^b	PC^C	$Kappa^d$	$Evaluation^6$
11	**22**	22	1	1	0.000000238	1	****
12	**22**	22	1	1	0.000000238	1	****
13	**22**	21	0.91	0.9	0.00005507	0.9	****
						SCVI/Av	0.99

Content Validity Ratio (CVR) = (Ne- -)/(-)

Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts

[c] *Probability of chance occurrence (PC)= [————-] * 0. 5*

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

c) Socializing Theme

Table 4.9 indicates that all items within the *Socializing* theme, specifically SI, S2, and S3, were considered highly relevant and demonstrated excellent validity. Both the I-CVI and Kappa values for these items exceeded 0.90. The S-CVI/Av for the socializing theme was 0.93, reflecting strong overall content validity. Based on the expert ratings and the corresponding score values, all items within the socializing theme were retained without needing modifications.

Table 4.9
Content validity of the *Socializing* theme

Code	N	***N[e]***	***CVR[a]***	***/ - CVI[b]***	***PC[C]***	***Kappa[d]***	***Evaluation[6]***
SI	22	21	0.91	0.95	0.000005245	0.95	****
S2	22	20	0.81	0.9	0.00005507	0.9	****
S3	22	21	0.91	0.95=	0.000005245	0.95	****
						SCVI/Av	0.93

[a] ***Content Validity Ratio (CVR) = (Ne -|)/(|)***

Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts

[c] *Probability of chance occurrence (PC)=['] * 0. 5^*

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 and Kappa>0.74 (****); good validity=I-CVKO. 78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVI<0.4 and Kappa <0.40 (*)*

d) Esteem Theme

Table 4.10 illustrates that the Esteem theme was evaluated as excellent, with all elements E1, E2, and E3 achieving I-CVI values above 0.90. None of the elements in the Esteem theme was rated below 0.90 in terms of Kappa values, indicating strong agreement among the experts. As a result, none of the three items required any revisions or elimination. The S-CVI/Av for the Esteem theme also demonstrated excellent content validity, with a score of 0.95. Consequently, all items within the esteem theme were retained in the framework based on these high ratings.

Table 4.10
Content validity of the *Esteem* theme

Code	N	***N[e]***	***CVR[a]***	***I - CVI[b]***	***PC[C]***	***Kappa[d]***	***Evaluation[6]***
E1	22	21	0.91	0.95	0.000005245	0.95	****
E2	22	21	0.91	0.95	0.000005245	0.95	****
E3	22	21	0.91	0.95	0.000005245	0.95	****
						SCVI/Av	0.95

[a] ***Content Validity Ratio {CVR)=(Ne-^/§***

[b] *Content validity for the individual item (I-CVI) = number of experts providing a*

rating of 3 or 4 /number of experts

[c] *Probability of chance occurrence (PC)=['] * 0. 5^*

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 and Kappa>0.74 (****); good validity=I-CVKO. 78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVI<0.4 and Kappa <0.40 (*)*

e) Enjoyment Theme

Table 4.11 reveals that the elements within the Enjoyment theme, specifically EJ2, EJ3, and EJ4, were deemed highly relevant and exhibited excellent validity, with both I-CVI and Kappa values achieving perfect scores of 1.00. EJl was also rated excellent, with an I-CVI and Kappa value of 0.95. The S-CVI for the enjoyment theme was 0.99, indicating nearly perfect content validity. Consequently, no items within the enjoyment theme required revision or elimination based on the expert evaluations.

Table 4.11
Content validity of the *Enjoyment* **theme**

Code	*N*	*N*[e]	*CVR*[a]	/ - *CVI*[b]	*PC*[C]	*Kappa*[d]	*Evaluation*[6]
EJl	**22**	21	**0.91**	0.95	0.000005245	0.95	****
EJ2	**22**	22	**1**	**1**	0.000000238	1	****
EJ3	**22**	22	**1**	**1**	0.000000238	1	****
EJ4	**22**	22	**1**	**1**	0.000000238	1	****
						SCWAv	**0.99**

[a] ***Content Validity Ratio (CVR)*** *= (Ne* -1)/(|)

[b] *Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts*

[c] *Probability of chance occurrence (PC)=['] * 0. 5^*

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 and Kappa>0.74 (****); good validity=I-CVK0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVI<0.4 and Kappa <0.40 (*)*

f) Guidance Theme

Table 4.12 presents the findings on the content validity of the *Guidance* theme. The expert panel unanimously agreed that item Gl demonstrated outstanding validity, receiving perfect scores 1.00 for both the I-CVI and Kappa values. Similarly, items G2 and G3 were also rated as having excellent content validity, with both I-CVI and Kappa values exceeding 0.90. The guidance theme achieved a strong S-CVI/Av value of 0.97, reflecting robust content validity. As a result, none of the items within the *Guidance* theme required any revisions or modifications.

Table 4.12
Content validity of the *Guidance* theme

Code	*N*	*N*[e]	*CVR*[a]	/ - *CVI*[b]	*PC*[C]	*Kappa*[d]	*Evaluation"*
Gl	22	22	1	1	0.000000238	1	****
G2	22	21	0.91	0.95	0.000005245	0.95	****
G3	22	21	0.91	0.95	0.000005245	0.95	****
						SCWAv	0.97

[a] ***Content Validity Ratio (CVR)*** = *(Ne* -|)/(|)

Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts

[c] *Probability of chance occurrence (PC)=['] * 0. 5^*

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 and Kappa>0.74 (****); good validity=I-CVK0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVI<0.4 and Kappa <0.40 (*)*

g) **Self-Monitoring Theme**

Table 4.13 presents the items within the *Self-Monitoring* theme, specifically SMI, SM2, and SM3. Most experts agreed that SM3 is an excellent element, with I-CVI and Kappa values nearing a perfect score of 1.00. The S-CVI/Av for the self-monitoring theme also reflects strong content validity, with a value of 0.97. Element SMI received I-CVI and Kappa scores of 0.9, while SM2 scored 0.95 in both metrics, which fall within the excellent range. As a result, no modifications or revisions were needed for any of the three items in the *Self-Monitoring* theme.

Table 4.13
Content validity of the *Self-Monitoring* theme

Code	*N*	*Ne*	*CVRa*	/ - *CVIb*	*PCC*	*Kappad*	*Evaluation"*
SMI	**22**	**20**	0.81	**0.9**	0.00005507	0.9	****
SM2	**22**	**21**	0.91	0.95	0.000005245	0.95	****
SM3	**22**	**22**	1	**1**	0.000000238	1	****
						SCWAv	0.97

Content Validity Ratio (CVR) = (Ne- -)/(-)

Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts

[c] *Probability of chance occurrence (PC)*= [————] * 0. 5

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

h) Continuous Theme

Table 4.14 highlights the content validity of the *Continuous* theme, with elements CI and C2 achieving perfect scores of 1.00 for I-CVI and Kappa, indicating excellent validity. Notably, none of the elements within the continuous theme were rated below 0.90 for either I-CVI or Kappa values, including element C3, which received a strong score of 0.95 for both I-CVI and Kappa values. The S-CVI/Av for the *Continuous* theme was also impressive, with a nearly perfect score of 0.98, reflecting excellent overall content validity. Consequently, all items within the *Continuous* theme are deemed acceptable and require no further revisions.

Table 4.14
Content validity of the *Continuous* theme

Code	*N*	*Ne*	*CVRa*	*I - CVIb*	*PCC*	*Kappad*	*Evaluation*[6]
CI	22	22	1	1	0.000000238	1	****
C2	22	22	1	1	0.000000238	1	****
C3	22	21	0.91	0.95	0.000005245	0.95	****
						SCWAv	0.98

[a] *Content Validity Ratio (CVR) = (Ne- -)/(-)*

[b] *Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4/number of experts*

Probability of chance occurrence (PC)= [$\frac{m}{Ne\{N-A)}$ **-1 * 0. 5"**

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

Based on the content validity calculations for all themes in the GMHealth Framework, all eight themes remain constant without any eliminations from the framework.

4.3.2.3 Item Relevancy and Clarity

The items of the GMHealth instruments are being evaluated through the relevance and clarity of each item under different elements. All the items with the code are tabulated in Table 4.15.

Table 4.15
Code for each element and theme

Theme	Element	Criteria
Self-Representation	Avatar	AVI: I have the freedom to choose how I represent myself
	Profile	**PR1**:1 can personalize my profile based on my interests
	Autonomy	AU1: Gamified applications with options catch my attention.
Improvement	Feedback	**FBI:** The application provided me with instant feedback on my progress. **FB2:** The application provided me with information on my status, such as my score and level.
	Goals	**GL1:**1 was able to set my own goals freely.

	Library/Information tools box	**LI1**: I was able to understand the content presented in the application. **LI2:** The information presented in the application increased my knowledge **LI3:** The gamified application motivated me to share knowledge about health.
Socializing	Community	**CM1:** I am able to share my health progress with other members. **CM2:** I enjoy supporting each other in gamified applications.
	Social Media	**SOM1:** My motivation increases when I share my achievements. **SOM2:** I can link my gamified application with my social media platform.
	Peer-Support	**PS1:** I appreciate receiving real-time feedback while communicating with the community. **PS2**: I feel involved while using gamified application **PS3:** I am comfortable sharing my opinions with others.
Esteem	Leaderboards	**LB1:** I am able to keep track of my rank in the gamified application, **LB2:** I am able to monitor my progress easily. **LB3:** I am able to keep track of my accomplishments within the gamified application.
	Progress	**PG1:** The application provides clear progress indicators, allowing me to know my position immediately.
	Level	**LV1:** I am able to understand what is expected of me in the next stage.
Enjoyment	Badges	**BG1:** I find this gamified application enjoyable to use without getting bored.
	Challenge	**CH1:** The challenges provided are moderate in difficulty, making them neither too easy nor too difficult. **CH2:** The gamified application provides audio/visual indicators to help me complete the challenges.

	Points	**PT1:** I prefer gamified mobile health applications that have enjoyable features.
Guidance	Virtual Coaches	**VCl:** I am motivated by the presence of virtual coaches. .
		VC2: The virtual coaches were very helpful
	Chatbox	CB1: I received real-time support from the virtual coaches
	Virtual Agents	**VA1:**1 feel a sense of guidance
Self-Monitoring	Logbook	**LG1:** I can easily log my daily progress in Gamified Mobile Health applications.
	Trend Alert	**TA1:** I can effortlessly track my health condition.
	Visualization of Data	**VDl:** I am able to understand my health condition through clear data visualisation.
Continuous	Story/Theme	**STl:** The interface of the gamified application captures my attention.
		ST2: I find myself becoming more immersed in the gamified health application
	Notifications	**NT1:** The notifications increase my awareness.
	Reminder	**RM1:** The gamified mobile application's positive reminders motivate me to improve.

a) ***Item Relevancy***

i) Self-Representation

Table 4.16 presents the findings on the relevance of the *self-representation* items. The expert review panel rated items for Avatar, Profile and Autonomy as having excellent validity, with each item being considered highly relevant based on their I-CVI scores. Additionally, regarding relevancy, the S-CVI for the Self-Representation items mostly achieved a perfect score of 1. The average CVR for items AVI, PR1, and AU1 also indicated maximum relevance, with a flawless score of 1. Therefore, all items were deemed relevant and acceptable by the expert panel

Table 4.16
Relevancy *of the Avatar, Profile* and *Autonomy* items

Code	N	*N*[e]	*CVR*[a]	/ - *CVI*[b]	*PC*[C]	*Kappa*[d]	*Evaluatloj*
Avatar							
AVI	22	22	1	1	0.000000238	1	****
						S-CVI/AV	1
Profile							
PR1	22	22	1	1	0.000000238	1	****
						S-CVI/AV	1
Autonomy							
AU1	22	22	1	1	0.000000238	1	****
						S-CVI/AV	1

[a] ***Content Validity Ratio (CVR)*** = *(Ne- -)/(-)*

Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts

[c] *Probability of chance occurrence*

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

ii) Improvement

All items under the improvement theme in Table 4.17 are considered highly relevant, demonstrating excellent validity with I-CVI and Kappa values exceeding 0.80, with the highest value being 1.00. The S-CVI for the improvement items for both elements stands at 0.98, reflecting outstanding content validity. The seven items' CVR values were also highly relevant, ranging from 0.90 to 1.00. All items in the improvement theme are considered relevant and require no elimination.

Table 4.17
Relevancy of the *Feedback, Goal* and *Library/Information Tools* items

Code	*N*	*N*[e]	*CVR*[a]	*icvi*[b]	*PC*[C]	*Kappa*[d]	*Evaluation*[6]
Feedback							
FBI	22	21	0.91	0.95	0.000005245	0.95	****
FB2	22	21	0.91	0.95	0.000005245	0.95	****
						S-CVI/AV	0.95
Goal							
GL1	22	22	1	1	0.000005245	1	****
						S-CVI/AV	1
Library/Information Tools							
LI1	22	21	0.91	0.95	0.000005245	0.95	****
LI2	22	22	1	1	0.000000238	1	****
LI3	22	22	1	1	0.000000238	1	****
						S-CVI/AV	0.98

[a] *Content Validity Ratio (CVR) = (Ne- -)/(-)*

[b] *Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts*

[c] *Probability of chance occurrence (PC)=* $\frac{m}{-1} * 0.5$"

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

iii) Socializing

According to Table 4.18, all items under the socializing theme were rated highly relevant, indicating excellent validity. The I-CVI values for each item, from CM1,CM2,S0M1,S0M2,PS1,PS2 and PS3, received perfect scores,which is 1. All experts unanimously agreed on the relevance of these items, each achieving a Kappa value of 1.00. The S-CVI/Av for the socializing items also scored a perfect 1.00, demonstrating outstanding content validity for each element from Community, Social Media and Peer Support. As a result, none of the seven items from the Socializing theme required any modification or revision.

Table 4.18
Relevancy of the *Community, Social Media* and *Peer-Support* items.

Socializing							
Code	*N*	*N*[e]	*CVR*[a]	/ - *CVI*[b]	***PC***[C]	*Kappa*[d]	*Evaluation*[6]
Community							
CM1	22	22	1	1	0.00000238	1	****
CM2	22	22	1	1	0.00000238	1	****
						S-CVI/AV	**1**
Social Media							
SOM1	22	22	1	1	0.00000238	1	****
SOM2	22	22	1	1	0.00000238	1	****
						S-CVI/AV	**1**
Peer-Support							
PS1	22	22	1	1	0.00000238	1	****
PS2	22	22	1	1	0.00000238	1	****
PS3	22	22	1	1	0.00000238	1	****
						S-CVI/AV	**1**

[a] ***Content Validity Ratio (CVR)*** = *(Ne- -)/(-)*

[b] *Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts*

Probability of chance occurrence (PC)= f$\frac{}{Ne\backslash(N\text{-}A)l}$**-1 * 0. 5"**

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

iv) Esteem

Based on Table 4.19, all items in the Esteem theme were rated as highly relevant, with I-CVI values exceeding 0.90 from LBl to LB3 items, including PGl and LV1. The experts unanimously agreed that items LBl, LB2, LB3, PGl, and LV1 demonstrated exceptional relevance, each receiving a perfect Kappa value 1.00. The S-CVI/Av for the Esteem items also indicated excellent content validity, with a perfect score of 1.00 for Leaderboard, Progress and Level items. In summary, the items in the Esteem theme are considered highly relevant and require no revisions.

Table 4.19
Relevancy of the *Leaderboard*, *Progress* and *Level* items

			Esteem				
Code	*N*	*N*[e]	*CVR*[a]	*I - CVI*[b]	*PC*[C]	*Kappa*[d]	*Evaluation*[6]
Leaderboard							
LBl	22	22	1	1	0.000000238	1	
LB2	22	22	1	1	0.000000238	1	
LB3	22	22	1	1	0.000000238	1	
						S-CWAV	1
Progress							
PGl	22	22	1	1	0.000000238	1	****
						S-CWAV	1
Level							
LV1	22	22	1	1	0.000000238	1	****
						S-CWAV	1

[a] ***Content Validity Ratio (CVR)*** = *(Ne- -)/(-)*

[b] *Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts*

Probability of chance occurrence (PC)= $f_{\overline{Ne\backslash(N-A)l}}$ **-1 * 0. 5"**

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

v) Enjoyment

According to Table 4.20, all items in the Enjoyment theme were rated as relevant, with Kappa values ranging from 0.90 to 1.00, reflecting excellent validity. Additionally, the S-CVI/Av for the Enjoyment items showed an outstanding score from 0.90 to 0.95, where Badges- 0.90, Challenges- 0.98 and Point- 0.95. All experts agreed that item CH2 had exceptional relevance, achieving perfect scores for both I-CVI and Kappa values (1.00). As a result, no items or elements in the enjoyment theme required any changes and were considered relevant.

Table 4.20
Relevancy *of the Badges, Challenge* and *Point items*

Enjoyment							
Code	N	*N*[e]	*CVR*[a]	*I - CVI*[b]	*PC*[C]	*Kappa*[d]	*Evaluation*[6]
Badges							
BGl	22	20	0.81	0.90	0.00005507	0.90	****
						S-CVI/AV	0.90
Challenge							
CHI	22	21	0.91	0.95	0.000005245	0.95	
CH2	22	22	1	1	0.000000238	1	
						S-CVI/AV	0.98
Point							
PTl	22	21	0.91	0.95	0.000005245	0.95	****
						S-CVI/AV	0.95

[a] ***Content Validity Ratio (CVR) =(Ne- p/(p***

[b] *Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts*

[c] *Probability of chance occurrence (PC)= [-* ***M*** *-] * 0. B*[N]

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 and Kappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity=I-CVI<0.4 and Kappa <0.40 (*)*

vi) Guidance

According to Table 4.21, all items in the guidance theme, from VC1, VC2, CBl and VAl, were rated as highly relevant, each receiving perfect scores for both I-CVI and Kappa values, indicating excellent validity with a score of 1.00. The S-CVI/Av for the guidance items for each element was also a perfect 1.00, demonstrating outstanding content validity. Therefore, all items in the guidance theme are considered highly relevant and flawless.

Table 4.21
Relevancy of the *Virtual Coaches, Chatbox* and *Virtual Agents* items

Guidance							
Code	*N*	*N*[e]	*CVR*[a]	*I - CVI*[b]	*PC*[C]	*Kappa*[d]	*Evaluation*[6]
Virtual							
Coaches	**22**	**22**		1	0.000000238	1	
VC1	**22**	**22**		1	0.000000238	1	
VC2							
						S-CVI/AV	
Chatbox							
CBl	**22**	**22**			0.000000238		
						S-CVI/AV	
Virtual							
Agents	**22**	**22**			0.000000238		
VAl							
						S-CVI/AV	

[a] ***Content Validity Ratio (CVR)*** = *(Ne- -)/(-)*

[b] *Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts*

Probability of chance occurrence (PC)= [- $_{Ne\backslash(N-A)V_{V}^{1}}$ **-1 * 0. 5"**

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

vii) Self-Monitoring

As stated in Table 4.22,the items of TA1 and VDl in the Self-Monitoring theme stated a perfect value for I-CVI and Kappa 1.00, representing excellent relevancy. However, the relevancy for LGl is still considered good relevancy with the value of I-CVI and Kappa,0.95. The Self-Monitoring theme items also have a good SCVI/Av value with a 0.98 score for Logbook, a perfect 1 for Trend Alert and Visualization of Data items. Hence, no modification or revision is needed for this theme.

Table 4.22
Relevancy of the *Logbook, Trend Alert* and *Visualization of Data* items

Self-Monitoring							
Code	*N*	*N*[e]	*CVR*[a]	/ - *CVI*[b]	*PC*[C]	*Kappa*[d]	*Evaluation*
Logbook							
LGl	22	21	0.91	0.95	0.000005245	0.95	****
						S-SCWAV	0.95
Trend Alert							
TA1	22	22	1	1	0.000000238	1	****
						S-SCWAV	1
Visualization of Data VDl	22	22	1	1	0.000000238	1	****
						SCVI/AV	1

[a] ***Content Validity Ratio (CVR)*** = *(Ne- -)/(-)*

Content validity for individual item (I-CVI) = number of experts providing a rating of 3 or 4 / number of experts

[c] *Probability of chance occurrence (PC)= {Ne"N_Ay\ * 0. 5"*

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

viii) Continuous

Based on Table 4.23, all items in the Continuous theme were measured as relevant and had good content validity, with I-CVI and Kappa values ranging from 0.90 to 1.00. All experts agree that STl, ST2, and NTl were very relevant, with CVR, I-CVI, and Kappa Values of 1.00. The reading for SCVI/Av for every element from Story/Theme, Notification and Reminders is considered excellent, with a range of 0.95 to 1.00. No modification or revision is needed for any item in the Continuous theme.

Table 4.23
Relevance of the *Story/Theme, Notification* and *Reminder* items

Continuous							
Code	*N*	*N*[e]	*CVR*[a]	*I-CVI*[b]	*PC*[C]	*Kappa*[d]	*Evaluation*[6]
Story/Theme							
STl	22	22	1	1	0.000000238	1	****
ST2	2	21	0.91	0.95	0.000005245	0.95	****
						S-SCWAV	0.98
Notification							
NTl	22	22	1	1	0.000000238	1	****
						S-SCWAV	1
Reminder							
RM1	22	21	0.91	0.95	0.000005245	0.95	****
						SCVI/AV	0.95

[a] *Content Validity Ratio (CVR) = (Ne- -)/(-)*

Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts

[c] *Probability of chance occurrence (PC)= {Ne"N_Ay\ * 0. 5"*

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

b) Item Clarity

i) Self-Representation

Based on Table 4.24, all experts agreed that the items in AVI, PRl, and AUl were exceptionally clear, with both the I-CVI and Kappa values achieving a perfect score of 1.00. The S-CVI/Av for the clarity of the Self-Representation items was also remarkable, with a perfect score of 1.00 for all items in Avatar, Profile and Autonomy, indicating exceptional clarity. Therefore, all items under the self-representation theme are considered very clear and do not require any revision or elimination.

Table 4.24
Clarity *of the Avatar, Profile* and *Autonomy* items

Code	*N*	*N*[e]	*CVR*[a]	/ - *CVI*[b]	*PC*[C]	*Kappa*[d]	*Evaluation"*
Avatar							
AVI	22	22	1	1	0.000000238	1	****
						S-CVI/AV	1
Profile PRl	22	22	1	1	0.000000238	1	****
						S-CVI/AV	1
Autonomy							
AUl	22	22	1	1	0.000000238	1	****
						S-CVI/AV	1

[a] *Content Validity Ratio (CVR) = (Ne- -)/(-)*

Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts

[c] *Probability of chance occurrence (PC)= l_{Ne}}"$_{N\_A)}$}]* * 0. 5"

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

ii) Improvement

Table 4.25 stated,all items in the Improvement theme were rated as very clear, demonstrating excellent validation, with the I-CVI and Kappa values for items FBI, FB2, GLl, LIl, LI2,and LI4 scoring 1.00. However, item LI3, while still considered very clear, received an I-CVI score of 0.95. All experts agreed that the items in the Improvement theme showed excellent clarity. The S-C VI/Av score for the Improvement items was a perfect 1 for Feedback and Goals items and 0.99 for the Library/Information Tools item, indicating strong validity. Therefore, no revisions are needed for the Improvement items.

Table 4.25
Clarity of the *Feedback, Goal* and *Library/Information Tools* items

Code	*N*	*N*[e]	*CVR*[a]	/ - *CVl*[b]	*PC*[C]	*Kappa*[d]	*Evaluath*
Feedback							
FBI	22	22	1	1	0.000000238	1	****
FB2	22	22	1	1	0.000000238	1	****
						S-CWAV	1
Goal							
GLl	22	22	1	1	0.000000238		****
						S-CWAV	1
Library/Info rmation							
Tools	22	22	1	1	0.000000238	1	****
LIl	22	22	1	1	0.000000238	1	****
LI2	22	21	0.91	0.95	0.000005245	0.95	****
LB							
						S-CWAV	0.98

[a] *Content Validity Ratio (CVR) = (Ne- -)/(-)*

[b] *Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts*

Probability of chance occurrence (PC)= **-1 * 0. 5"**

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

iii) Socializing

According to Table 4.26, all 22 experts agreed that the items in the Socializing items, specifically CM1, S02, PS1, PS2, and PS3, demonstrated very clear and excellent validity, with CVR, I-CVI, and Kappa values of 1.00. For item CM2 and SOI, the Kappa value, though slightly lower at 0.95, was still considered a clear item. Additionally, the clarity of the Socializing items is further supported by the S-CVI/Av result of 0.98 for Community and Social Media and a perfect 1 for Peer-Support, indicating evident and strong validity.

Table 4.26
Clarity of the *Community*, *Social Media* and *Peer-Support* items

Socializing							
Code	*N*	*N*[e]	*CVR*[a]	/ - *CVI*[b]	*PC*[C]	*Kappa*[d]	*Evaluation*[6]
Community							
CM1	22	22	1	1	0.000000238	1	****
CM2	22	21	0.91	0.95	0.000005245	0.95	****
						S-CVI/AV	0.98
Social Media							
SOM1	22	21	0.91	0.95	0.000005245	0.95	****
SOM2	22	22	1	1	0.000000238	1	****
						S-CVI/AV	0.98
Peer-Support							
PS1	22	22	1	1	0.000000238	1	****
PS2	22	22	1	1	0.000000238	1	****
PS3	22	22	1	1	0.000000238	1	****
						S-CVI/Av	1

[a] ***Content Validity Ratio (CVR)*** *= (Ne- -)/(-)*

[b] *Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts*

[c] *Probability of chance occurrence (PC)= [—-* **-1 * 0. 5"**

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

iv) Esteem

Table 4.27 shows that the Esteem items were rated as excellent in clarity, with items LBl, LB2, LB3, PGl, and LVl scoring 1.00 for both I-CVI and Kappa values. None of the esteem items was rated below 0.90. Therefore, no modifications were needed for any of the six items, and they were considered very clear.

Table 4.27
Clarity *of the Leaderboard, Progress* and *Level* items

				Esteem			
Code	*N*	*N*[e]	*CVR*[a]	*I - CVI*[b]	*PC*[C]	*Kappa*[d]	*Evaluation*[6]
Leaderboard							
LBl	22	22	1	1	0.000000238	1	
LB2	22	22	1	1	0.000000238	1	
LB3	22	22	1	1	0.000000238	1	
						S-CWAV	0.99
Progress							
PGl	22	22	1	1	0.000000238	1	****
						S-CWAV	1
Level							
LVl	22	22	1	1	0.000000238	1	****
						S-CWAV	1

[a] ***Content Validity Ratio (CVR)*** = *(Ne- -)/(-)*

[b] *Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts*

Probability of chance occurrence (PC)= [- **-1 * 0. 5"**

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

v) Enjoyment

For the Enjoyment items in Table 4.28, the value of BGl was considered very clear in reading the I-CVI, and the Kappa Value scored a perfect one at 1.00. However, CHI, CH2 and PTl are still in an obvious category where the I-CVI and Kappa values still scored higher than 0.90, which is 0.95. Next, the Enjoyment items scored between 0.95 and 1.00 on SCVI/AV for Badges, Challenges and Point items, which indicates excellent validity and clarity of all items.

Table 4.28
Clarity *of the Badges, Challenge* and *Point items*

Enjoyment							
Code	*N*	*N*[e]	*CVR*[a]	/ - *CVI*[b]	*PC*[C]	*Kappa*[d]	*Evaluation*[6]
Badges							
BGl	22	22	1	1	0.000000238	1	****
						S-CWAV	1
Challenge							
CHI	22	21	0.91	0.95	0.000005245	0.95	****
CH2	22	21	0.91	0.95	0.000005245	0.95	****
						S-CWAV	0.95
Point							****
PTl	22	21	0.91	0.95	0.00000524		
						S-CWAV	0.95

[a] ***Content Validity Ratio (CVR)*** = *(Ne* - -)/(-)

[b] *Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts*

Probability of chance occurrence (PC)= [- **-1 * 0. 5"**

[d] *Kappa (K) = (I-CVI-Pc)/ (I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 and Kappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

vi) Guidance

In the Guidance theme in Table 4.29, all experts agreed on the clarity of the items, with the I-CVI and Kappa values for all items from VC1, VC2, CBl and VAl recording a perfect score of 1.00, indicating excellent clarity. The S-CVI/Av for the Guidance items from Virtual Coaches, Chatbox and Virtual Agents elements was 1.00, reflecting outstanding validity. As a result, all items in the Guidance theme are considered clear and do not require any revision.

Table 4.29
Clarity of the *Virtual Coaches, Chatbox* and *Virtual Agents* items

			Guidance				
Code	*N*	*N*[e]	*cvR*[a]	*i - cvr*	*PC*[C]	*Kappa*	*Evaluation*[6]
Virtual							
Coaches	**22**	**22**		1	0.000000238	1	
VC1	**22**	**22**		1	0.000000238	1	
VC2							
						S-CVI/AV	
Chatbox							
CBl	**22**	**22**			0.000000238		
						S-CVI/AV	
Virtual							
Agents	**22**	**22**			0.000000238		
VAl							
						S-CVI/AV	

[a] ***Content Validity Ratio (CVR)*** = *(Ne- -)/(-)*

[b] *Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts*

Probability of chance occurrence (PC)= [- $_{Ne\backslash(N-A)V_{V}^{1}}$ **-1 * 0. 5"**

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

vii) Self-Monitoring

According to Table 4.30, all experts agreed on the clarity of items TA1 and VD1, with I-CVI and Kappa values showing excellent validity at 1.00. Although LGl recorded a CVR value of 0.81, its I-CVI and Kappa values were still within the very clear range, indicating excellent validity with a score of 0.90. The S-CVI/Av for the Self-Monitoring items was measured at 0.90 for Logbook, a perfect 1.00 for Trend Alert and Visualization of Data, reflecting excellent overall clear validity. As a result, all items in the Self-Monitoring theme remain unchanged.

Table 4.30
Clarity of the *Logbook, Trend Alert* and *Visualization of Data* items

Self-Monitoring							
Code	*N*	*N*[e]	*CVR*[a]	/ - *CVI*[b]	*PC*[C]	*Kappa*[d]	*Evaluation*
Logbook							
LGl	22	21	0.81	0.90	0.000005507	0.90	****
						S-SCWAV	0.90
Trend Alert							
TA1	22	22	1	1	0.000000238	1	****
						S-SCWAV	1
Visualization of Data							
VD1	22	22	1	1	0.000000238	1	****
						SCWAV	1

[a] ***Content Validity Ratio (CVR)*** = *(Ne- -)/(-)*

Content validity for individual item (I-CVI) = number of experts providing a rating of 3 or 4 / number of experts

[c] *Probability of chance occurrence (PC)= {Ne"N_Ay\ * 0. 5"*

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

viii) Continuous

In terms of clarity in Table 4.31, all experts agreed that the items in the Continuous theme (ST1, ST2, NT1, RM1) demonstrated excellent validity, with both I-CVI and Kappa values scoring a perfect 1.00. No items in the continuous theme were rated below 0.90, confirming they are clear and well-validated. The S-CVI/Av for the Continuous items for every element also achieved a perfect score of 1.00. Therefore, all items in this theme are considered very clear, with no need for elimination or revisions.

Table 4.31
Clarity of the *Story/Theme*, *Notification* and *Reminder* items

			Continuous				
Code	*N*	*N*[e]	*cvR*[a]	*i - cvr*	*PC*[C]	*Kappa*[d]	*Evaluation*[6]
Story/Theme							
ST1	22	22	1	1	0.000000238	1	
ST2	22	22	1	1	0.00000023	1	
						S-SCWAV	1
Notification							
NT1	22	22	1	1	0.000000238	1	****
						S-SCWAV	1
Reminder							
RM1	22	22	1	1	0.000000238	1	****
						SCWAV	1

[a] *Content Validity Ratio (CVR) = (Ne- -)/(-)*

[b] *Content validity for the individual item (I-CVI) = number of experts providing a rating of 3 or 4 /number of experts*

Probability of chance occurrence (PC)= [- $_{Ne\backslash(N-A)V_{v}^{1}}$ **-1 * 0. 5"**

[d] *Kappa (K) = (I-CVI-Pc)/(I-Pc)*

[e] *Evaluation criteria for the level of content validity: the relationship between I-CVI and Kappa; excellent validity=I-CVI>0.78 andKappa>0.74 (****); good validity=I-CVI<0.78 and >0.60 and Kappa < 0.74 (***); fair validity = I-CVI <0.6 and >0.40 and Kappa <0.59 (**); and poor validity= I-CVK0.4 and Kappa <0.40 (*)*

4.4 Finalize Theme and Element of The GMHealth Framework

Following by expert content validation, the finalized GMHEALTH Framework consists of eight core themes and 26 elements, each designed to enhance and sustain user engagement within gamified mobile health applications. The framework incorporates the newly added Guidance theme alongside several refined elements to ensure a more comprehensive and user-centred design.

Self-Representation supports user identity and personalization through Avatars, Profiles, and Autonomy, while Self-Management provides essential tools for tracking and monitoring personal health data, such as Logbooks, Data Visualization, and Trend Alerts. To maintain continuous engagement, the Continuous theme integrates Storylines, Notifications, and Reminders.

User motivation is strengthened through Enjoyment, which applies gamified elements like Badges, Points, Challenges, and Virtual Rewards, and through Esteem, which offers recognition via Leaderboards, Progress indicators, and Levels. The newly introduced Guidance theme enhances engagement by providing automated, supportive interactions through Virtual Coaches, Chatboxes, and Virtual Agents. Socializing further promotes engagement by fostering community interaction through Social Media integration and Peer Support.

Lastly, the Improvement theme supports user learning and progression through Feedback, Goal Setting, and access to Information Resources, ensuring the framework holistically encourages sustained user engagement and positive behavioral change. Figure 4.1 shows the final look of the GMHealth Framework.

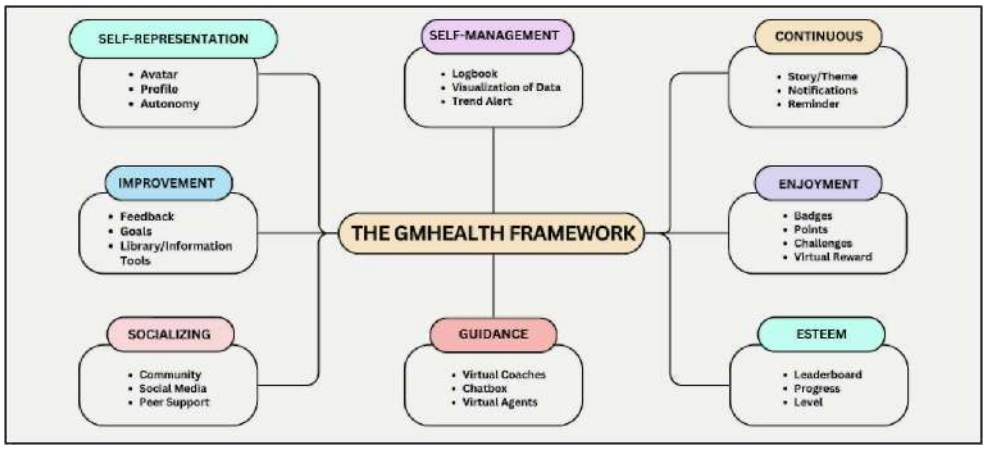


Figure 4.1 The Validated Gmhealth Framework

4.5 Experts' Recommendations and Suggestions

In the open-question section, a total of 22 experts participated in the study; however, only some of them provided recommendations and suggestions. These contributions offered valuable insights for enhancing the GMHealth instrument, with the aim of making the framework more acceptable, practical, and aligned with the needs of the mobile health (mHealth) domain. The code of ech expert can found at Table

One of the advice from the Expert 12 under the "Self-Representation" theme is, *"Profile is a must, to know basic demography and info about the patient as well as the apps. Avatar is very interesting, however, it needs to think about the size of the apps if the avatar is included. It is important because if the apps size is big, it will sometimes affect the memory of the smartphones and cause lagging to the phone, and user will decide to uninstall it. "* The expert is concerned that the larger app may require more storage, which could strain the smartphone's memory, leading to performance issues such as lagging. This could discourage users from using the GMHealth application, as they may choose to uninstall it if it negatively affects their performance. Therefore, the comments are specific suggestions for GMHealth products and the prototype.

The next theme is under the Improvements theme, with suggestions under the "goal" element. Expert 12 highlighted the need for clear guidance to help users or patients set their personal goals in alignment with the targeted mission of the application. This guidance would ensure that users establish meaningful and achievable objectives, making the app more effective in supporting their health journey.

Next, the biggest concern from the experts on the Socializing theme stated *"need to consider patient's privacy and willingness to share their experience or story. However, support or sharing experience from others can become good motivational support for the patient in managing their disease'"*, *"the need of socializing element depends on the aim of the mobile apps, if its related to disease monitoring, not everybody would like to share their disease progress via social media and get socialize with others"* and *"Personally, I prefer to not share my progress/data with others"*. It is a good suggestion and advice, since some m-health applications can be shared with social media and any online platform. It is essential to carefully consider the patient's privacy and comfort level when sharing personal experiences or stories. While some patients may be hesitant or unwilling to disclose sensitive information about their health, creating an environment where others can share their experiences could offer

significant motivational support. Hearing from peers managing similar conditions can provide encouragement, foster a sense of community, and offer practical insights, ultimately helping patients feel less isolated and more empowered to manage their disease. Hence, all the advice regarding the Socializing theme will be applied carefully in developing the GMHealth prototype's product.

The next one is the Enjoyment theme, where Expert 6 comments, *"double item to evaluate, entertainment and encourage feature, audio or indicator"*. The amendments and correction already be made on the confusion statement from *"The Gamified Application provides audio or indicator that help me to complete the challenge",* and "/ *prefer Gamified Mobile Health Application that contains entertainment (and encouragement) feature"* to *"The gamified application provides audio/visual indicators to help me complete the challenges"* and " *I prefer gamified mobile health applications that have enjoyable feature ",* therefore, on Enjoyment theme a little changes had been made.

Under the 'Guidance' theme, the expert suggested combining the elements of virtual coaches and virtual agents, as both serve similar functions in supporting GMHealth users. This integration could streamline the user experience by consolidating guidance and support into a unified feature. Additionally, when developing the GMHealth prototype, careful consideration should be given to the Chatbox functionality. Since a Chatbox requires real-time communication and responses, maintaining it would demand significant resources, including a dedicated team of administrators to manage interactions and answer user questions. This could increase both the operational cost and resource requirements for the app. Hence, this comment is more of a suggestion for developing a good Guidance theme for GMHealth prototypes and other GMHealth apps.

Next, the expert suggested the notification and reminder feature for the' Continuous' theme. They expressed concern about the frequency and timing of these messages, noting that if notifications are sent too frequently, they could become disruptive or irritating to users. This could lead to frustration and potentially result in users disengaging from or uninstalling the GMHealth application. Therefore, finding a balance that ensures reminders are helpful without overwhelming the user is crucial. Hence, no amendment is needed to any items for the Continuous theme.

Lastly, under the 'Self-Monitoring' theme, Expert 5 suggested revisions to improve the clarity and accuracy of the items. The expert states, *"The term 'progress'*

usually means the indicator/feedback displayed by the apps and not something that can be updated/inserted by the user. The item *"I can freely insert my daily progress in Gamified Mobile Health applications"* might be changed to *"I can log my daily activities.....".* Consequently, 7 *can freely insert my daily progress in Gamified Mobile Health applications'* was revised to 7 *can easily log my daily activities in Gamified Mobile Health applications.'* For the second item, the initial draft, 7 *can trace my health condition easily,'* was updated to 7 *can effortlessly track my health condition,'* reflecting a smoother, more user-friendly phrasing. Lastly, the third item, originally phrased as 7 *am aware of my health condition by looking at the data visualization presented,'* was revised to *'I am able to understand my health condition through clear data visualization.'* These changes were made to ensure that all three items in the Self-Monitoring theme are more precise and aligned with the user engagement, as they required significant revision.

Based on the overall feedback from the experts, the majority provided positive comments. It offered valuable suggestions for enhancing user engagement by applying gamification elements in the GMHealth framework. They emphasized that incorporating well-designed game mechanics could significantly improve user interaction and motivation, making the framework more effective in promoting healthier behaviors. Experts also highlighted areas where gamification could be optimized, such as reward systems, progress tracking, and personalized feedback, which could further increase user engagement and satisfaction. Their input suggests that these enhancements would make the framework more engaging and adaptable to various healthcare contexts. Table 4.32 shows the latest findings of the GMHealth instrument after the amendments have been made based on the expert's suggestions and comments.

Table 4.32
The Final Result of the Validated Instrument of The GMHealth

Instrument Before	**Instrument After**
Self-Representation Elements: Avatar, Profile, Autonomy	Self-Representation Elements: Avatar, Profile, Autonomy
• I am free to make my choice of self-representation	• I have the freedom to choose how I represent myself

• I can customize my profile based on my interest • The choice provided in gamified application grabs my attention	• I can personalize my profile based on my interests • Gamified applications with options catch my attention
Improvement Elements: Feedback, Goals, Library, Information Tools	Improvement Elements: Feedback, Goals, Library, Information Tools
• I received instant feedback on my progress while using gamified application. • I received instant feedback on my progress while using gamified application. • I received information on my status eg.score, level • I can freely set my own goals • I understand the content provided in the Gamified Application • The information presented in gamified application increases my knowledge • The Gamified Application motivates me to integrate the knowledge sharing	• The application provided me with instant feedback on my progress. • The application provided me with information on my status, such as my score and level. • I was able to set my own goals freely. • I was able to understand the content presented in the application. • The information presented in the application increased my knowledge. • The gamified application motivated me to share knowledge about health.
Socializing Elements: Community, Social Media, Peer-Support	Socializing Elements: Community, Social Media, Peer-Support
• I can share my health progress with other members • I love to interact and support each other in Gamified Applications • My motivation increase while sharing my achievement	• I am able to share my health progress with other members. • I enjoy supporting each other in gamified applications. • My motivation increases when I share my achievements.

• I can link my Gamified Application with my social media platform. • I love to receive real-time feedback while communicating with the community. • I feel involved while using gamified application • I am freely sharing my opinion with others	• I can link my gamified application with my social media platform. • I appreciate receiving real-time feedback while communicating with the community. • I feel involved while using gamified applications • I am comfortable sharing my opinions with others.
Esteem Elements: Leaderboard, Progress, Level.	Esteem Elements: Leaderboard, Progress, Level.
• I can trace my current ranking while using gamified application • I can monitor my progress easily • I can track my current achievements while using the gamified application • I can know my position immediately • The progress indicator are presented clearly • I know what to do in the next stage.	• I am able to keep track of my rank in the gamified application, • I am able to monitor my progress easily. • I am able to keep track of my accomplishments within the gamified application. • The application provides clear progress indicators, allowing me to know my position immediately. • I am able to understand what is expected of me in the next stage.
Enjoyment Elements: Badges, Challenges, Virtual Rewards.	Enjoyment Elements: Badges, Challenges, Virtual Rewards.
• I enjoy using this Gamified Application without feeling bored • The challenges provided are moderate, not too difficult or easy • The Gamified Application provides audio or indicator that help me to complete the challenge.	• I find this gamified application enjoyable to use without getting bored. • The challenges provided are moderate in difficulty, making them neither too easy nor too difficult. • The gamified application provides audio/visual indicators to help me complete the challenges.

• I prefer Gamified Mobile Health Application that contains entertainment (and encouragement) features.	• I prefer gamified mobile health applications that have enjoyable features.
Guidance Elements: Virtual Coaches, Chatbox, Virtual Agents	Guidance Elements: Virtual Coaches, Chatbox, Virtual Agents
• I am highly motivated to use Gamified Application with the presence of the coaches. • I received real-time support from the coaches • The virtual coaches were very helpful • I feel a sense of guidance	• I am motivated by the presence of the virtual coaches. • I received real-time support from the virtual coaches. • The virtual coaches were very helpful • I feel a sense of guidance
Self-Monitoring Elements: Logbook, Trend Alert, Visualization of Data	Self-Monitoring Elements: Logbook, Trend Alert, Visualization of Data
• I can freely insert my daily progress in Gamified Mobile Health applications • I can trace my health condition easily • I am aware my health condition by looking at the data visualization presented.	• I can easily log my daily progress in Gamified Mobile Health applications. • I can effortlessly track my health condition. • I am able to understand my health condition through clear data visualization.
Continuous Elements: Story/Theme, Notifications, Reminder.	Continuous Elements: Story/Theme, Notifications, Reminder.
• The interface of Gamified Application grabs my interest • The notification makes me become more aware • I become more immerse in the gamified health application	• The interface of the gamified application captures my attention. • The notifications increase my awareness.

- The gamified mobile application give positive reminders as an encouragement for me to do better.
- I find myself becoming more immersed in the gamified health application.
- The gamified mobile application's positive reminders motivate me to improve.

4.6 Findings of Phase 3: Framework Evaluation

This section summarizes the results from evaluating the GMHealth framework through the prototype app, *LetsGoFit*. The primary objective was to examine the framework's efficacy in facilitating user engagement and gamification within a functional mobile health context.

4.6.1 Prototype Demonstration Findings

The demographic data of the respondents are presented in the Table 4.33. The results indicate that most respondents are female, with 24 out of 34 (70.6%) female and 10 (29.4%o) males. Regarding age, most respondents fall within the age range of 26-35 years old, with 19 (55.9%>) respondents, followed by age 18-25 years old with nine respondents (41.1%), and one respondent (2.9%>) comes from the age range 36-45 years old.

In terms of education level, the Table 4.33 reveals that 27 out of 34 respondents (79.4%o) are pursuing a bachelor's degree, making it the most common education level among the participants. This is followed by those with a Certificate or Diploma, comprising four out of 34 respondents (11.8%>), and two (5.9%) hold a Master's degree.

Additionally, the respondents were asked whether they have ever used a gamified mobile health application to gauge their awareness of gamification in current mobile health apps. The responses show that 21 out of 34 respondents (61.8%) answered 'Yes,' indicating a majority awareness. Meanwhile, nine respondents (26.5%>) answered 'No,' and the remaining four (11.8%) selected the 'Maybe' option.

Table 4.33
User's Demographic

Questions	Range	Frequency (n)	Percentage (%)
Gender	Male	**10**	**29.4**
	Female	**24**	**70.6**
Age	18-25	14	41.1
	26-35	19	55.9
	36-45	~T~	2.9
	45 and above	0	0
Level of Education	Certificate/Diploma	4	11.8
	Bachelor's degree	27	79.4
	Master's degree	2	5.9
	Doctoral Degree	0	0
	Others	1	2.9
Have you ever used a Gamified Mobile Health Application?	Yes	**21**	61.8
	No	9	26.5
	Maybe	4	11.8

4.6.1.1 Findings on 'Self-Representation' Theme

According to Diagram 4.1, 58.8% of respondents, the majority, strongly agree that they have the freedom to choose how they represent themselves while using LetsGoFit. This finding underscores the application's ability to empower users with customization options, allowing them to create a personalized experience that resonates with their preferences. Additionally, *64.1%* of respondents agree that they can personalize their profiles based on their interests when using LetsGoFit, with only 5.9% feeling neutral about this feature. This highlights the significance of profile customization in enhancing user engagement and satisfaction, as most users appreciate the ability to tailor their profiles to reflect their interests and identities.

Moreover, regarding the statement "Gamified applications with options catch my attention," approximately 67.7% of respondents strongly agree with this feature, indicating a strong majority. This suggests that the various options and features within the gamified application successfully capture and retain users' attention, contributing to a more engaging and immersive experience. Only 2.9% of respondents felt neutral about

this aspect, emphasizing the overall positive reception. These results highlight the positive reception of self-representation features in the LetsGoFit application among the respondents, suggesting that the ability to personalize and engage with the application meaningfully enhances user satisfaction and engagement.

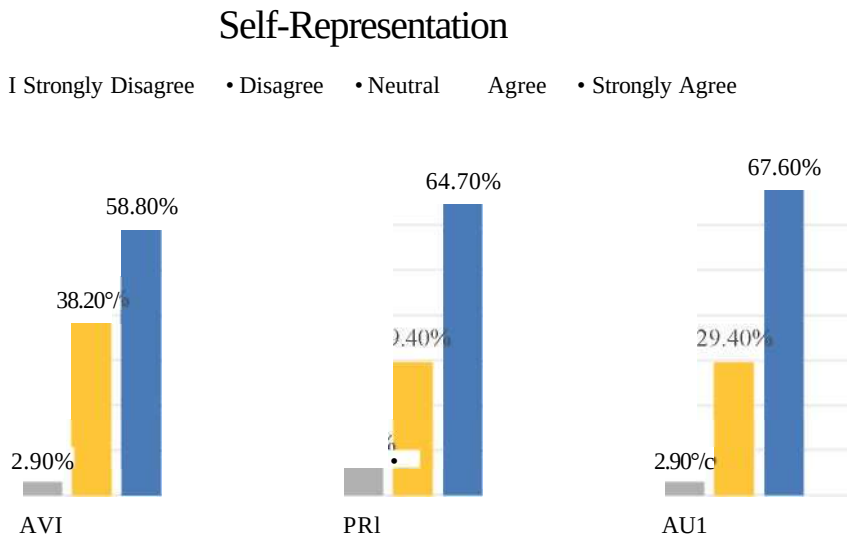


Diagram 4.1 Graph for Self-Representation Findings

Table 4.34
Self-Representation theme through prototype findings

Code	SD	D	N	A	SA	Mean	Std.Dev
Avatar AVI	0	0	1	13	20	4.56	.561
Profile PRl	0	0	2	10	22	4.59	.609
Autonomy AU1	0	0	1	10	23	4.65	.544
Total Mean						4.60	

4.6.1.2 Findings on 'Improvement' Theme

According to user evaluation of the "Improvement" theme in Diagram 4.2 and Table 4.35, the *LetsGoFit* application received good comments from many respondents. About 52.9%) of participants firmly agreed that the *LetsGoFit* apps offer quick comments on their activities and improvement. Following this were 38.2% of

respondents who agreed, and 8.8% who felt neutral about this aspect. Most respondents (55.9%) highly agreed when asked whether the application included information about their status, such as scores and levels; 38.2% agreed.

Next, more than half of the respondents (67.6%) firmly agreed that the LetsGoFit apps let people choose their goals according to their capacity. About 38.2% of the respondents said *LetsGoFit* app was easily comprehensible. Moreover, 64.7% strongly believed that the LetsGoFit app improved their understanding of exercise and fitness. Finally, 2.9% of respondents said they had no opinion on whether the gamified application may inspire them to disseminate health-related knowledge. On the other hand, 55.9% strongly agreed that they were inspired to inform others about their health knowledge and 41.2% agreed. These comments on the strengths of the LetsGoFit apps in offering practical tools to improve user involvement, knowledge, and motivation.

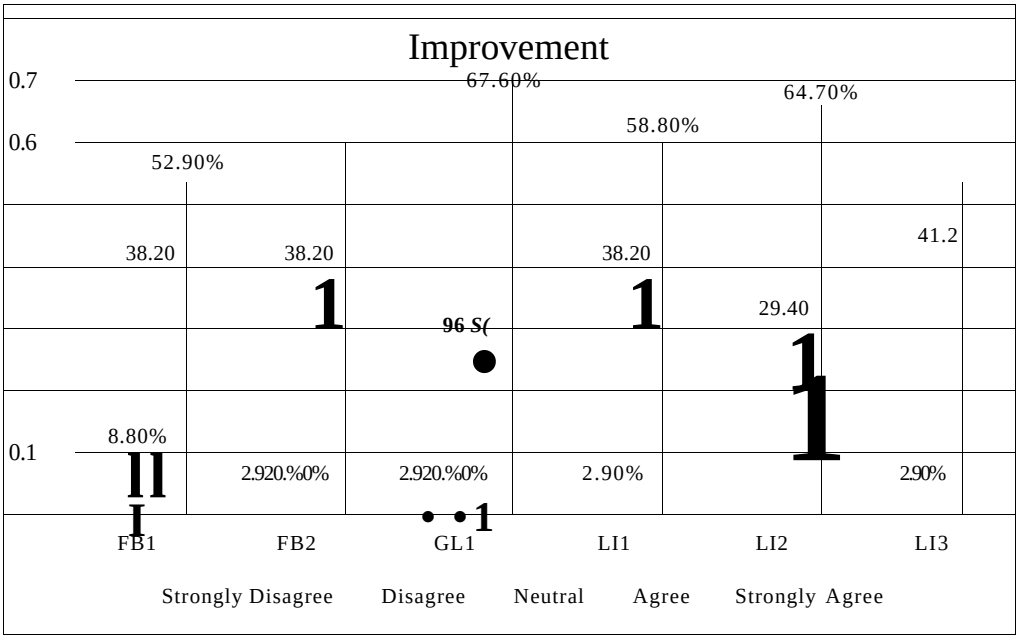


Diagram 4.2 Graph for Improvement Findings

Table 4.35
Improvement theme through the prototype's findings

Code	SD	D	N	A	SA	Mean	Std.Dev
Feedback							
FBI	0	0	3 (8.8%)	13 (38.2%)	18 (52.9%)	4.44	.660
FB2	0	1 (2.9%)	1 (2.9%)	13 (38.2%)	19 (55.9%)	4.47	.706
Goal							
GL1	0	1 (2.9%)	1 (2.9%)	9(26.5%)	23 (67.6%)	4.59	.701
Library/Information Tools							
LI1	**0**	0	1 (2.9%)	13 (38.2%)	20 (58.8%)	4.56	.561
LI2	**0**	0	2 (5.9%)	10 (29.4%)	22 (64.7%)	4.59	.609
LI3	**0**	0	**1 (2.9%)**	**14 (41.2%)**	**19 (55.9%)**	4.53	.563
Total Mean						**4.53**	

4.6.1.3 Finding on 'Socializing' Theme

In the "Socializing" theme of the user evaluation based on Diagram 4.3 and Table 4.36, it was evident that the *LetsGoFit* application facilitated user interaction and sharing health journeys through social media platforms. For the question *"I am able to share my health progress with other members'"*, 52.9% of respondents strongly agreed, 35.5%) agreed, and 8.8%> felt neutral. Most respondents (58.8%>) enjoyed supporting each other within the *LetsGoFit* app. Next, only 2.9% disagreed that their motivation increased when sharing their achievements through social media, while 58.8%> strongly agreed that they felt motivated to share their achievements with others.

Moreover, about 61.8% of respondents strongly agreed that they could link their social media accounts with *LetsGoFit* to receive social support from others. About 26.5%) of respondents agreed they received real-time feedback while communicating with the community. A substantial 58.8%> of respondents felt involved in the *LetsGoFit* application, with only 5.9% feeling neutral about this aspect.

Lastly, 55.9% felt comfortable sharing their opinions with others, although one respondent disagreed about sharing opinions within the community. These findings underscore the effectiveness of the *LetsGoFit* application in fostering a supportive and interactive environment for its users, enhancing their motivation and engagement through social connectivity.

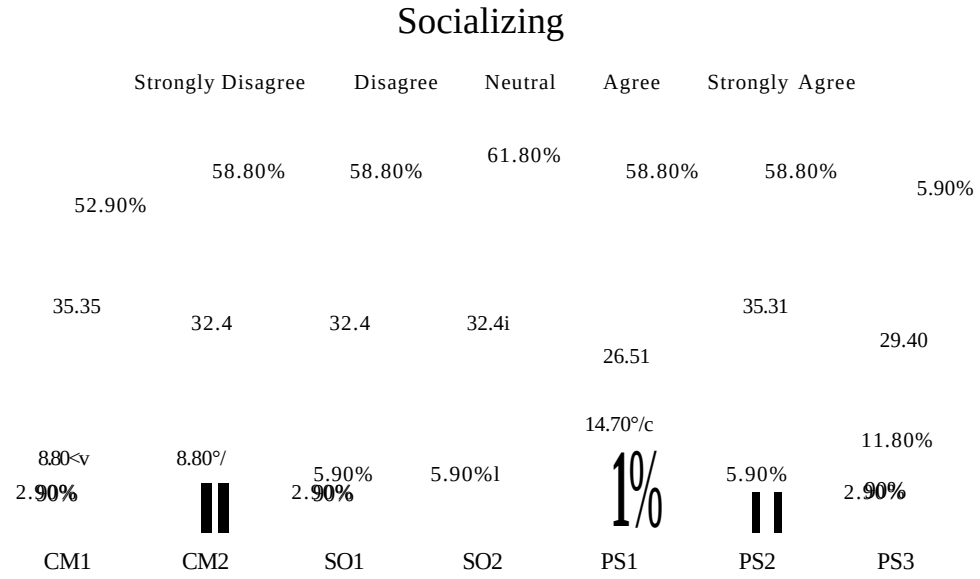


Diagram 4.3 Graph for Socializing Findings

Table 4.36
Socializing theme through prototype findings

Code	SD	D	N	A	SA	Mean	Std.Dev
Community							
CM1	0	1 (2.9%)	3 (8.8%)	12 (35.3%)	18 (52.9%)	4.38	.779
CM2	0	0	3 (8.8%)	11 (32.4%)	20 (58.8%)	4.50	.663
Social Media							
501	0	1 (2.9%)	2 (5.9%)	11 (32.4%)	20 (58.8%)	4.47	.748
502	0	2 (5.9%)	0	11 (32.4%)	21 (61.8%)	4.50	.788
Peer-Support							
PS1	0	0	5 (14.7%)	9 (26.5%)	20 (58.8%)	4.44	.746
PS2	0	0	2 (5.9%)	12 (35.3%)	20 (58.8%)	4.53	.615
PS3	0	1 (2.9%)	4 (11.8%)	10 (29.4%)	19 (55.9%)	4.38	.817
Total Mean						**4.46**	

4.6.1.4 Finding on Esteem Theme

In the "Esteem" theme, user reviews were very positive about the parts of the *LetsGoFit* app that help with self-evaluation and track progress. Based on Diagram 4.4 and Table 4.37, 67.6% strongly agreed that keeping track of their rank in the LetsGoFit app was easy. Also, 20.6% agreed with this feature, and 8.8% were unsure. Other than that, most respondents (70.6%) strongly agreed that the *LetsGoFit* apps made tracking their health progress easy. Another 20.6% agreed, 5.9% were unsure, and one person did not agree with this feature. Next, 61.8% of respondents strongly agreed with the statement "*I am able to keep track of my accomplishments within the gamified application*" 26.5% agreed, and 11.8% respondents felt neutral.

Next, about 61.8% strongly agreed that *LetsGoFit* apps give them clear progress signs that let them know immediately where they are. Last but not least, around 67.6% of respondents strongly agreed that they knew what was expected of them in the subsequent stage, while 23.5% of respondents agreed with this aspect. These answers show how well *LetsGoFit* gives users clear, actionable feedback and progress-tracking tools that boost their drive and sense of accomplishment.

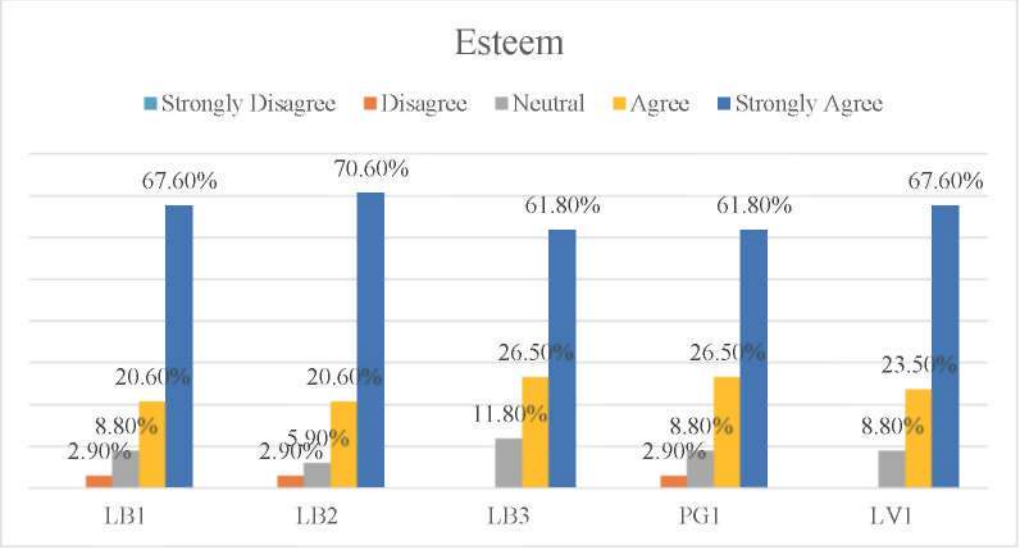


Diagram 4.4 Graph for Esteem Findings

Table 4.37
Esteem theme through prototype findings

Code	SD	D	N	A	SA	Mean	Std.Dev
Leaderboard							
LB1	0	1 (2.9%)	3 (8.8%)	7 (20.6%)	23 (67.6%)	4.53	.788
LB2	0	1 (2.9%)	2 (5.9%)	7 (20.6%)	24 (70.6%)	4.59	.743
LB3	0	0	4(11.8%)	9(26.5%)	21(61.8%)	4.50	.707
Progress							
PGl	**0**	**1 (2.9%)**	**3 (8.8%)**	**9 (26.5%)**	**21 (61.8%)**	4.47	.788
Level							
LVl	**0**	**0**	**3 (8.8%)**	**8 (23.5%)**	**23 (67.6%)**	4.59	.657
Total Mean						**4.54**	

4.6.1.5Findings on 'Enjoyment' Theme

In the "Enjoyment" theme, the feedback largely revolves around the gamification elements implemented in the GMHealth framework, based on Diagram 4.5 and Table 4.38 . These elements are crucial in making the *LetsGoFit* application engaging and fun. A significant 67.6% of respondents strongly agreed that the *LetsGoFit* application is enjoyable and does not make them bored. Additionally, 20.6% agreed with this sentiment, and 8.8% felt neutral. Regarding the challenges provided in the *LetsGoFit* app, *64.1%* of respondents strongly agreed that they are at a moderate difficulty level, neither too easy nor too complicated. A respondent felt neutral about this feature. Next, for the statement *"The gamified application provides audio/visual indicators to help me complete the challenges"* 70.6% of respondents strongly agreed, 23.5% agreed, and 5.9% felt neutral.

Lastly, 20.6%) of respondents preferred the *LetsGoFit* app to include enjoyable features such as badges, points, trophies, and scores to enhance engagement and encourage long-term use. These responses underscore the importance of gamification elements in the *LetsGoFit* application, which contribute significantly to user enjoyment and sustained engagement. The presence of well-designed challenges and clear indicators helps maintain user interest and motivation, making the overall experience more rewarding.

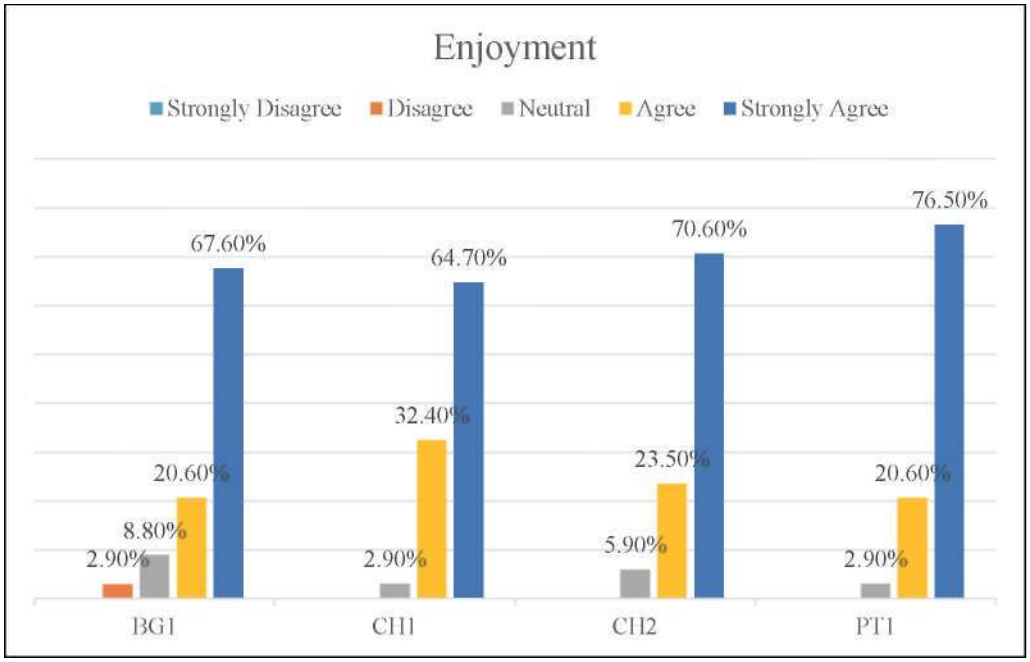


Diagram 4.5 Graph for Enjoyment Findings

Table 4.38
Enjoyment theme through prototype findings

Code	SD	D	N	A	SA	Mean	Std.Dev
Badges							
BGl	**0**	**1 (2.9%)**	**3 (8.8%)**	**7 (20.6%)**	**23 (67.6%)**	4.53	.788
Challenge							
CHI	0	0	1(2.9%)	11(32.4%)	22(64.7%)	4.62	.551
CH2	0	0	2(5.9%)	8(23.5%)	24(70.6%)	4.65	.597
Point							
PT1	0	0	1(2.9%)	7(20.6%)	26(76.5%)	4.74	.511
Total Mean						**4.64**	

4.6.1.6Finding on 'Guidance' Theme

The presence of virtual coaches in the *LetsGoFit* app plays a crucial role in motivating users to engage with and complete more fitness tasks. According Diagram 4.6 and Table 4.39,about *64.1%* of respondents strongly agreed that they were more motivated to gain and complete fitness tasks with the help of virtual coaches. Additionally, 23.5% agreed with this sentiment, while only 11.8% felt neutral. Real-time feedback is another critical aspect of virtual coaches' making a substantial impact. About 55.9%) of respondents strongly agreed that they received timely and actionable

feedback from the virtual coaches provided in the *LetsGoFit* app. This immediate feedback helps users make necessary adjustments and improvements during their fitness journey.

Virtual coaches are particularly valued for their ability to provide clear and helpful guidelines for performing tasks and challenges. More than half of the respondents (64.7%) strongly agreed that the virtual coaches were very helpful, while 29.4%) agreed. This guidance ensures that users understand how to perform exercises correctly and safely. The overall sense of guidance provided by the *LetsGoFit* app, primarily attributed to the virtual coaches, is highly appreciated by users. About 73.5% of respondents strongly agreed that they felt a sense of guidance within the app, followed by 23.5% who agreed, and only 2.9% felt neutral about this feature. This strong sense of guidance helps users feel supported and confident in their fitness journey.

Integrating virtual coaches within the *LetsGoFit* app, as part of the GMHealth Framework's "Guidance" theme, effectively motivates users, provides time feedback, and offers this. This enhances user engagement and improves health outcomes by ensuring that users are well-supported throughout their fitness journey.

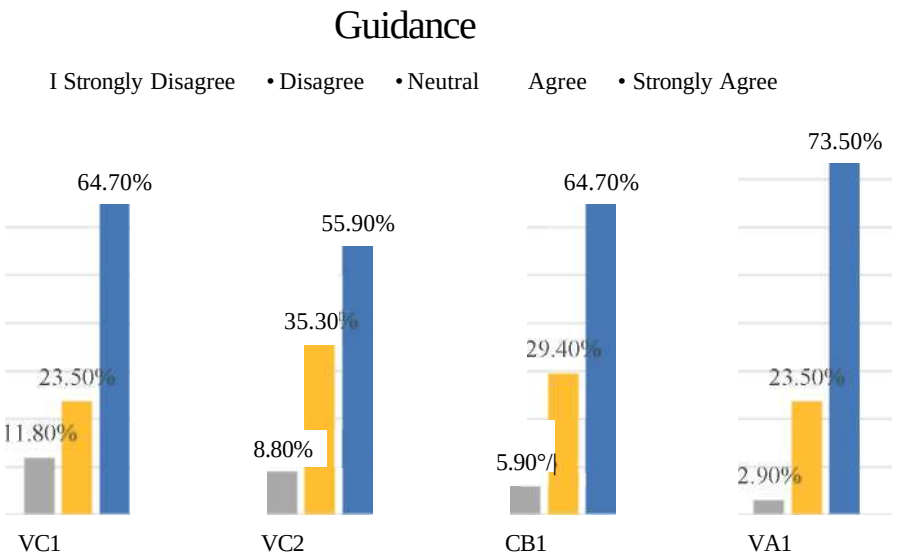


Diagram 4.6 Graph for Guidance Findings

Table 4.39
Guidance theme through prototype findings

Code	SD	D	N	A	SA	Mean	Std.Dev
Virtual Coaches							
VC1	0	0	4(11.8%)	8 (23.5%)	22 (64.7%)	4.53	.706
VC2	0	0	3 (8.8%)	12 (35.3%)	19 (55.9%)	4.47	.662
Chatbox							
CB1	0	0	2 (5.9%)	10 (29.4%)	22 (64.7%)	4.59	.609
Virtual Agents							
VA1	0	0	1 (2.9%)	8 (23.5%)	25 (73.5%)	4.71	.524
Total Mean						**4.58**	

4.6.1.7Findings on 'Self-Monitoring' Theme

The "Self-Monitoring" theme is important to mobile health apps because it helps users keep good records of their health progress. Based on Diagram 4.7 and Table 4.40, a large majority, 73.3% strongly agreed that the *LetsGoFit* app made it easy to keep track of their daily progress. This ease of use is crucial for tracking and participating over time. Also, 20.6% of those who answered agreed, while only 5.9% were unsure about this feature. Most of the people who answered *{64.1%* of those who did) strongly agreed that the *LetsGoFit* app's graphs and charts made it easy to keep track of their health. People can better understand and make sense of their health information with this type of data visualization. Only 2.9% of people were unsure how they felt about this trait. Clear data visualization is key to helping people understand their health problems.

The *LetsGoFit* app's clear data visualizations helped about 67.6% of those who answered highly agree that they could understand their health condition. Also, 29.4% agreed, which shows that most users think the way the info is presented is good and easy to understand. The "Self-Monitoring" theme in the *LetsGoFit* app is an important part that makes users more interested in the app and helps them understand their health progress. The app makes it easy for users to monitor their health by letting them easily log information, see how their data changes if there are any drastic changes, and use effective tracking. This allows users to make smart health choices and inspires them on their fitness path.

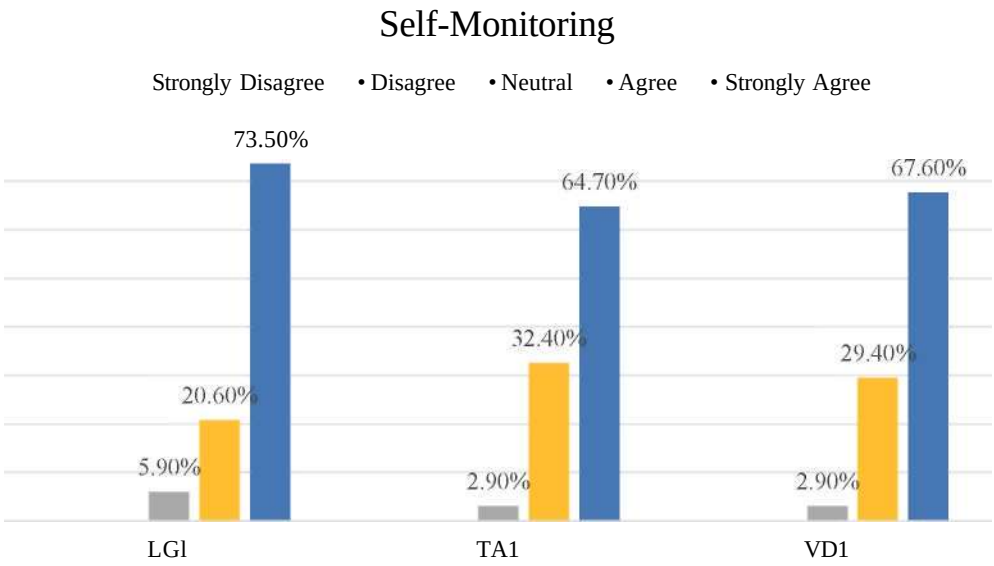


Diagram 4.7 Graph for Self-Monitoring Findings

Table 4.40
Self-Monitoring theme through prototype findings

Code	SD	D	N	A	SA	Mean	Std.Dev
Logbook							
LGl	**0**	**0**	**2 (5.9%)**	**7 (20.6%)**	**25 (73.5%)**	4.68	.589
Trend Alert							
TA1	**0**	**0**	**1 (2.9%)**	11(32.4%)	**22 (64.7%)**	4.62	.551
Visualization of Data							
VD1	**0**	**0**	**1 (2.9%)**	**10 (29.4%)**	**23 (67.6%)**	4.65	.544
Total Mean						**4.65**	

4.6.1.8 Finding on Continuous Theme

Based on the feedback from the Continuous theme, the *LetsGoFit* application excels in maintaining user interest. The *LetsGoFit* application's interface is designed to effectively capture and retain users' attention. Based on the Diagram 4.8 and Table 4.41, about 64.7%) of respondents strongly agreed that the interface captures their attention, making it engaging and visually appealing. Additionally, 26.5% of respondents agreed with this sentiment, while 8.8%> felt neutral. This highlights the importance of a well-designed interface in keeping users engaged.

Next, the *LetsGoFit* app's notification pop-ups significantly increase users' awareness and engagement. Approximately *64.1%* of respondents strongly agreed that these notifications help them stay informed and attentive to their fitness activities.

Another 23.5% agreed, while 8.8%> felt neutral about this feature. The effectiveness of timely notifications in maintaining user engagement is evident from these responses. Moreover, the ability of the *LetsGoFit* app to immerse users in their fitness journey is crucial for sustained engagement. More than half of the respondents (64.7%>) strongly agreed that they became more immersed in the app, indicating a high level of user engagement. However, 2.9% disagreed and did not feel immersed in the *LetsGoFit* experience.

In addition, positive reminders are vital in keeping users motivated and committed to their fitness goals. A substantial 73.5% of respondents strongly agreed that the positive reminders provided by *LetsGoFit* help them stay motivated and continue their exercise routines. Additionally, 20.6% agreed with this sentiment, and 5.9%) felt neutral. This underscores the importance of regular motivational prompts in supporting users' fitness journeys. The Continuous theme within the *LetsGoFit* app demonstrates its effectiveness in maintaining user interest and motivation through an appealing interface, timely notifications, immersive experiences, and positive reminders.

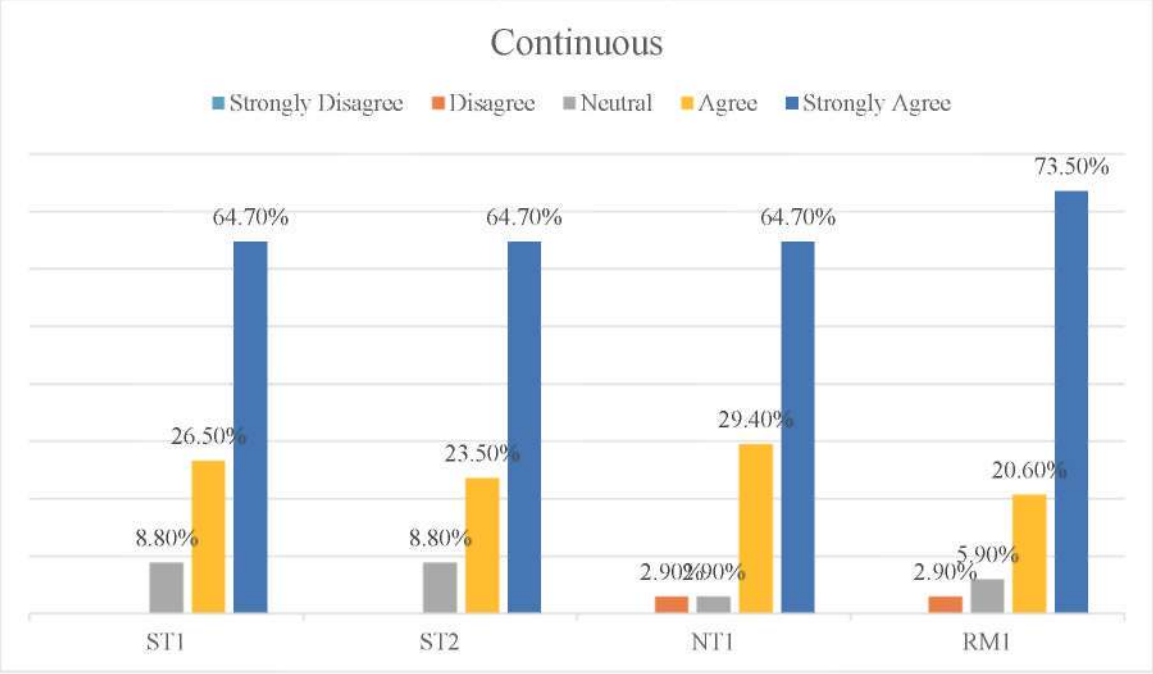


Diagram 4.8 Graph for Continuous Theme

Table 4.41
Continuous theme through prototype findings

Code	SD	D	N	A	SA	Mean	Std.Dev
Story/Theme							
STl	0	0	3 (8.8%)	9 (26.5%)	22 (64.7%)	4.56	.660
ST2	0	1 (2.9%)	3 (8.8%)	8 (23.5%)	22 (64.7%)	4.50	.788
Notification							
NT1	0	1 (2.9%)	1 (2.9%)	10 (29.4%)	22 (64.7%)	4.56	.705
Reminder							
RM1	0	0	2 (5.9%)	7 (20.6%)	25 (73.5%)	4.68	.589
Total Mean						4.58	

4.7 Summary of User's Prototype Evaluation.

Table 4.41 show, the results of the total mean for each theme of the GMHealth framework, calculated from the average scores of each element and criterion within each theme. These averages were then computed into a total mean to identify the overall outcome of the evaluation based on the GMHealth framework.

According to Table 4.41, the highest mean score among the eight themes of the GMHealth Framework is for the "Self-Monitoring" theme, with a value of 4.65. This is closely followed by the "Enjoyment" theme, with a mean score of 4.64, the "Self-Representation" theme, with a mean score of 4.60, and the other five themes.

The highest mean value for the "Self-Monitoring" theme underscores its critical importance in a gamified mobile health application. This theme is essential for enabling users to maintain their health by monitoring their health conditions, allowing users to log their daily health metrics and activities, providing visual representations of their health progress through graphs and charts, and offering alerts based on trends in their health data to keep users informed and engaged. The high mean score of 4.65 for the "Self-Monitoring" theme highlights its effectiveness and necessity in helping users stay on top of their health and fitness goals.

The Socializing theme obtained the lowest mean score among all assessed themes, with a value of 4.46. While comparatively lower, this score remains within the *excellent* range according to the interpretation scale, reflecting a strong level of user satisfaction with the social interaction features of the application. The slightly reduced rating may be attributed to users feeling insecure about sharing their health status, as some consider such information highly private. According to the feedback from

respondent, this hesitation to engage in health-related social interactions could limit participation in community features, despite their potential to foster support and motivation. Although opportunities for enhancement exist in this area, the current implementation of the socializing component is still perceived positively and contributes meaningfully to the overall user engagement.

Other than that, with a mean score of 4.64, the "Enjoyment" theme indicates that the gamification elements, such as badges, challenges, and virtual rewards, are highly valued by users. These elements are crucial for keeping the application engaging and enjoyable, ensuring users remain motivated and interested over the long term. Furthermore, the "Self-Representation" theme, scoring a mean of 4.60, reflects the importance of allowing users to personalize their experience and represent their progress and achievements within the app. This personalization helps in creating a more relatable and motivating environment for users.

In addition, the overall mean score for all themes was calculated to validate user engagement with the *LetsGoFit* application, which is based on the GMHealth Framework. The mean value of 4.57 indicates high user satisfaction and engagement with the *LetsGoFit* app. This comprehensive evaluation demonstrates that the GMHealth framework effectively meets the third objective of this research project: *To evaluate a gamified mobile health framework that contributes to an engaging experience through prototype testing.*

In summary, the high mean scores across the themes, particularly in "Self-Monitoring," "Enjoyment," and "Self-Representation," validate the GMHealth framework in creating an engaging and supportive environment for users. The overall mean score of 4.57 with a percentage of 91.4% further confirms that the LetsGoFit application successfully engages the user to keep using the application by implementing the GMHealth framework, meeting the research objectives and providing a valuable tool for health and fitness management. The other mean of the other theme was presented in Table 4.42.

Table 4.42
The total mean for each theme and the overall mean for all themes.

Theme	Total Mean Average
Self-Representation	4.60
Improvement	4.53
Socializing	4.46
Esteem	4.54
Enjoyment	4.64
Guidance	4.58
Continuous	4.58
Self-Monitoring	4.65
Overall Mean	4.57 (91.4%)

4.8 Findings on Phase 4: Framework Documentation.

For the final phase of this research study, a comprehensive framework documentation was meticulously prepared to encapsulate all the data and findings related to the GMHealth research study. This documentation included the outcomes from various stages, beginning with the investigation phase, which provided a thorough review of the relevant literature and an in-depth examination of the Wheel of Sukr study. Preliminary findings from these analyses were systematically recorded.

Furthermore, all critical processes and activities undertaken during the development phase were documented. This included expert consultations, face validity assessments, and the rigorous evaluation processes applied to the prototype. Detailed records of data analyses, calculations, and evaluations were maintained to ensure transparency and traceability. The documentation demonstrates that the research was conducted systematically, adhering to established scientific standards. It also verifies that the study successfully met its objectives and comprehensively answered all the research questions, contributing significantly to the field. Hence, all the data, raw, proofs, tables and information related to the GMHealth framework were documented clearly.

4.9 Summary

This chapter provides an overview of the evaluation process for this research project, utilizing multiple validation methods. The face validation phase was carried out to determine whether the items in the GMHealth instrument were appropriate, reasonable, and clear. In addition, expert validation was conducted using the content validity method, where experts evaluated the relevance and clarity of the GMHealth framework's items. The results were quantified to provide insights into the framework's effectiveness and to gather feedback for refinement. This chapter also includes an assessment of user engagement through the prototype demonstration of the *LetsGoFit* application. The overall mean engagement score was 91.7%, reflecting a strong level of interaction with the application. Lastly, recommendations and suggestions from experts are presented to guide potential improvements to the GMHealth framework. These suggestions highlight areas for enhancement and aim to ensure that the framework remains practical and adaptable for use in healthcare.

CHAPTER 5
CONCLUSION AND SUGGESTED FUTURE WORK

This chapter will present a comprehensive discussion of the overall outcomes of this research project. It will cover the journey from the initial stages of identifying the challenges associated with implementing gamification in the healthcare sector to the final phase of validating the GMHealth Framework. Expert validation was conducted with professionals from diverse backgrounds, ensuring a multi-dimensional framework assessment. Additionally, prototype evaluation was performed through the prototype of the *LetsGoFit* application. The research addressed the identified problems, acknowledged the limitations, and provided recommendations for future framework improvements. These outcomes contribute to the potential enhancement of gamification applications in healthcare, offering insights for further research and practical implementations.

5.1 Project Outcomes

The project outcome provides a summary of the entire process involved in developing the GMHealth framework from its initial to its final stages. This summary highlights the key steps, including Phase 1: Problem Investigation, Phase 2: Framework Development, Phase 3: Framework Evaluation, including creating the *LetsGoFit* prototype, and Phase 4: Documentation. Additionally, it is crucial to ensure the research objectives have been successfully met.

The outcomes are summarized on a chapter-by-chapter basis to enhance clarity and comprehension. This structured approach allows for a clear presentation of the results achieved at each project stage, making it easier to understand how each phase contributed to the overall success of the framework's development.

Chapter 1 introduces the research project, detailing the widespread use of mobile health applications globally and the benefits they offer users in maintaining their health. This chapter also discusses existing mobile health applications that encourage user engagement by integrating gamification elements, which enhance user engagement. In this section, the problem statement has been identified, highlighting a few issues: *the lack of understanding about how gamification is applied in real-world mHealth apps.*

Additionally, the chapter identifies research gaps and formulates research questions to address this issue. To effectively respond to the research questions, specific objectives are outlined to solve the identified problem statements. Moreover, the significance of the study is presented, giving benefits to designers, medical practitioners, and gamified health users. This chapter also establishes the research scope and limitations, providing a framework for understanding the study's parameters.

Chapter 2 presents a comprehensive literature review of the project, focusing on key operational definitions such as gamification, mobile health applications, user engagement, and gamified applications. This chapter aims to clearly understand these concepts and their relevance to the research topic. Additionally, the chapter categorizes mobile applications to provide a better understanding of the mHealth landscape. It explores existing gamification applications within the healthcare sector, examining popular apps available in the App Store to identify the gamification elements most implemented in mHealth applications. The important part of this chapter is the selection of relevant frameworks and theoretical foundations related to health and gamified health. This process is essential for developing a new framework to enhance user engagement and health outcomes effectively. Finally, the chapter concludes by reviewing findings from various articles and papers discussing gamification elements related to healthcare. This analysis provides insights into the current state of research in the field and identifies gaps that the GMHealth framework aims to address.

Chapter 3 provides a comprehensive overview of the methodologies in developing the GMHealth framework, detailing the processes initiated from the problem investigation stage. It begins by outlining the framework development process, including a thorough mapping of related frameworks and a literature review informing the gamification elements' criteria. This stage involves extracting key items for the GMHealth framework based on the findings from the literature. In this chapter, the initial draft of the GMHealth framework is developed before undergoing revisions based on feedback from experts. The chapter also describes the procedures implemented for the evaluation of the framework. This includes assessments of expert validation, face validation, and user evaluation. Overall, this chapter is dedicated to the focused development of the GMHealth framework.

Chapter 4 focuses on the calculations and findings derived from the expert validation process, employing content validation techniques to assess the validity of the GMHealth instrument. In this chapter, the feedback from experts is analyzed to evaluate

the effectiveness of the GMHealth framework. Additionally, face validation of the GMHealth framework is conducted to measure whether the instrument is relevant, reasonable, and clear. User engagement metrics are also calculated following the prototype evaluations, allowing the determination of the overall mean engagement score. This chapter also discusses the experts' comments and suggestions, highlighting potential improvements for both the GMHealth framework and the prototype of the gamified mobile health applications.

5.2 Research Questions and Objectives Revisited

The study successfully addresses three research questions and meets the associated objectives. The research is completed through a series of processes discussed in detail below.

5.2.1 First Research Question and Objective

The first research question of this study is, *"What are the elements of a gamified mobile health framework that contribute to an engaging experience?"* To address this question, a comprehensive approach was undertaken to identify the gamification elements relevant to the healthcare context. A broad range of studies were retrieved using keywords such as "gamification," "gamified mobile health," "m-health," and "user engagement". An analysis of existing gamification frameworks, such as *The Wheel of Sukr, Andrzej Marczewski Framework and Octalysis Framework,* was conducted to identify their limitations and gaps, leading to the GMHealth Framework's development. The current landscape of mobile and gamified applications was also explored at the most popular gamified health apps in the App Store 2022 to determine which gamification elements are most implemented in the demand market and trend today. As a result of these thorough steps, the first objective of this study, *to identify the key elements of a gamified mobile health framework that contribute to an engaging experipience* are successfully achieved.

5.2.2 Second Research Question and Objective

The second research question of this study is, *"How to construct the GMHealth Framework for gamifying mobile health applications? "* To answer this question, the most suitable and promising framework was identified for developing the new enhancement of framework. The *Wheel of Sukr* by AlMarshedi et al., (2017) was selected as a reference point for constructing the GMHealth framework, which can be applied in various general healthcare contexts. A mapping process was conducted to align the *Wheel of Sukr* framework with the findings from the literature review on gamification, ensuring the frameworks and literature review shared similar criteria and definitions. This step facilitated the extraction of relevant criteria that would inform the development of the instrument for the GMHealth framework. Following these steps and procedures, the second objective of this study, 'To *construct a gamified mobile health framework that contributes to an engaging experience while using gamified mobile health application"* was effectively addressed. The resulting framework enhances user engagement in mobile health applications by thoughtfully integrating gamification elements.

5.2.3 Third Research Question and Objective

The final research question of this study is, *"How suitable is a gamified mobile health framework for enhancing user engagement?"* To solve this question, the initial draft of the GMHealth Framework was distributed to experts from diverse backgrounds, including academia, healthcare professionals, and industry experts. Their feedback, comments, and advice were sought to validate and assess the effectiveness of the GMHealth instrument. Additionally, the prototype of the GMHealth Framework, *LetsGoFit,* is undergoing a user evaluation to measure user engagement related to the GMHealth framework. This dual approach, expert validation and user evaluation, provided comprehensive insights into the framework's applicability and effectiveness. As a result of these efforts, the final objective of the study, 'To *evaluate a gamified mobile health framework that contributes to an engaging experience through prototype evaluation",* has been successfully achieved through the prototype, the *LetsGoFit* application. This evaluation affirms the framework's potential and offers actionable recommendations for future enhancements and implementations.

5.3 Contribution of this study

This study offers several important contributions to the domain of gamification in mobile health (mHealth), addressing both theoretical and practical gaps identified in existing literature. Previous gamification frameworks such as the Octalysis Framework (Chou, 2019), Andrzej Marczewski's framework (Marczewski, 2017), and the Wheel of Sukr (AlMarshedi et al., 2017) have provided valuable foundations for understanding user motivation and engagement. However, these models were either developed for broader domains such as business and education or were limited in scope to specific contexts such as chronic disease management. As a result, they do not fully capture the diverse health behaviours, preventive care needs, and lifestyle practices that are central to mHealth adoption. As a result, this study proposes the validated GMHealth Framework, which extends prior work by providing a comprehensive GmHealth Framework to embedding gamification elements systematically into mobile health applications.

Second, this study contributes methodologically through the development of a validated instrument for the GMHealth Framework. Many earlier works have remained at a conceptual stage, lacking rigorous testing or standardized tools to measure effectiveness (Mustafa et al., 2023; Dewitz, 2022). By employing expert validation techniques, including face validation and content validity analysis across multidisciplinary experts, this study ensures that the framework is both theoretically grounded and practically applicable. This process not only strengthens the reliability of the GMHealth Framework but also provides a replicable methodological model for future research in gamified health technologies.

Third, this research advances knowledge by demonstrating the operationalization of the framework through the development of a prototype application, LetsGoFit. Unlike prior studies that present only theoretical contributions, the prototype serves as a proof of concept, showcasing the feasibility and effectiveness of applying gamification principles in real-world contexts. The evaluation revealed a notably high level of user engagement, with 91.4% of participants actively interacting with the prototype, underscoring the potential of the GMHealth Framework to improve sustained engagement in health interventions.

Finally, this study contributes to the broader discourse on mHealth by systematically identifying and addressing the gaps in gamification implementation. Existing applications often suffer from low retention rates and lack standardized guidelines for integrating motivational features effectively (Xu et al., 2022; Freyer et al., 2024). By providing a validated framework, measurement instrument, and empirical demonstration, this study delivers both theoretical clarity and practical guidance for researchers, developers, and healthcare practitioners. Moreover, it opens new directions for future research in areas such as gamification for wearable devices, personalization of game mechanics to user health goals, and the incorporation of multiplayer or social features to further enhance engagement.

5.4 Limitations and Recommendations for Future Research

This study faced several limitations that also suggest directions for future research. First, the instrument used was restricted to several themes from AlMarshedi et al., (2017), namely Esteem, Self-Monitoring, Enjoyment, Continuous, Self-Representation, Socializing, and Improvement. An additional theme, Guidance, was introduced to better align with the GMHealth framework. Future studies could extend this by incorporating new gamification elements suited to emerging technologies such as smartwatches, smart glasses, and AR/VR headsets. These devices enable real-time monitoring, instant feedback, and seamless integration with daily routines. New factors, including real-time data processing, advanced personalization, and user-device interaction, could be explored to enhance the framework's relevance and adaptability to evolving mobile health technologies.

Second, the prototype developed using the validated GMHealth framework was confined to the "Health and Fitness" category, designed mainly for users aiming to maintain their health and track progress. While this was beneficial, it limited the framework's evaluation to a narrow scope. Future work should test its application in other health app categories. For instance, applying it to "Reminder Apps" could assess its effectiveness in supporting medication adherence or appointment management, while its use in "Monitoring Apps" could highlight engagement in managing chronic conditions or tracking vital signs. Similarly, in "Patient Portal Apps," the framework may enhance patient engagement by improving record access, communication with healthcare providers, and appointment scheduling. A broader evaluation across multiple

app categories would validate the framework's versatility and highlight opportunities for refinement, ultimately supporting improved user engagement across diverse health technologies.

Another promising direction is the inclusion of multiplayer functionality, as the current GMHealth framework is designed for single users. Real-time multiplayer features could encourage engagement by enabling team-based challenges or competitions, such as daily step count contests or live group workouts. Asynchronous features could also allow users to join challenges and compare progress without being online simultaneously, providing flexibility and sustained engagement. Additionally, multiplayer interactions could strengthen collaboration by allowing users to form teams and pursue shared health goals. However, this must be balanced with privacy considerations, as not all users may wish to share health data, which could reduce motivation. Addressing such concerns will be important in extending the framework to include social and competitive elements effectively.

The study also encountered several internal challenges. Securing professional experts for face and content validation proved difficult. Despite multiple invitations and follow-ups, only a few experts contributed, and their delayed responses slowed documentation and analysis, impacting the overall timeline. Another challenge arose during prototype development, which required specialized skills in mobile health application design. Identifying developers with the necessary expertise was not straightforward, leading to delays and affecting the timely achievement of the third objective,evaluating the GMHealth framework.

Recruiting users for prototype testing also presented difficulties. Participants were required to install the prototype on their devices, but not all were familiar with APK installation processes, and some used non-Android platforms, reducing participation. These barriers limited the number of evaluators and extended the testing timeline. Despite these challenges, the study was completed successfully, but these experiences underline the need to plan for technical expertise, platform compatibility, and user-friendly installation in future projects.

In summary, the study's limitations suggest several areas for further research. Expanding gamification elements, integrating wearable technologies, and incorporating multiplayer features could broaden the framework's scope and relevance. Testing it across different health app categories would also strengthen its generalizability. At the same time, addressing issues of privacy, expert availability, technical development, and

user accessibility is vital for smoother implementation. These improvements will contribute to refining and extending the GMHealth framework, ensuring its continued role in enhancing user engagement in mobile health technologies.

5.5 Conclusion

This study successfully developed a new gamification framework for health to enhance user engagement in gamified mobile health applications. The research followed a comprehensive approach that included problem identification, framework development, evaluation, and detailed documentation, all conducted to achieve the study's objectives. The resulting framework presents an innovative approach that can be implemented in the healthcare sector to improve user engagement, promote healthier behaviors, and serve as an efficient and cost-effective platform for health practitioners in managing patient care.

Although this study acknowledges certain limitations and suggests future research, applying the validated of GMHealth framework in the health domain is practical and effective. The findings highlight the potential of gamified frameworks to positively impact user engagement within health applications, creating a solid foundation for future exploration and improvement. This framework could benefit users of all ages and across various healthcare fields, contributing to a more engaging and accessible health management experience.

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APPENDICES

APPENDIX 1

Copyright Of The *LetsGoFit* Application

AKTA HAK CIPTA 1987

PERATURAN-PERATURAN HAK CIPTA (PEMBERITAHUAN SUKARELA) 2012

SIJIL PEMBERITAHUAN HAK CIPTA
[Subperaturan 8(2)]

No. Pemberitahuan	CRLY2023M05012
Tajuk Karya	LETSGOFIT : GAMIFIED MOBILE HEALTH APPLICATION
Kategori Karya	SASTERA
Tarikh Permohonan	13OKTOBER2023

Saya dengan InJ mengesahkan di bawah Akta Hak Cipta 1987 [Akta 332] dan Peraturan-Peraturan Hak Cipta (Pembentahuan Sukarela) 2012 bahawa karya hak apta dengan No Pemberitahuan seperti di atas bagi pemohon UNIVERSITI TEKNOLOGI MARA CAWANGAN MELAKA (E 0914311-04) sebaga* PEMUNYA dan NURUL HIDAYAH BINTI MAT ZAIN (800201145894), SITI NURKHAIRINA BINTI YAHIZAN (970612105688) sebagai PENCIPTA telah didaftarkan ke dalam Daftar Hak Cipta menurut seksyen 26B Akta Hak Cipta 1987 [Akta 332]

KAMALBIN KORMIN
PENGAWAL HAK CIPTA
MALAYSIA

APPENDIX 2

Publications Of SCoRED 2023

2023 IEEE 21st Student Conference on Research and Development (SCOReD)

Playing for Wellness: A Review on Pioneering a Gamified Mobile Health Framework

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***Abstract*— There has been an increase in mobile health (m-Health) applications for physical activity, nutrition, health monitoring, and health knowledge in recent years. Besides, m-Health applications are identified based on their functionality, patient health status, and health domains. The new concept, such as gamified m-Health, is created specifically for health context purposes that implement game elements in the m-Health application. However, there is still a lack of understanding about how gamification should be applied in m-Health apps, leading to poor user experience while using the application. Therefore, this paper proposed a new gamified m-Health framework, namely the GMHealth framework, for gamifying mobile health applications. This paper discusses the frameworks and theoretical foundations, issues, and trends in the gamification frameworks related to m-Health applications. As a result, this new GMHealth framework can be a guideline in producing highly promising m-Health applications to reduce treatment adherence problems and boost user engagement with healthcare intervention.**

Keywords: ***Gamification, Mobile Health, m-Health, User Experience, User Engagement.***

I. INTRODUCTION

Over 100,000 health applications (apps) are available for smartphones worldwide, with the most common downloads being exercise, diet, and weight loss apps. Consumers want to access health information on their digital devices, and more than 500 million people use mobile health (m-Health) apps worldwide [1]. Smartphone ownership is across all social and demographic groups, making mobile apps a potentially promising tool to optimize user experience in their health care, particularly for those with high health care needs. Applying game concepts to healthcare is a promising model for reshaping the consumer experience. Healthcare systems increasingly use m-Health apps to improve quality by spending less money, improving user quality of life, convincing, and making users take more responsibility for their health [2].

In health and well-being, gamified m-Health is increasingly recognized as an important tool to foster the sustained usage of a system, promote certain health behaviours [3] and positively affect health-related intervention [4]. Based on a study by [5], gamified m-Health is an application created specifically for health purposes that includes game elements such as goals, conflicts, the ability to win or lose, and rules. According to [4], the gamified m-health application is designed not only for entertainment but also with the objective of aiding users in healthcare-related aspects, such as managing their health status. The gameplay presented in m-Health interventions might positively impact users' emotional experiences and boost their pleasure and self-esteem [6][7]. The advantage of game mechanics is that users are highly motivated to change their health behaviours and stick with the application [8][9]. Besides, the m-Health application has been categorized into several different terms, and each term has a different function for medical practitioners and users. Some apps are suitable for only medical and health expert use, and some are focused on the general user, not only the patients. Table I shows some of the categories of mobile health application and examples of the apps in the current market and their specification use.

TABLE I. CATEGORY OF MOBILE HEALTH APPLICATION [10][11]

Element	Description
Clinical Assistance Apps	Clinical support applications serve multiple purposes, including enabling physicians to review electronic health records (EHRs) or retrieve laboratory results during appointments. Additionally, these applications may facilitate image viewing and patient education, providing doctors with the means to illustrate information to patients during consultations. Example: *Mobile MIM, Syngo. Via, WebViewer, DrawMD*
Monitoring Apps	Monitoring applications enable doctors to observe a patient's behaviour or symptoms remotely. For instance, a patient might utilize an app to conduct an ECG and subsequently share the results with their healthcare provider. Examples: *American Well, InTouch Health, AirStrip-Patient Monitoring*
Remainder Apps	An application that can be used to remind patients of appointments or when to take medication, for example. Examples: *CarrotFit, Glow, Fitbit*
Healthy Life Apps	A category that encompasses fitness and diet apps and other apps, patients rather than doctors largely use healthy life apps. Examples: *Sparva, Nikerun, Period-Tracker.*
Efficiency Comm Apps	Facilitating communication among medical facilities promotes interoperability collaboration and enhances patient care. For instance, secure communication apps enable doctors to transmit patient information to specialists in different facilities. This not only streamlines the workflow in medical practices but also aligns with the goal of achieving greater efficiency, a pursuit shared by many healthcare professionals.

APPENDIX 3

Publications Of I-JaMCSIIX 2023

LetsGoFit Unlocked: Revolutionizing Wellness with Gamified Mobile Health

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khairinayahizan.works@gmail.com, nurul417@uitm.edu.my, fariza062@uitm.edu.my, ismassabah@uitm.edu.my, azida632@uitm.edu.my

***Abstract*— Mobile applications have emerged as valuable tools to promote physical well-being in an era marked by the fusion of technology and health-conscious lifestyles. Despite the growing awareness of the importance of exercise and stretching in maintaining health, many women struggle to find accessible and personalized solutions to incorporate regular physical activity into their lives. Existing fitness apps often lack tailored stretching exercises for women, leading to a gap in addressing their unique physiological requirements. Therefore, we developed a women's stretching exercises application called *LetsGoFit*, which combines the convenience of mobile technology with the engaging elements of gamification to create a user-friendly and enjoyable exercise experience. The gamified mobile health implemented Rapid Application Development (RAD), providing a flexible and iterative approach to software development that emphasizes rapid prototyping and continuous feedback. The development of *LetsGoFit* is based on the GMHealth framework that consists of eight themes: *Self-Representation, Self-Monitoring, Esteem, Enjoyment, Continuous, Guidance, Socializing* and *Improvement*. In conclusion, *LetsGoFit* represents a novel approach to promoting women's health through a gamified mobile health application. The accessibility of a mobile application with aspects of gamification empowers women to maintain their stretching exercises, contributing to improved physical health and overall quality of life.**

Keywords*— *mobile health, gamification, engagement, Rapid Application Development, gamification framework

APPENDIX 4

Award For I-Jamcsiix 2023

UNIVERSITI TEKNOLOGI MARA

In partnership with

TADULAKO UNIVERSITY

ii

i-JaMCSIIX

2023

CEtmnCATE OF AWAttD

THIS IS TO CERTIFY THAT

NURUL HID AYAH MAT ZAIN
SITI NURKHAIRINAYAHIZAN
FARIZA HANIS ABDUL RAZAK
ISMASSABAH ISMAIL
NOR AZIDA MOHAMED NOH

HAS BEEN AWARDED THE

G0tt> AWAUD

IN

ERNATIONAL JASIN MULTIMEDIA AND COMPUTER SCIENCE INVENTION AND INNOVATION EXHIBITION (I JAMC5IIX)

8 NOVEMBER 2023

ASSOCIATtPROT^E^OR TS. ok! MOHD RASDI ZAINI ^B
RECTOR ^ ^
UiTM CAWANGAN MELAKA

APPENDIX 5

Letter For An Expert's Appointment

Kolej Pengajian Pengkomputeran, Informatik, dan Matematik

Universiti Teknologi MARA(Melaka)
Kampus Jasin
77300 Merlimau, Jasin
Melaka Bandaraya Bersejarah
Tel: (+606) 2645000

UNIVERSITI TEKNOLOGI MARA

Reference: 100 - KJM (FSKM 14«Haj
Date: uT" September 2023

MS.NURHANIS SURAYA ZAIM
Protech Synergy Sdn Ehd
Wisma Amlek, Level 1,
No. 15. Jalan Tandang,204A.
46050 Petaling Jaya.

Dear Ms.Nurhanis.

APPOINTMENT AS AN EXPERT REVIEWER FOR A CONCEPTUAL FRAMEWORK FOR GAMIFYING MOBILE HEALTH APPLICATION (GMHEALTH FRAMEWORK)

Thank you for agreeing to be an expert reviewer for the following student master's study. Below are the details:

NAME OF STUDENT	: SITI NURKHAIRINA BINTl VAHIZ.AN
U i TM STUDE NT NO.	.2020425626
FACULTY	: COLLEGE OF COMPUTING, INFORMATICS AND MATHEMATICS [KPPIM]
RESEARCH TITLE	: THE GMHEALTH: A CONCEPTUAL FRAMEWORK FOR GAMIFYING MOBILE HEALTH APPLICATION
MAIN SUP ERVISOR	: Ts. D R NU RU L H IDAYA H BINTI MAT ZAI N
CO-SUPERVSIOR	: PROF MADYA DR, FARIZ.A HANIS BT RAZAK

2 For your information, the student would like lo humbly solicit your opinions, suggestions, or recommendations lo review and validate her inilial framework: A Conceptual Framework for Gamifylng Mobile Health Application (GMHealth Framework).

3. We look forward to receiving your feedback. Kindly provide feedback on the form al your earliest convenience, preferably wilhin two weeks: 21 ^ September 2023 You can confirm your participation in this study and start the review process by referring to this link:
Expert Review Form

5. Your cooperation, time, and assistance are greatly appreciated. Once again, thank you in advance for your time and effort in making this research successful.

Thank you.

Sincerely,

Ts. DR. NURUL HID AYAH MAT ZAIN
Senior Lecturer
Universiti Teknologi MARA (UiTM) Cawangan Melaka
Kampus Jasin, 77300 Merlimau. Melaka
Ea nurul4i7@uiim.edu.my

APPENDIX 6

Expert's CV From The Healthcare Sector

MUHAMMAD NUR FIRDAUS BIN MOHD HILMI

ASSISTANT MEDICAL OFFICER

CONTACT **INFO**

FS 24/11/1997 (27 years old)

I ghuroba97@gmail.com

^ 0111-8717321

• f * Besut, Terengganu.

LANGUAGE

Malay
Spoken
Written
English
Spoken
Written

First Aid and CPR
Comprehension of physiology • • i
Understanding of medical • •
terminology
Work in team

2017 - year 1 semester 1: 2.79
2018 - year 1 semester 2:3.11
- year 2 semester 1: 3.20
2019 - year 2 semester 2: 3.50
- year 3 semester 1: 3.42
2020 - year 3 semester 2: 3.75

CGPA:3.19

A young and dedicated person. Culturally sensitive and able* to communicate with different background of people. Self motivated, hardworking, commited and have passion in learning and working. Able to cooperate effectively in team

WORK EXPERIENCE

• Disember 2023 - Resent - Diabetes Resource Center (DRC) Medical Hospital Sultanah Nur Zahir ah
- root Assessment
- Fundus Camera
- Counseling. Patient
- Self Monitoring Blood Glucose (5MBG)
-Blood Tacking

• October 2023 - November 2023 • Car Nose Throat (EXT) Hospital Suttanah Nur Zahirah
-Wound Dressing
-Change Tracheostomy Tube
-Ear suction
- Ear pack
-Assist Direct Laryngoscope
-Assist Medical Official in Open Theater Room

March 2023 - September 2023 - Emergency Department HoiplUI Sultan* Nur Zahirah :
-_-'-.-•_ L I• SuppOfl
-Trauma Life Support
-Malaysia Triage category
- Basic Electrocardiogram (ECG)
-Advance Life Support
Pre-Hospita! Care IPHO

February 2021 - March 2023- Klinik Kesihatan Kuala Besut:
-Emergency unit
•Pusat Kuarantin Rawatan COVKI (PKRC) I LI M Wilayah Timor.
-Pusat Pemberian Vaksin (PPV| Kota Put/a Besut.

EDUCATIONS

INSTITUT LATIHAN KEMENTERIAN KESIHATAN MALAYSIA (PEMBANTU PERUBATAN) ALOR SETAR, KEDAH — 2015-2019
Diploma Pembon tu *perubatan*

UNIVERSITITEKNOLOGI MARA JASIN MELAKA — **2015-2017**
Diploma in *Planting Industry Management*

SEKOLAH MENENGAH KEBANGSAAN NASIRUDIN SHAH — 2010-2014
Sij'il *pelajaran Malaysia*

APPENDIX 7

An Expert's CV From The Industry

MUHAMMAD SYARIFUDDIN BIN SA'ARI

WEB DEVELOPER

O O

OBJECTIVE

Looting for hill-time of contract position 35 Software Engineer (Front-End Developer}

PERSONAL STATEMENT

Muhammad Sya rif uddin Bin Sa'arL a dedicated person who .always focus on his task and completing each task, with ftill effort. Always confident and cheerful person when working in team with strong and warmth leadership characteristic.

LANGUANGES:

BAHASA MALAYSIA	**{EXCELLENT)**
ENGLISH	**{INTERMEDIATE)**
JAPANESE	**{BEGINNER)**

TECHNICAL SKILLS

- **ADOBE PHOTOSHOP. ADOBE ILLUSTRATOR for designing UI/ JX of systems far front-end faces**
- **Knowledge in front-end programming language such as HTML5. CSS, and JavaScript at intermediate level**
- **Basic knowledge of hack-end prog ramming language Such as PHP and MySOL server**
- **Knowledge in ol her PHP framework fiuth as Laravel and and cloud based server Such as GilHub**

PERSONAL SKILLS

Management

- **Able to manage every priority of every task from urgent and important unci II the least urgency task**
- **Well planned in completing every task before deadline.**

Communication

- **Always communicate and understanding the task given and finalised all of the detail (ask before executing the task.**

Technology

- **Well managed to be known every hardware device problem to be Fixed**
- **Kept up to date with the latest language and version of framework of programming languages**

EDUCATION

UiTM CAWANGAN TERENGGANU KAMPUS KUALA TERENGGANU
DIPLOMA IN COMPUTER SCIENCE
2015-2018 I CGPA - *2.23 J i.OO*

UiTM CAWANGAN MELAKA KAMPUS JASIN
BACHELOR OF COMPUTER SCIENCE {HONS.) IN MULTIMEDIA COMPUTING
2018-2021 I CGPA - 3.D2 / J.CO

APPENDIX 8

Certificates for the Expert's contributions

CERTIFICATE

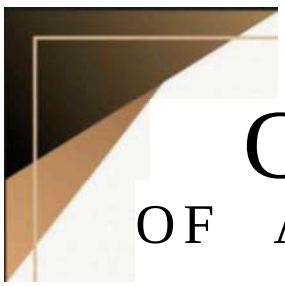
W o i- A C: K N o w 1.1: D G I: M I: N T

THIS CERTIFICATE IS PROUDLY PRESENTED TO:

Thank you for your invaluable contribution as an expert reviewer. Your expertise and insights have played a crucial role in ensuring the quality and credibility of the work, and we truly appreciate the time and effort you invested in this process.

Postgraduate Student
Master in Science (Computer Science)
UiTM Shah Alam

Senior Lecturer Universiti Teknologi M/
(UiTM) Cawangan Melaka Kampus Jasin
77300 Merlimau. Melaka

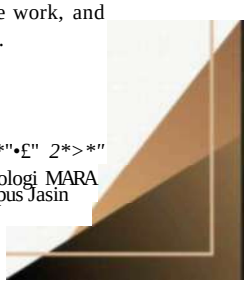


CERTIFICATE

OF ACKNOWLEDGEMENT

THIS CERTIFICATE IS PROUDLY PRESENTED TO:

Thank you for your invaluable contribution as an expert reviewer. Your expertise and insights have played a crucial role in ensuring the quality and credibility of the work, and we truly appreciate the time and effort you invested in this process.



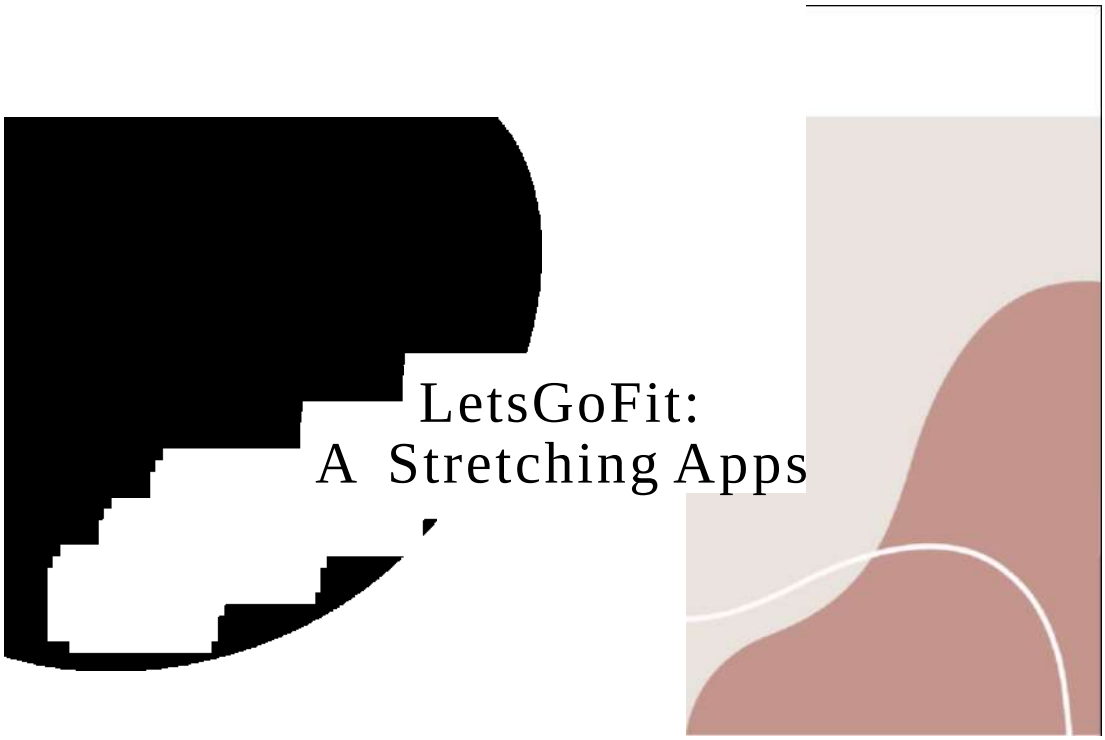
li-l/Pr- /W tiisf"'^ Iri+fo /"•£" 2*>*"*

Postgraduate Student
Master in Science (Computer Science)
UiTM Shah Alam

Senior Lecturer Universiti Teknologi MARA
(UiTM) Cawangan Melaka Kampus Jasin
77300 Merlimau, Melaka

APPENDIX 9

Material for User's Evaluation Procedure



Laptop

Android phone

Android USB wire

Procedure & Step :

1. Open the link given to download .apk file

(LETSGOFIT EVALUATION - Google Drive)

1. Download the .apkfile
2. Connect your Android smartphones with the USB wire.
3. Copy and paste the .apkfile in any of your Android's directory.
4. The logo of the apps will pop-up and click the "install" option.
5. The application had been installed and ready to explore.
6. After exploring the apps, you need to fill the evaluation form in the given link.
7. Link : Evaluation of LetsGoFit : A Stretching Fitness Apps (google.com)
8. Thankyou for your help :)

* This application might have a few advertisement,

Just click "watch video" and click on the exit (x) icon to perform the next task.

-Deadline 17/5/2024 for submission of evaluation form.

APPENDIX 10

Research Ethics Approval

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• I'^'iiwliJiLj:! -.l-LIL **InutjMt**

MARA

Raferanca : HW-TWCPI rsi/B)
Our relarence : RECAK/2azz (PG/MR/143)
Dale :29JuneZ022

T4 Di Hurul Hidayah blnti Mil Zaln
ISitl Nurkhalrina blntl Yahiian -20ZIM25e26}
Faculty of Computer arid Mathematical Sciences.
UITM Malaka Branch
Jaaln Cam pus
77BDD Merllmaij
Utaka

Dear Te Dr NurJ Hidayah,

APPROVAL LETTER - UITM RESEARCH ETHICS COMMITTEE

Thank you for submitling your research propos-al to the Research Ethica Cammltee (REC). Aner considering your application, Ihe Conmiltee approved your proposal titled 'The GMheallh. A Framework 1or Gamlfylng Mobile Health Application" at LhTM Jaaln, Malaka.

Details of the-approval are as lullows.

R*1. number.	**REC'a&2Ci22** ***trG.WR.H43)***
Aupruval PtiicJ	**29 June 2022 mill 31 Decemher 20Z2**
Authorised personnel:	1. TaDr Nurul Hidayah blnli MaLZain Z. Siti NurUiairlna b'inli Yahizan

The LhTM Raaearch Elhicj Committee oparalas In accordance 1o 1he ICH Good Clinical Practice Guidelines, Malaysian Good Clinical Practice Guidelines and 1he Declaralion or HeleinKi. The approval ol Ihia project la conditional upon your continuing compliance ivih these guidelines and decla radon.

We draw bo your attention me requiremenl thai a report on Ihla research, rnuat ba submitted every 12 months rrom Die date of Ihe approval or on 1he complelion of 1he prefect whichever ocoune Arel. Faiure lo submit reports will result In withdrawal ol consem tor Die project lo proceed. Amendments, If any, to 1he study documents are 1o be aubmllted to 1he REC for approval.

If vou requre lurmar Information, please contact 1he REC Secretariat at 0j-r;5iiBD&!i'r}3-5S44Z7S4 or email at racEecrelarialrOjullni.edu.m/.

Yours sincerely,

EMERITUS PROFESSQR/DATO' DR RAYMOND AZMAN ALI
Chairman
UiTM Research E1hcs Commrtlee

e.c Rector. LhTM Melaka Branch

UniiTmN Trtjwfep MARA
All* J, hflguiUA *YiJK'UJA*
«HV Slah Attn. Srt%^». M« * *H*.*
Tft|-i0!hH4lSO4/!3;

APPENDIX 11

Face Validations' Questionnaires

Face Validation for the GM Health Framework Instrument

Assalornualaikum and a very good day. I am Sir! tJurkl-.airina FJmri Yahlian, a Haater sludeni frani the College of Computing, Informatics and Mathematics, UITH Shah JUam.

Looking at your rich background m academic, research,or Industrial experlise, we would like ra humbly solicit your expertise In development instrtimeiirts. Hence, E am inviting you to participate In rhia Face validotlon evolualion for Hit GM Health Framework instranient.

The- study obtained ethics committee approval from ihe UITM Research Ethics Comnlttee (HEC/0b/2QZa (PG/HR/UJ). The UITM Research Ethics Commitree operates m accordance to the ICH Goad Clinical Practice Guidelines, Malaysian Good Clinical Practice Guidelines and Hie Declaration of Hels Inkl.

Introduction or Research

En this technological era. rhe potential oF gamificarion is highly acceptable in **many** sectors, such a± marketing, bu^ness. education and healrh. The ownership aF smartphones has became wider, arid smarlphenes have became one platform to make users more engaged in using mobile healrh services m their daily lives. Hence, this study proposed a conceptual framework far aamlhed mHealih UfipiLU" ^HL..

Purpose of Research

This study alms to develop, a new conceptual fromework ForgamiFied mHealrh applications. In rhia srudy, gamlfied mHeolth applications ore defined as associate game elements in mobile healrh applications. It Is not just designed For entertainment hut aims ra asaist users In healthcare-reinred areas, far example, maintaining their health status cSreypouv, 2020}.

Research Procedure

The panel needs ra campl&re TWO (!) sections:

- ' Section A. Demography
- • Section Et Face Validation Evaluation.

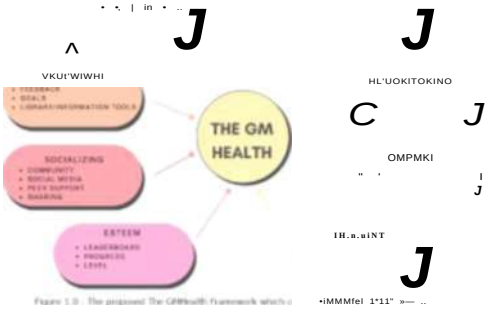
The feedback recti ved use is m value of agree (YES] *and* disag ree **[NO).** Experts' suggestions and feedback *are* encouraged to improve the Instrument.

Part r. •v=ll• .'ii In Research

Your participation m this research is entirety volunrory. You may refuse ro participate in the study or withdraw from participating, m the research at any time without penalty.

UiitlPM –, 77: –

THE PROPOSED CONCEPTUAL FRAMEWORK **FOR GAMIFIED MOBILE** HEALTH (GM HEALTH FRAMEWORK)



INSTRUCTION TO EXPERT

Deur •.-•pel!:.

The proposed GM Health Framework contains eight dimensions. 26 elements related lo conceptual fromework for garnilied mobile health. This section needs your expert judgement on the **degree** of **relevance** of eoch element to the conceptual framework. Your review should be based on the definition ond relevant terminologies that are provided to you. Please be as objective and constructive as passible in your review and use me following rating scale.

1 = Not relevant
2 = Element needs some revision
5 = Relevant but needs some minor
4 = Highly relevant

IdHH, IOSOPV Fiu^JUUnb IirHIIIIiri -uiin^IM-iliLiimJ

Participation lit Research

your pOrtiCi buliOn ill IhiS research I a entirety voluntary. VOu rrlfly rtFuM Fa participate in Fhe siudy or withdraw From parricipan Ipg in the ieseerch or any n me without jtfnu iy.

Benefit of Research

TI.is study beneFits aumified inrtealth developers as a guideline reproducegandtled in Health flppllcotions that are moie engaging and Bltrociwe. Besides, medical preo rioners can use the garni Ned mHealth application as on economical owareneu and educate rhe patienr or user to improve their ouality of lite. In addition, users con easily Track their health condition and engage mare with the mobile health application, information obtained From this research wil benefit the individuals, researchers, Institutions, ond community to advance knowledge and fulure practise.

The research does of cuinuinuny harmful risks ra fltt perl icipanf. The participant Freely withdraws from rhls iesearch proptci.

The Investigators will keep your information confidential and mil not be mode li public unless disclosure Is required by law. By signing this consent Icnm, you will ouihorlze the review oF retards, analysis ond use oF thedoFa Fram Fhls research.

Il you have any questions about this research ar your n uh i;, pit j i - -un ICLI

- * Postgrad student: Sitl NuikhelrIna Blnn Yehiwn COllc-MFHSuO)
- * MamsupervisorTs.Dr.NurulHidoyohBlnn MaiZom(0la-372e5D6)
- * CO-SUperVISOr: PrQf. MadyO Dr. FOniO Hanls Bihli Abdul fiBiOk

SECTION B EXPERT REVIEWER CONSENT FORM

fl. 1. Category of Expert:

Mwk only one olta

Academic kins

Industry

IfiiUi ill Su Pki

£l. ***Esteem***

Opera-or i: Create a feelings of admiration and respect for the urser

The elements for Esteem theme:

Lcujcrbcurt]
p n g n n
Level

2.2. General comments about the element:

23. *Enjoyment*

Operational Definition: Creating a game-like expe'ierce.

The elements for Enjoyment theme:

WaK onry (JIM enalpei AILT

Bodoes				
Chofciiges				
Virtual	c j	0	0	0
P*.	0	0	0	0

APPENDIX 12

Content Validations' Questionnaires

Expert Review: A Conceptual Framework for Gamified Mobile Health Application

SECTION C ! VALIDATION OF A CONCEPTUAL FRAMEWORK P GAMIFIED MOBILE HEALTH -iGMHEftLTH FRAMEWORK]

INTRODUCTION TO GMHEALTH FRAMEWORK

figure 10 shows the tH Health framework consists or eiiniinemesrhat *can* picmcte belle' uiei e gjg=me '. " -'s o'£ocs.ed " c n e w r » i • e ?r" cice '*' lhe existing framework, The Wheel of Sukr hy AjMarshedi (2015).

The main purpose ol '"e Wltesl c' iu-- is 1c ;s* it n •'« self-management o iicL *"•;i k • •.•• ir^csuts n Sin. J •'•liil.-iii. I h-; luivows'k e o" ii-Le i " io l -i L*~j-*e gem ' i i; ! o cn-.l o=hc-. 'J. . i ihin'i|= ?" i£ J: l i« '-"/heel £l h.i–i provide?, a guideli-e -a deiig l .J gj™ified sell-management system for diatw Tire framework was validated by the authors using a mixed-method study (AlMarshedietal., 2017). The Wrteel of Sukr consists of B themes: fun, esteem gron'th " 31 i vet ion f jitsiii-aai iry iioi^i iring, self-'esre^-YMtion ond Lef- management.

it of GM Health comes out with new additional • • ail ?! s -is c em?ivrf " ";r -n - aromote Detter user engagement for users rouse mobile health aOjli:^1ic-ii? iitLz-irg ic --rep'esenrc- ". self-monitoring, esteem, improvement.. MctaHdng, guidance, •r.ontinuos.and enjoyment.

The addition of the new Iheme. 'Guidance' will help the user to be r "o - i i the mobi e " ecu i :0|-H i.ifior cue : ec"i o "ic •« i-iiiii- = i-i e>.oi- er.-.-. which in turn makes usetsmore [c-ruse-a on set' iiig o–a JCll e- iig n g–,e' gocM. ; sioL'ii ?1 ci.. i^iJ ' Jthc " i ¨ Tiiai thi 'tuics'ite' rr;riH -;ii:o niche: ••ld uw feel u sense or gu cj ' ; e with • e L'e&sno= ot s pel ic-ncl iiicich lo keep them s iyo*J-*J <H Jt ii»r rtfi .i»if -.linJuli" J, Hjiw J<«lifl<u-*i.*ui(Juiii] Iil«sI^ Jvj . . . ii (i.e.. e-spedally toward hea 'I–i^i cietarv IraOitsl j ' c iicidcie adherence (Tsicuris e' ill. *202*^:. I "le'e'-ji e. " •ii* e ement -H <eep the-n -i ; ' e mo ¨ v c e J o on-^o of with the mobile opu ioolion ir long -eim fAfycufii et al., 2014).

The CM Health framework remained the ex stir-5 element and proposed a new elernetir includ ny Ms ^.idciKe 1-ie "e J 2 sei-ero charges lothe elements suLh us I.i-i-.i ,. • I IKUIKK ii.i'.' I*, i.i.-. ji.t... |Eiii|tfi ei .J. K-IB. •-•."». .iwj-'rv u cl •J., !QM), 'Reminder' JTamacho-Rivera et al , KiTO; White et al.. 201*. Adams et o l, Sai7), 'Virtual Coache5'(Tsiouri5 et al..zn20J,'Chatbc«' (Afyouni et al., 2019)ond Virtual Agents'! Lim et al., 2Q20|. Accord ing to the latest research, there is a need -.ji mobi f -ecu "1 j^|i l ;jti-ji~ ce^iaii vatu'e? " if ;;_lc 5e c^JeJ to ensue EdT«r user engagement while using mobile health app i vr k ns

1 ^ F5teem

Operational Defirition: Create a feelings ot admiration and respect for the user

The elements for Esteem theme:

Leoderboord	
P™,™	
Level	O

1 &- Genera l cam me nts about the element:

1 ~> *Enjoyment*

Ope'ationa Definition: Creating a game-lik-e expern

The elements for Enjoyment ftieme:

•Mv.	O	O	O	O
chakeng«5				
Virtual	O	0	O	O
Point	'. J			

Continuous

Operational Definition: Creating a fruitful e>penence for the user, where gamitication in a social and psychological context can result in personal growth in Term erf managing the activities, learning new habits, and understanding their health condition better.

The elements for Continuous: theme:

ins *c/al per fir/.*

Srory/Thar*	O	
Notification		O
« m i n * r		O

Zfl. General comment about the element:

25. Would you like to odd any theme or 1 Framework? If yes, please suggest. -1 The GmHealth

APPENDIX 13

Prototype's Evaluation Questionnaires

1£2.2G.1&G1 **FW** **EiaLdlion u1** LaiiGLiFln. ASraiL'iriqF**Musi A>ii**

Evaluation of LetsGoFit: A Stretching Fitness Apps

Tick all the question based on your experience while exploring the application given.

Indicator
1 = Strongly Disagree
1 = Disagree
5 = Neutral
4 = Ag ree
5 = Strongly Agree

H. Self-Re presentation"

Mark cnty one *ova)* per ro^

I have rhe free con to choose haw I represent myself	o	o	a	o	•
I *can* personalize my profile cased on my interests	o	o	*r:*	o	•
Gamified applications with options catch my attention	o	o	*CD*	o	o

1SZ2IS. 1QB1 FW EiaLdlfri m LrtsQ[rFt:ABJralcrtngHiiKiAaf4

11. E stc c m *

Mark oj?Jy oj?e *oval per* ro *w.*

I am able to keep trade of my gamified application	o	o	o	r;	o
I am able ID monitor my progress easly.		o	o		o
I am able to keep trade of my occompEshments within the gamified application.	o	o	o		o
The application provides dear progress Indicators, allowing m to know my position immediately.	o	o	o	o	o
I am able to understand what is expected of me in the next stage	o	o	o		o

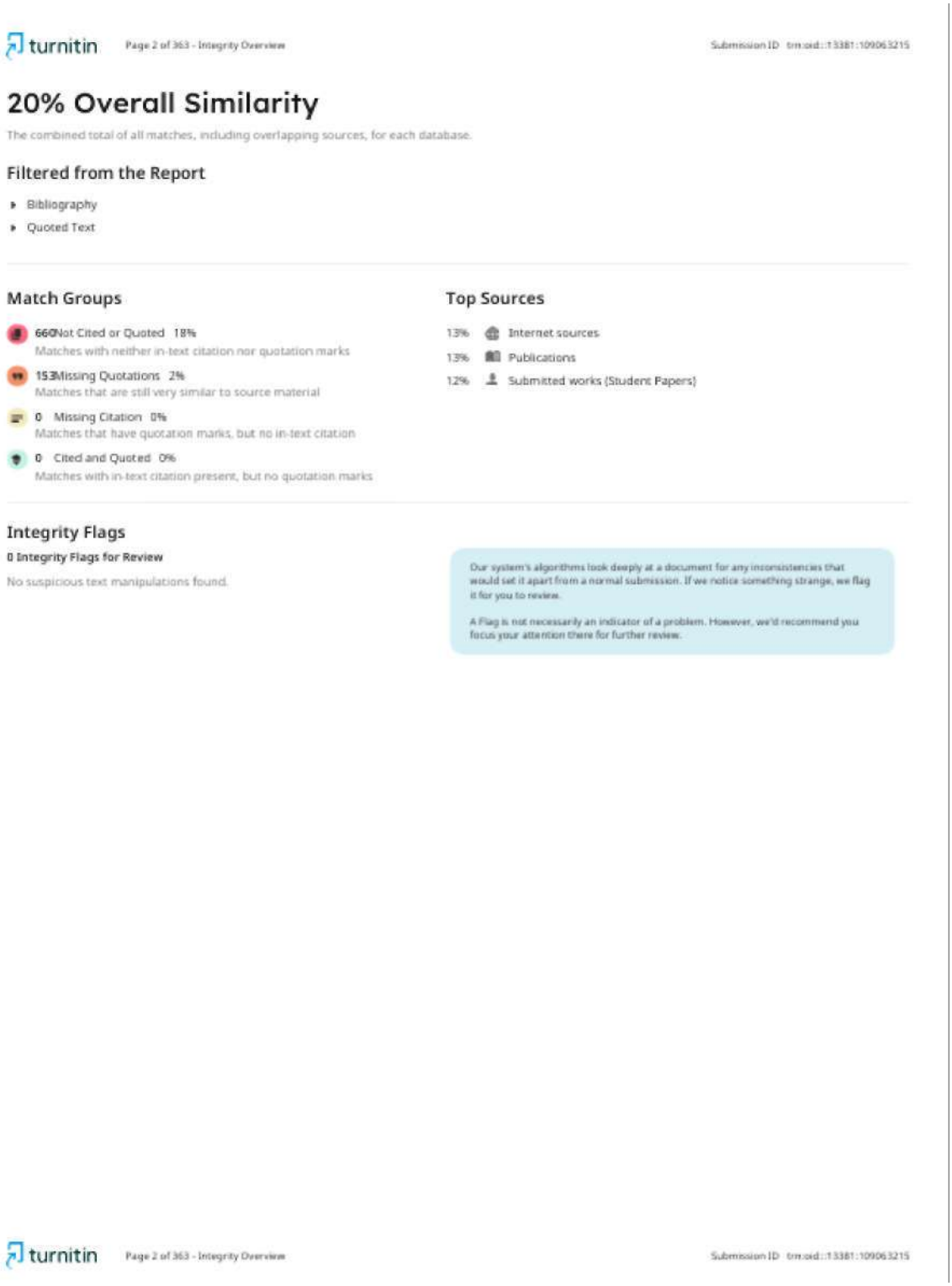
15- Continuous'

The interface of the gamified application captures my		O	O	G	O
	o	o	o	o	o
I find myself becoming more immersed in the gamified application	O	o	o	o	o
The gamified mobile applications positive	o	o	o	c	o

16. Any eonninenrt/sugg*stion^r*cQiTinn*:rtdcitioni:

APPENDIX 14

Index Similarity



turnitin Page 2 of 363 - Integrity Overview Submission ID trn:oid::1:3381:109063215

20% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

Filtered from the Report

- Bibliography
- Quoted Text

Match Groups

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AUTHOR'S PROFILE

Siti Nurkhairina binti Yahizan is a dedicated academic achiever and a passionate technology enthusiast. She earned her First-Class Honours degree in Bachelor of Computer Science (Hons.) Multimedia Computing (2018-2020) and a Diploma in Computer Science (2015-2018) from Universiti Teknologi MARA (UiTM), Melaka Branch, Jasin Campus. She further advanced her academic pursuits by completing a master's degree in computer science at UiTM Shah Alam, specializing in the field of gamification.

Throughout her Master's journey, she proactively expanded her professional capabilities by working in diverse roles, including Marketing Executive, Research Assistant, Freelance Photographer and Graphic Designer, and Teaching Assistant. These multifaceted experiences strengthened her competencies in communication, research, multimedia production, branding, and academic facilitation.

Khairina's areas of interest span a variety of interdisciplinary topics, including game design, gamification elements, mobile health applications (mHealth), multimedia, and human-computer interaction. Beyond her academic work, she has a strong passion for photography, continuously honing her skills in capturing moments and enhancing images through advanced photography and editing techniques. Among her notable accomplishments are:

- Representing UiTM as the sole participant in the IEEE Malaysia Final Year Project (FYP) Competition 2020 and receiving a Merit Award.

- **Winning Gold Awards at the *I-JamCSIIX* competitions in both 2020 and 2023.**
- **Securing 1 st Runner-Up in UiTM' s Health Competition for Rare Diseases.**
- **Receiving a consolation prize in a poster competition organized by Dewan Bahasa dan Pustaka Malaysia and Keretapi Tanah Melayu Berhad.**

Siti Nurkhairina's dedication to her academic and extracurricular endeavours highlights her commitment to excellence and innovation in the field of computer science and beyond.

LIST OF PUBLICATIONS:

Pioneering a Gamified Mobile Health Framework. *2023 IEEE 21st Student Conference on Research and Development, SCOReD 2023,* **208-213. https://doi.org/10.1109/SCOReD60679.2023.10563872**

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