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The Rewardable Persuasive Model: A Mobile Exergame Conceptual Design Model that Facilitates Youths to Exercise through Mobile Gaming

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***Abstract*— This study seeks to assess current design models to propose a conceptual design model for a mobile exergame that promotes physical activity among youths. Encouraging youths to engage in physical activity rather than remaining sedentary is essential due to the numerous health benefits associated with regular exercise. Exercise is a subset of physical activity structured for fitness. Exergames have the potential to inspire youths to be active by combining exercise and gaming engagingly and enjoyably. The proliferation of mobile gaming has further broadened the availability and accessibility of exergames. In this study, we conducted four stages of information gathering to assess and propose a mobile exergame conceptual design model: a literature review, a user survey, expert reviews, and in-depth user interviews. Based on the study's findings, we identified appropriate components and their rationale by adapting an existing design model to our conceptual design model for a mobile exergame. This conceptual design model is called the Rewardable Persuasive Model (RPM). This model aims to help youths achieve their weekly physical activity targets using an engaging and functional mobile application (app). The app incentivizes exercise by integrating it as a key element for unlocking gameplay. With the introduction of these components, an exergame can be designed to engage youths and facilitate physical activity effectively. In a future study, youths will use an app to assess the RPM's effectiveness over time. This assessment will ascertain its appropriateness for facilitating exercise during inactivity.**

***Keywords*—Design model; mobile exergames; mobile gaming; persuasive; rewardable.**

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I. INTRODUCTION

The latest Malaysian National Health and Morbidity Survey findings showed that one in three adults are physically inactive, and almost half lead a sedentary lifestyle [1]. Regular physical activity (PA) can help prevent non-communicable diseases (NCDs), where the four top NCDs in Malaysia are diabetes, hypertension, high cholesterol, and obesity. The increasing trend in overweight and obesity among Malaysian adults in the last 13 years is a cause for concern [1], as a substantial proportion of adults in Malaysia engage in a sedentary lifestyle characterized by low PA and unhealthy diets [2], [3].

An exergame (exercise and game) is an interactive digital game that incorporates physical exertion as the primary factor in achieving the game's objective within the digital environment [4]. Interacting with exergames can meet the recommended weekly PA [5]. Exergame is an inventive way to increase PA levels among sedentary university students [6]. It is more engaging than traditional exercise, leading to increased belief in capability and a greater desire to participate in exergaming in the future. Mobile exergames on smartphones further mobilize the exergame experience [7], with 'Pokémon Go' being one example.

This study aims to review existing design models and propose a mobile exergame conceptual design model that facilitates PA for youths. We incorporated a User-Centered Design (UCD) approach to include the youths and experts in the design process to ensure a well-rounded design model that caters to the youths' needs. The resulting conceptual design model would facilitate PA for youths to ensure long-term health benefits.

A. Importance of Physical Activity

Regular PA can positively affect the human body's physiological and psychological aspects. PA refers to any activity of the body's skeletal muscles that leads to energy expenditure [5]. Exercise is a component of PA that is planned and structured to enhance or sustain physical fitness. A sedentary lifestyle is when a person engages in minimal or no physical activity as part of their daily routine. Sedentary activities, like using mobile devices for reading or gaming, are typically done whilst sitting or reclining. A highly sedentary lifestyle and low cardiorespiratory fitness are strongly linked to higher premature mortality [8].

Increasing PA levels among youths is essential, given the numerous health benefits of regular PA. However, data suggest that many youths are not meeting PA guidelines [9]. Innovative approaches are needed to engage youths in PA and overcome barriers such as limited access to resources and lack of motivation [10].

B. Youths

Current undergraduates in university, predominantly born from the mid-1990s through the 2000s, are part of the generation commonly known as Generation Z [11]. As digital natives, these youths have been online since childhood and are proficient with smartphones and tablets [12]. They depend on their devices to complete their daily tasks, and they prefer receiving bite-sized information for their education, thus their partiality to using handheld devices when learning [13]. Smartphone usage is common among them, and its utilization (for work or entertainment) is generally conducted when sedentary.

Certain factors affect youths' motivation to exercise when engaging in any PA. According to [14], youths are motivated to be involved in PA when there are high attraction factors: being active and healthy, being able to progressively master skills, getting their accomplishments recognized, and interacting/supporting one another socially. In contrast, youths are averse to doing PA when there are possibilities of incompetence, injury occurrence, and lack of social support. Youths are motivated to be involved in PA when the attraction factors are high, and the aversion factors are low. Designing exergames that address these concerns would ensure youths' commitment to PA for the long term. In designing a mobile exergames design model, care should be emphasized in designing components that can encourage physical movement even when playing games.

C. Exergames

Exergames can potentially increase PA levels among youths by blending exercise and gaming in an engaging and fun way [15]. Unlike traditional video games that often promote sedentary behavior, exergames encourage players to move their bodies to interact with the game, thereby increasing energy expenditure and overall PA. Also, most exergames require additional accessories, making the mobilizing experience restrictive and cumbersome [16], [17]. On the other hand, a mobile exergame can be installed on a smartphone, a device readily available to youths.

The rise of mobile gaming has further expanded the reach and accessibility of exergames. Games like Pokémon Go, which integrates gameplay with the physical environment, have demonstrated the ability to increase PA, especially among previously inactive populations [18], [19]. As technology advances, it is expected that the quality and immersive nature of exergames will only improve, making them even more engaging and effective at promoting PA [20], [21], [22].

Moreover, studies indicate that exergames offer cognitive, social, and physical health benefits. One study found that preschool children who participated in exergame-based interventions demonstrated more significant improvements in executive function than those who received traditional PA training [23]. The social aspects of exergames, such as the ability to compete or collaborate with peers, can also enhance engagement and motivation for PA.

D. Design Models

When designing exergames, it is essential to consider the underlying motivational factors that can drive sustained engagement. A well-designed design model that complements the elements of physical exercise and motivation can create successful exergames [24]. Csikszentmihalyi's Flow Theory (FT) [25] has long defined a psychological flow state in which players are in the zone, with no external variables impeding development. Components from this model were tested for compatibility with video games and determined to be viable for future adoption and evolution, with the emergence of Sweetser & Wyeth's GameFlow Model (GFM) [26] and Sinclair et al.'s Dual Flow Model (DFM) [27]. While GFM was introduced for video and serious games, DFM was explicitly proposed for exergame usage. The DFM focused on achieving the flow state of attractiveness and effectiveness during gameplay, corresponding to the player's psychological and physiological conditions.

Though several mobile exergames are on the market [18], they have yet to be thoroughly researched against the above design models, which are more suited for on-site exergames. A study by [28] created questionnaires for their mobile exergame called "Exermon", that included statements reflecting on three different design models, namely the FT, GFM, and DFM, presenting a mobile exergame idea that focuses on the physical, motivational, engagement, and enjoyment impacts of playing the game. For mobile-dependent individuals, mobile exergames can motivate physical activity that is both enjoyable and physically productive during gameplay.

Reward motivation has been identified as a key driver of behavior change in the context of PA [29], [30], [31]. Existing research has explored various reward-based design models for exergames targeting different age groups, including older adults [32] and students in physical education classes [33]. However, the specific design considerations for promoting reward motivation in exergames for youths still need to be fully addressed.

II. Materials and Methods

Four stages were followed to determine the most suitable components for conceptualizing a proposed mobile exergame design model. The stages include a literature review, a survey with users, a review with experts in their field, and an in-depth interview with users.

A. Stage 1: Literature Review

In the first stage, we reviewed existing theories and models towards developing a mobile exergame design model. We noted that the Pleasurable Persuasive Model (PPM) [34], [35] could be adapted to fit the mobile environment. We also reviewed other models/theories: Fogg's Behavior Model [36], [24], Vroom's Expectancy Theory [37], [38], and the FITT Principle [39].

B. Stage 2: Survey with Users

The second stage involved gathering data through a survey conducted among undergraduate students at a public university [14]. The user data in this study was gathered via an internet-based questionnaire. The survey consisted of two questionnaires that collected data from the respondents on their socio-demographic profile (including age, gender, race, income, and smartphone usage) and health status (such as physical activity level and average sitting time) using a pre-validated, self-administered questionnaire called the International Physical Activity Questionnaire (IPAQ) [40], [41]. From the findings in the study, User Personas (UPs) were created as representations of current Malaysian youths in terms of their PA levels and smartphone usage.

After completing the first two stages, we conceptualized an early version of our proposed conceptual design model, the Rewardable Persuasive Model (RPM), for review by experts and users in Stages 3 and 4, respectively. This first version is called RPM-version1 (RPMv1). We also created a Low-Fidelity (Lo-fi) prototype designed with the RPMv1.

C. Stage 3: Experts' Review

The third stage involved interviewing three academic experts and two fitness experts. The experts were approached for advice on their respective fields. All the experts have more than five years of working experience, and the three academicians have doctorates. These experts would validate and verify the RPMv1, a list of selected physical exercises, and/or review the Lo-fi prototype.

Each reviewer received an Expert Reviewer (ER) Brief containing consent for participation and a review form. The review form consisted of items that the experts needed to review depending on their field of expertise:

- Item 1: RPMv1 Components
- Item 2: RPM Framework
- Item 3: Select Physical Exercises' Information
- Item 4: Lo-fi prototype

Table 1 summarizes the ERs' field of expertise and the items they needed to review in the ER Brief.

TABLE I
ERS' FIELD OF EXPERTISE AND ITEMS TO REVIEW

ER	Field of expertise	Item 1	2	3	4
ER 1	Health & Exercise Psychology (Health Behavior), Food & Nutrition, Nutritional Cognitive Neuroscience, Health & Fitness, Sports in Islam	/	/	/	/
ER 2	User Experience, User Interface Design, Ethnography, Sensitive Research Methods, Social Media Warfare	/	/	/	/
ER 3	Computer Graphics, Computer Vision, Games, Extended Reality, Computer Interaction	/	/	/	/
ER 4	Fitness Training		/	/	
ER 5	Fitness Training		/	/	

/ Indicate the Item each ER would review:
Item 1 - RPMv1 Components
Item 2 - RPM Framework
Item 3 - Select Physical Exercises' Information
Item 4 - Lo-fi prototype

D. Stage 4: Interview with Users

The fourth and final stage involved interviewing eight participants online about their views on engaging in fitness activities. The interview process had three parts. In part 1, we inquired about their demographic profile and smartphone usage. In part 2, we delved into their feedback on the motivation, ability, and triggers needed to engage in fitness activities. Finally, in part 3, we administered the IPAQ to assess their PA levels and habits. We also reviewed the components of the RPMv1 with them.

III. RESULTS AND DISCUSSION

The findings in each stage of the methodology are explained.

A. Stage 1: Literature Review

One of the first theories we note is the Fogg Behavior Model (FBM) [36], which states that three elements must converge at the exact moment for a target behavior to occur: Motivation, Ability, and Trigger/Prompt. Thus, to perform a target behavior, a person must be persuaded to be motivated, able to enact the behavior, and triggered to execute it (refer to Fig. 1 of the FBM).

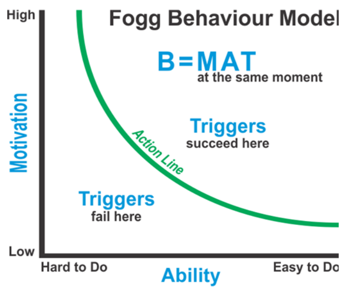

Fig. 1 The Fogg Behavior Model (FBM) [36]

Another theory is the Pleasurable Persuasive Model (PPM) [34], which motivates users to continue physical exercise over time. The PPM's development directly referenced the FBM and a truncated version of the FITT Principle [39], called 'Regular Physical.' The PPM has four design strategies: Pleasure, Guidance, Encouragement, and Reminder. This ensures that the players will be encouraged to exercise effectively and regularly (refer to Fig. 2 of the PPM).

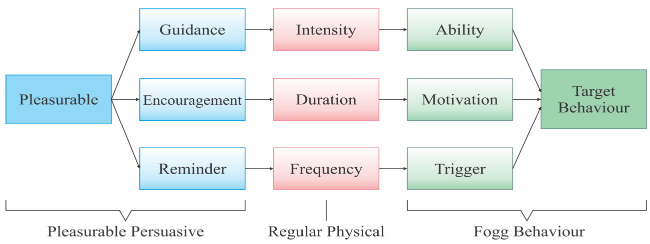

Fig. 2 The Pleasurable Persuasive Model (PPM) [34]

The Vroom Expectancy Theory (VET), proposed by Victor Vroom in 1964, is a motivational theory that focuses on the relationship between an individual's expectations, effort, and performance outcomes [37]. The theory has three key elements: Expectancy, Instrumentality, and Valence. A person is motivated to a degree that (a) effort will lead to acceptable performance (Expectancy), (b) performance will be rewarded (Instrumentality), and (c) the value of the rewards is highly positive (Valence).

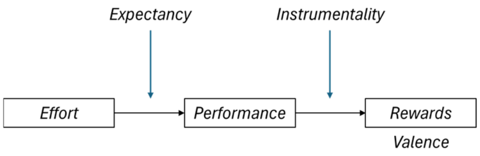

Fig. 3 The Vroom Expectancy Theory (VET) [37]

We note from the theory that in the context of encouraging people to do things when rewards are present, individuals would be motivated to engage in a particular behavior or task if they believe that their efforts will lead to a desired outcome and that there is a clear connection between their performance and the reward. The PPM is based on the FBM, and we adapted the PPM to enable the ability to mobilize the experience, thus incorporating the VET by including incentives for motivating individuals. Considering these factors and ensuring that expectations are aligned with rewards to maximize motivation and performance is essential.

B. Stage 2: Survey with Users

Thirty-five respondents participated in the survey. From the findings, three User Personas (UPs) were derived based on their weekly PA levels: Low, Moderate, and High. It was found that income status, time management, daily smartphone usage, and fitness self-rating directly correlate with PA levels. The UPs share a common factor: smartphone usage is essential to manage the youths' daily activities regardless of their PA. The derived UPs would assist in conceptualizing a mobile exergame design model by concentrating on the influencing factors from the Low and Moderate PA level groups: time management, financial constraints, and communications (refer to Table 2 of the UPs of the Youths).

TABLE II
SUMMARY OF THE USER PERSONAS (YOUTHS)

User Persona	 Alia	 Baharin	 Kelvin
PA Level	Low	Moderate	High
Pain Points	- Communications Financial constraints - Time management menu	Financial constraints - Time management	- Time management
Motivation	Complete the degree course - Lose weight	Complete the degree course Find a high-paying job	Complete the degree course - Find a job with a work/life balance

We note that the respondents could utilize their sedentary time to engage in some fitness activities for time management. To encourage them to do so, a mobile app that rewards performing fitness actions with gameplay could be developed. There are mobile games that use micro-transactions or watching ads to further gameplay. We could use this similar concept by performing fitness actions instead to ease financial constraints. For communications, they can be motivated to see their peers on a scoreboard to know how much they have carried out/progress in fitness or games.

With the findings from these two stages, we conceptualized the first version of our proposed model: the RPMv1. We adapted the PPM to our RPMv1 by replacing two components in the Pleasurable Persuasive segment: Encouragement to Value and Pleasurable to Reward. This is done to align with the VET to accommodate the value of the performance and obtain rewards. This gives individuals a sense of choice and allows them to control their preferences. We also note that the 'Regular Physical' segment was adapted from the FITT Principle, and we reinstated it to its original format to include 'Type' as the PPM was developed for a single fitness activity, stationary biking. The FITT principle (an acronym for Frequency, Intensity, Time, and Type) is a method of creating an efficient workout plan. It offers the structure to initiate fitness activity for both cardiovascular and strength training, depending on a person's current fitness level and goals. By reinstating the FITT Principle, multiple fitness activities can be performed (see Fig. 4 of the RPMv1 within the RPM Framework (version 1)).

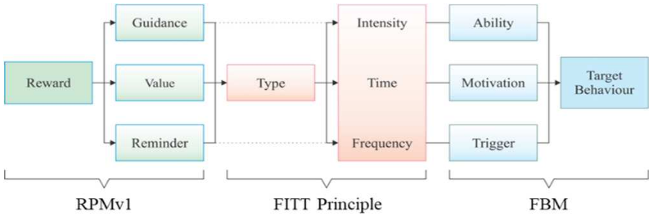

Fig. 4 The RPMv1 within the RPM Framework (version 1)

The RPMv1 is an early version of a mobile exergame conceptual design model to facilitate PA for players through accessible mobile exergaming. The concept of the design model is that the player needs to execute a fitness activity to receive a reward based on the intensity of the fitness performed. In modern digital games, rewards provide social meaning for players primarily through motivation, enhanced status within gaming societies, and the use of rewards as social tools. Rewards can take many forms, depending on the user's motivation: achievement, competition, or pleasure. The RPM Framework (version 1) is part of a larger framework consisting of the RPMv1, an established design principle (the FITT Principle), and an existing psychological model (the FBM).

The Reward component is the reward received when a task is done. This is possible when the three components of Guidance, Value, and Reminder to perform PA converge. To play a mobile game, the player must do the required physical exercise to receive a reward. The Guidance component guides users in performing the PA correctly to achieve the reward. A video representation and instructions are available for review by the player before and during the exercise required to achieve the reward. The Value component gives players options to select the exercise based on the time it takes to obtain a required reward once they have completed specific exercises. The more time it takes to execute a fitness activity, the higher the reward value. Finally, the Reminder component reminds players via timer and sound effects during the exercise session to ensure completion and provide a history of what exercises have been done to keep players informed.

The RPMv1 motivates users to exercise through a reward-based system. Each reward received has a gameplay value based on the type of exercise selected for gaming purposes. The model can be used in a mobile setting (i.e., smartphone), and the exercise is not dependent on extensive exercise equipment. Thus, various forms of body weight exercises can be implemented. The model relies on visual and auditory feedback to guide, remind, and show the reward value to the players. There is a cohesive relationship between the components in the Reward section and the FITT Principle, which allows various exercises to be performed in a single fitness routine/activity.

High-Intensity Interval Training (HIIT) is an exercise strategy that uses body weight predominantly as resistance [42], [43]. Combining aerobic and resistance training in a high-intensity, limited-rest design can deliver numerous health benefits in much less time than traditional programs. When body weight is used as resistance, it eliminates the limiting factors of access to equipment and facilities [42] In this research, body weight exercises are used as a means for players to perform PA for reward collection towards gaming use. Twelve basic exercises are introduced to players in stages to allow players to adapt to the exercises, which are grouped in threes:

- Full Body/Cardio: Jumping Jack, Step Ups, High Knees
- Lower Body: Wall Sit, Squats, Lunges
- Upper Body: Push Ups, Triceps Dips, Push Up with Rotations
- Core: Abdominal Crunches, Plank, Side Planks

To test the functionality of the RPMv1, we also prototyped a Low-Fidelity (Lo-Fi) mobile app that combines a fitness app and a game app. The app facilitates physical exercise, and players receive rewards for participating in a game once they have completed it.

C. Stage 3: Experts' Review

From our interviews with the ERs, we note that the RPMv1 was well received, with some changes required to the flow and settings. In the exercise segment, the ERs were concerned with one exercise (Step Ups), which can be hazardous with an improper setup. The ERs also noted that each exercise needs proper progression to cater to all fitness levels. The navigation was confusing for the Lo-Fi and required standardization in layout and text; refer to Table 3 for the summary of the Expert Reviewer's acceptance.

TABLE III
EXPERT REVIEWER'S ACCEPTANCE OF PROPOSED RPMV1, RPM FRAMEWORK, EXERCISE INFORMATION AND LO-FI PROTOTYPE

Item	**Expert Reviewer**				
	1	**2**	**3**	**4**	**5**
Item 1: RPMv1 Components					
1. Reward	/[a]	/	/		
2. Value	/	/	/		
3. Guidance	/	/	/		
4. Reminder	/	/	/		
Item 2: RPM Framework (v1)	/[a]	/[b]	/	/	/
Item 3: Select Physical Exercises' Information	/[c]	/		/[c]	/[c]
Item 4: Low Fidelity (Lo-Fi) prototype	/	/	/[d]		

[a] Amend flow and streamline the arrow points
[b] The placements of the components are confusing and can be improved
[c] Concern the 'Step Ups' exercise
[d] Standardize the layout and text

D. Stage 4: Interview with Users

We interviewed eight participants for this study. The participants were at home as the sessions were done during the Covid-19 lockdown. They were predominantly female (75%), with an average age of 22. They mainly were Android phone users (75%) and spent at least 4 hours daily on their smartphones, with two spending more than 10 hours. Five of them used their smartphones for gaming for less than 1 hour a day, two for more than 2 hours, and only one did not play mobile games. Those who played mobile games did so while sedentary, and only one also played while standing and walking to play 'Pokémon Go.' Seven of them performed PA during their leisure time, and we note from their responses in IPAQ-S that the results showed that they were in the moderate (50%) to high (50%) PA level groups. Their home life could have positively influenced them to perform more PA.

Our interviews also included questions based on the RPM components of Reward, Value, Guidance, and Reminder. The users' responses to the RPM are in Table 4.

TABLE IV
USERS' RESPONSES TO THE COMPONENTS IN THE RPM

Components	**Yes**	**No**
Reward (Target Behavior)	8	0
Value (Motivation)	7	1
Guidance (Ability)	7	1
Reminder (Trigger)	8	0

These responses showed they positively responded to the RPMv1 components for facilitating PA through rewards. The Rewardable Persuasive Model (RPM) is a proposed mobile exergame conceptual design model to facilitate PA for players through accessible mobile exergaming. The model was derived from a literature review of current psychological and design models, reviews with expert reviewers, and participation with users identified as university students via the User-Centered Design (UCD) approach. The RPM is part of a larger framework consisting of an established design principle and an existing psychological model.

The RPM was adapted from the PPM, which used FBM as basis. The adaptation changed two existing components in the PPM to include the VET, where there is value to the reward when users complete specific tasks. Players can select the reward value for accomplishing a physical exercise routine based on small effort for less reward value or considerable effort for more reward value. This motivates players to exercise through a reward-based system, which can be used for gaming. The RPM can be used in a mobile setting, and the exercise type is independent of equipment use, especially on stationary types.

Even with a limited sample size, our research provides an insightful initial understanding of youths' behavior and preferences. After reviewing the first version of our proposed design model (RPMv1) with our ERs and users, some changes were made. We moved the heading of the Reward component in the RPMv1 so that the Value, Guidance, and Reminder components are below it. For a Reward to be awarded, these three components must converge for users to perform PA successfully. For the FITT Principle, we combined the Time and Type components to link it to the Value component, as the Type of exercise is directly related to the Time needed to accomplish an exercise. Finally, when an exercise is completed, a Target Behavior has been achieved; hence, a Reward will be awarded. Thus, an arrow is redirected to

Reward for collection (see Fig. 5 for the updated RPM and the RPM Framework).

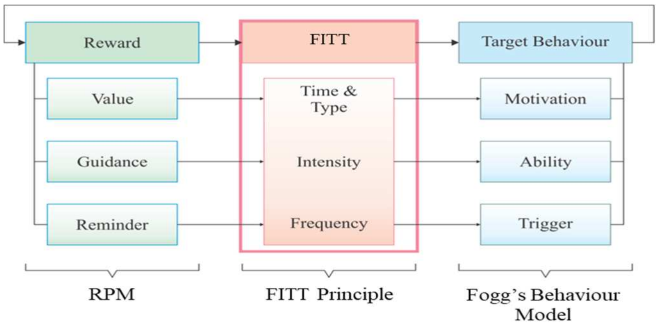

Fig. 5 The RPM within the RPM Framework

The components were also reviewed and updated to accommodate the changes in the updated RPM and how its relationship with the FITT and FBM affects it.

1) Value (Motivation): For the Value component, the 'Time' and 'Type' in the FITT dictate the Reward value. This correlates to the Motivation element of the FBM. 'Time' is an element of the workout plan, determining how long exercise is done during each session. There isn't one set rule for how long a person should exercise, and it will typically depend on their fitness level and the type of workout. Users can select the type of exercise that targets specific body parts or full body workout. Each exercise type has a value that relates to the reward outcome. The 'Type' of exercise a person chooses depends on their exercise goal. Users can select the type of exercise that targets specific body parts or full body workout. Each exercise type has a value that relates to the reward outcome. Example: Select the exercise type and time to obtain the required reward. Provide values to the reward when users complete specific exercises. Using VET, users can select reward value—the more physically demanding the reward value increases.

2) Guidance (Ability): The 'Intensity' in the FITT indicates how an exercise is performed for the Guidance component. This correlates to the Ability element of the FBM. Intensity is the hard work needed during exercise. The intensity changes depending on the type of workout being done. Exercise videos are available to guide users on the proper forms and techniques to perform the exercise in a safe environment. Users can select an intensity level to accommodate based on their ability to perform the exercise, ranging from easy to be advanced. Example: Guide users to recognize intensity to achieve the reward. A video representation and instructions are available for review by the players before and during the exercise required to achieve the reward.

3) Reminder (Trigger): For the Reminder component, the 'Frequency' in the FITT provides alerts/cues for an exercise. This correlates to the Trigger element of the FBM. Frequency depends on various factors, including the type of workout, how complicated the workout is, the person's fitness level, and exercise goals. Example: Integrated reminders for users through audio and visual feedback can keep them focused on reaching their goals and using a countdown on remaining time to complete the exercise. History records all exercises that have been done.

4) Reward: Reward is received when a task is done, and it is possible when the following three components, Guidance, Value, and Reminder to perform PA converge. Thus, a Target Behavior is achieved, and users receive their Reward for use in gaming. Reward mechanisms foster intrinsic motivation while giving extrinsic rewards.

By the introduction of these components, an exergame can be designed to engage youths and facilitate PA effectively.

IV. Conclusion

We have provided our findings of a mobile exergame conceptual design model that could facilitate youths' exercise through mobile gaming. We introduce the final version of our proposed mobile exergame conceptual design model, the Rewardable Persuasive Model (RPM). RPM comprises four main components: Reward, Value, Guidance, and Reminder. The RPM is part of a larger framework consisting of an established design principle and an existing psychological model: the FITT principle (for workout) and Fogg's Behavior Model (to achieve target behavior). This may assist youths in meeting their weekly PA goals through a functional and rewarding mobile app that makes performing PA the determining factor in granting gameplay. These acts of PA can manage the increasing occurrence of NCDs in Malaysia and offer the opportunity for it to be reduced by getting our youths to engage in more PA, thus improving their quality of life. This could have the domino effect of changing the lifestyle and mindset of the youths to engage in PA for long-term benefits. In a future study, youths would evaluate the RPM in a real-world application to ensure its viability for facilitating PA during sedentary or leisure time. This involves youths evaluating a mobile app to assess the RPM's effectiveness in a longitudinal study. The mobile app is based on the lo-fi prototype our experts evaluated in Stage 3.

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