Integration of Wearable, Persuasive, and Multimedia Design Principles in Enhancing Depression Awareness: A Conceptual Model

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Abstract. The prevalence of depression among university students in Malaysia can be reflected in unprecedented suicide acts and attempts among university students across the country. However, there is a scarcity of reliable, practical, and comprehensive methods to curb the issue at the root cause - to empower one's controllability awareness. This study believes that promotion and awareness regarding the pertinent to the importance of mental health problems, especially to specific target groups, can be enhanced through technology. Meanwhile, studies have confirmed the relevance of persuasive methods in wearable technology, though to varying degrees. Persuasive technology has been widely used to create awareness in various domains. Moreover, the multimedia elements could be a value-added property to ensure the effectiveness of the technological solutions in enhancing awareness. Accordingly, this paper discusses constructing a model that integrates wearable, persuasive, and multimedia design principles to enhance one's controllability awareness of depression. The model is constructed through the content analysis method. As a result, a triad of three design principles was consolidated and validated through multidisciplinary expert reviews. This paper discusses the refinement process made to the proposed model, which is aimed to serve as a guideline for developing solutions to enhance controllability awareness on depression issues.

Keywords: Wearable technology · Persuasive technology · Multimedia design · Conceptual model · Controllability awareness · Depression

1 Introduction

The recent National Health and Morbidity Survey reported that 2.3% of adults aged 18 and above in Malaysia experienced depression [1]. According to [2], lack of controllability awareness is the effect of depression and Obsessive-Compulsive Disorder (OCD). Controllability awareness is the ability of an individual to pay attention and differentiate whether the aspects of possible consequences are controllable or uncontrollable in

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responding to life situations [3]. Nevertheless, among Malaysian university students, the effects of depression are still unexplored [4] and remain challenging [5]. Accordingly, [6] agreed that it is significant to study the depression problem among students as they have a potential influence on their family, society, and the country and contribute to their country's labour force in the future. Furthermore, as the technology used among mental illness patients is on the rise [7], the promotion and awareness regarding the vitality of mental health problems, especially to specific target groups, can be promoted and enhanced [1] through technology.

1.1 Related Works

Wearable Technology (WT) is a promising means to help individuals develop awareness [8]. In mental health, the capability of WT in capturing behavioural, physiological, and social data related to severe mental illness [9] can be leveraged in enhancing depression awareness among undergraduates. Meanwhile, over the years, persuasive technology also has evolved to deal with diverse practices besides behaviour and attitude [10]. Since the actual transformation in behaviour requires a more extended evaluation period, a review by [10] found that 72% out of 85 studies finally evaluated their system effectiveness by measuring other various outcomes of behaviour-related or psychological including awareness. Moreover, with the help of interactive media, a well-designed application is able to persuade people effectively towards behaviour change [11, 12] as well as influencing them to utilize the technology for learning and sharing information in an interactive way [13].

1.2 Using Content Analysis in Model Development

Content analysis as a research method is an easy-to-use, explicit, and systematic tool for analyzing documents and text, which can be used to develop an understanding and provide new insights and knowledge in different contexts. For instance, [14] applies content analysis for decision criteria, techniques, theories, and Human Computer Interaction (HCI) components to develop a design model for youth personal decision aid. Furthermore, the components and elements in the interactive computer-assisted learning conceptual model were also determined using content analysis [15]. Similarly, [16] conducted content analysis to identify potential solutions from existing solutions for computerized personal-decision aid. Finally, in the study of conceptual design of Reality Learning Media (RLM) model, [17], the content analysis is referred to as the effort to gather basic information at the early stages of study.

Accordingly, this study believes that enhancing controllability awareness can be effective by consolidating all three technologies' design principles. Nevertheless, a previous review of persuasive multimedia principles in wearable technology had confirmed that the absence of the integration of wearable, persuasive and multimedia principles unfold a potential to integrate those principles in enhancing depression awareness [18]. Thus, this study aims to propose the conceptual model of wearable persuasive multimedia to enhance awareness, particularly controllability awareness, to lower the risk of depression, especially among undergraduates.

2 The Conceptual Model: Development Process

The innards for each component of a conceptual model are determined through the implementation of content analysis. As previously discussed, [14–16, 19] has applied this kind of analysis in developing their model. For this study, the analysis involved four phases, as depicted in Fig. 1. Sections 2.1–2.4 provide the discussion of detailed activity for each phase.

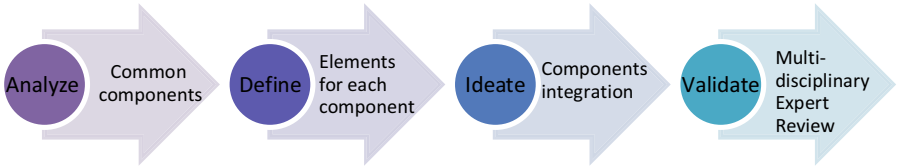

Fig. 1. Conceptual model development phases

2.1 Analyze: Common Components

Altogether, 22 studies were selected based on keywords related to persuasive multimedia in various domains and technologies and utilized persuasive or/and multimedia principles. Those criteria determine the common components and subcomponents, where both are the primary requirement of the conceptual model in enhancing controllability awareness. As displayed in Table 1, it clearly shows that most of the chosen sub-components (in bold) have a higher percentage of frequency compared to other potential sub-components.

2.2 Define: Elements for Each Sub-component

Sub-component: Persuasive, Multimedia, and Wearable Design Principles
In consequence, the previous analysis phase successfully identifies 29 persuasive and 13 multimedia design principles. Furthermore, a study by [18] also confirmed that some studies integrate both design principles. Therefore, all the persuasive multimedia studies are selected to define persuasive and multimedia principles because the effectiveness of principle integration has undergone an empirical test.

As for wearable, the user interface design was defined as an essential element because it will serve as an interface that can influence and attract users to achieve the target outcome. Therefore, all the studies that implemented user interface design were chosen in eliciting the common user interface components. Eventually, the most utilized interface design and suitable to be applied in wearable technology were considered the elements of this sub-component.

Sub-component: Controllability Awareness
The selected studies that target awareness as an outcome reported in various domains, including mental health. In psychological terms, awareness is when individuals are aware of their feelings and behaviour [20]. However, people who suffer from depression are

Table 1. Percentage of the frequency of common components and sub-components

Common components	Sub-components	Percentage of the frequency
Design principles	**Persuasive Design Principle**	**73.3**
	Wearable Design Principle	**18.8**
	Multimedia Design Principle	**45.5**
Target outcome	Behaviour	27.3
	Knowledge	9.1
	Perception	4.5
	Awareness	**36.4**
	Engagement	13.6
	Motivation	13.6
	Attitude	9.1
	Habit	4.5
User	Children	36.4
	Youth	**40.9**
	Adults	45.45
	Seniors	18.18
Technology	Computer-based	45.5
	Mobile Technology	40.9
	Wearable	**31.8**

caused by lack of controllability awareness [2]. Controllability awareness can be measured using four controllability aspects: Personal control, Shared control, Others in control, and No one in control, as stated in the Controllability Awareness Inventory (CAI) developed by [21]. [21] use the inventory to evaluate controllability awareness as a characteristic of stress tolerance. Meanwhile, [3] use it to assess the controllability awareness among schools' teachers as a predictor of effective coping in potentially traumatic stress situations after a Katyusha rocket attack. For this sub-component, controllability awareness is the most relevant element, even though it is not highlighted in any selected studies that intend to raise awareness in mental health.

Sub-component: Youth

This study will give proper attention to young adults undertaking tertiary education in Malaysian public universities, also known as university students. The consideration is due to various determinant factors of academic depression that may lead to deterioration in their academic achievement [22], may impair a relationship [23], problems in marriage, and affect their employment in the future [24]. Therefore, in identifying their emotion, the physiological symptoms such as heartbeat, respiration rate, blood pressure, Galvanic Skin Response (GSR) measurements, and other nervous system responses [25] could provide an accurate signal. Although only several selected studies used physiological

symptoms, all the studies that detect or monitor emotional changes reported measuring heart rate and heart rate variability. Thus, heart rate is the chosen element for the sub-component of the physiological parameter.

Sub-component: Wearable Technology

The behavioural, psychological, and social signals that often reflected the mental state changes [9] could be detected using the sensing technologies integrated into wearable devices. Therefore, it is crucial to identify an appropriate sensor in the wearable capable of measuring the targeted physiological parameter. For example, in detecting heart rate or heart rate variability, the selected studies utilizing wearable technology were reported using a pulse oximeter sensor to measure the symptoms.

Apart from the sensor, the other elements that need to be considered are the types of wearable as they can be divided into groups of screen-based and non-screen-based. For instance, studies that utilize smartwatches and fitness trackers can be considered as a screen-based group, while studies that use wearables such as gloves, shirts, and belts are categorized as non-screen-based. Unlike non-screen-based, users can directly access the application via the wearable screen without tethering with other devices such as smartphones. Furthermore, it is also imperative to consider the size of the screen as it will implicate the user interface design.

2.3 Ideate: Components Integration

In this phase, all the defined elements for each sub-component were integrated, forming a framework as depicted in Fig. 2. The framework was ideated based on the Generic Steps in Persuasive System Development suggested by [26], where all steps are essential in realizing an idea into reality. In the framework, many aspects are implicitly covered, including responsiveness, error-freeness, ease of access, ease of use, convenience, information quality, positive user experience, attractiveness, user loyalty, and simplicity. Those aspects need to be recognized when designing a persuasive system. However, prior to communicating the ideas to developers, precise requirements for software qualities need to be defined. Eventually, software quality checklists must be prepared to evaluate the persuasive system.

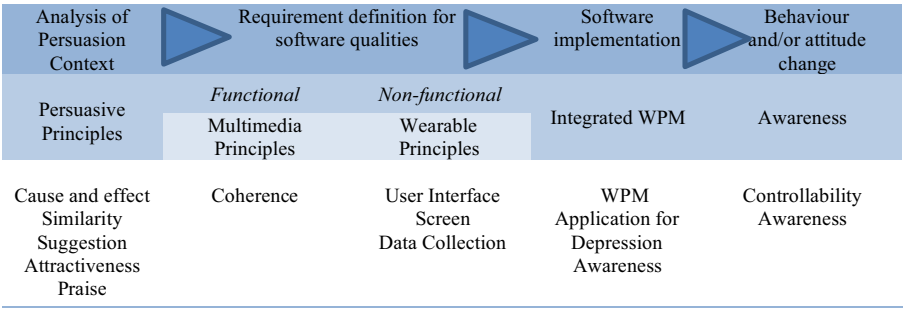

Fig. 2. The framework of Wearable Persuasive Multimedia (WPM) integration

For this study, multimedia principles are defined as functional requirements to describe how the system should behave, while wearable principles are the non-functional requirements that specify the qualities that should be owned by the system [27, 28]. Eventually, the selected persuasive principles are integrated with the system requirements and embedded in the Wearable Persuasive Multimedia application to enhance controllability awareness. Next, the framework was transferred into a conceptual model that will be explained in Sect. 3.

2.4 Validate: Multidisciplinary Expert Reviews

Finally, the conceptual model underwent a first validation process by using the multidisciplinary expert reviews method. The method was suggested by [29] and implemented in [30] to cover all the viewpoints, which are user acceptance, mobile intervention design, and persuasive design, that are required in their study. As this study will also be looking into multi-technology and human psychology, all appointed experts were among the academics and practitioners with years of experience in the related field of persuasive multimedia, wearable technology, and human psychology. The detailed information of all experts is demonstrated in Table 2.

Table 2. Experts' information

Expert	Position	Year of experience	Field	Organization
1	Academic	More than five years	Persuasive Technology, Multimedia Technology, Wearable Technology	Public university
2	Academic	More than five years	Persuasive Technology, Multimedia Technology	Public university
3	Academic	More than five years	Persuasive Technology, Multimedia Technology	Public university
4	Psychologist	More than five years	Human Psychology	Ministry of Health of Malaysia

The review process occurred through an online workshop. During the workshop, first, the researcher presents and introduces the model to the experts. The process of constructing the model, which is content analysis, is also explained in detail. Then, all the experts validate the model according to three main criteria as follow:

i) The chosen components and subcomponents
ii) The selected elements for each component
iii) The integration of design principles

The review process continued with a discussion where experts shared their comments, feedback, and recommendation.

3 The Conceptual Model: Result and Discussion

The main issue highlighted by the experts is how the conditions are set in selecting the elements in the Design Principles component. Before the review, all the principles that at least fulfil two criteria were chosen as depicted in Table 3.

Table 3. Design principles of persuasive, wearable and multimedia technology based on 2-selected criteria

Technology	Design Principles	Criteria				WPM
		☺	⌚	☑	💓	
Persuasive	Cause and effect	/		/	/	Y
	Similarity	/	/	/	/	Y
	Suggestion	/	/	/	/	Y
	Reduction	/	/			Y
	Mobile Simplicity	/			/	Y
	Attractiveness	/		/	/	Y
	Praise	/		/	/	Y
	Motivation					
	Experience					
	Cognitive					
	Emotional Appeal					
	Simulation	/	/			Y
	Social learning	/			/	Y
	Conditioning					
	Virtual rehearsal				/	
	Self-monitoring	/	/			Y
	Information quality	/			/	Y
Multimedia	Feedback	/			/	Y
	Segmentation					
	Coherence	/		/	/	Y
	Redundancy	/			/	Y
	Modality	/			/	Y
	Layout & consistency					
	Simulation					
	Navigation					
	Minimal input device					
	Personalization	/				
	Multimedia	/		/		Y
	Spatial contiguity	/			/	Y
	Temporal contiguity				/	

Table 4. Design principles of persuasive, wearable and multimedia technology based on n-selected criteria

Technology	Design Principles	Criteria				WPM			
		☺	⌚	☑	💓	1 criterion	2 criteria	3 criteria	4 criteria
Persuasive	Cause and effect	/		/	/	Y	Y	Y	
	Similarity	/	/	/	/	Y	Y	Y	Y
	Suggestion	/	/	/	/	Y	Y	Y	Y
	Reduction	/	/			Y	Y		
	Mobile Simplicity	/			/	Y	Y		
	Attractiveness	/		/	/	Y	Y	Y	
	Praise	/		/	/	Y	Y	Y	
	Motivation								
	Experience								
	Cognitive								
	Emotional Appeal								
	Simulation	/	/			Y	Y		
	Social learning	/			/	Y	Y		
	Conditioning								
	Virtual rehearsal				/	Y			
	Self-monitoring	/	/			Y	Y		
	Information quality	/			/	Y	Y		
Multimedia	Feedback	/			/	Y	Y		
	Segmentation								
	Coherence	/		/	/	Y	Y	Y	
	Redundancy	/			/	Y	Y		
	Modality	/			/	Y	Y		
	Layout & consistency								
	Simulation								
	Navigation								
	Minimal input device								
	Personalization	/				Y			
	Multimedia	/		/		Y	Y		
	Spatial contiguity	/			/	Y	Y		
	Temporal contiguity				/	Y			

Notes:
☺ *- principle utilized to target awareness*
⌚ *- principle implemented in wearable*
☑ *- most utilized principle*
💓 *- principle use in the health domain*
Y *- Yes*

However, the reviewers suggested constructing an n-criteria table, as shown in Table 4, where design principles can be appropriately selected based on the best number of selected criteria.

Consequently, the elements are chosen based on the frequency of the design principles that fulfil three-selected criteria because the number of principles is relevant to apply in the model. Moreover, more criteria in selecting the elements were considered to compensate for the shortage of probably more relevant studies. Based on experts' feedback, comments, and suggestions, the relationships among the four major components and their sub-components and their defined elements are finally expressed through the conceptual model (as depicted in Fig. 3). The proposed conceptual model is assembled based on Generic Steps in Persuasive System Development (as discussed in Sect. 2.3), comprising four main components: Design Principles, Technology, User, and Target Outcome. Every main component consists of sub-components and the selected elements. All the main components are connected according to their dependency on one another.

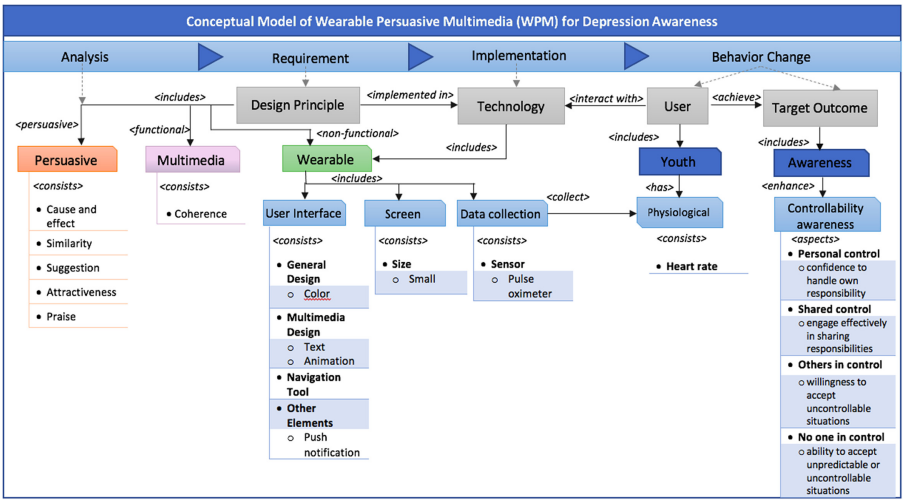

Fig. 3. Conceptual model of Wearable Persuasive Multimedia (WPM) for depression awareness

4 Conclusion

This study believes that awareness regarding the vitality of mental health problems, especially to specific target groups, can be promoted and enhanced through recent technology. In line with the plan to improve controllability awareness among university students pertinent to depression issues, an integrated model comprising wearable, persuasive, and multimedia design principles is proposed. The conceptual model is suggested due to the absence of wearable, persuasive, and multimedia design principles integration in enhancing controllability awareness in mental health-related issues. Thus, a conceptual model is constructed through a series of rigorous content analysis. Through all the processes, the main component and sub-components of the model and their elements

were identified. After thorough multidisciplinary expert review sessions, the conceptual model has undergone a refinement process. Finally, the proposed conceptual model is assembled based on Generic Steps in Persuasive System Development (as discussed in Sect. 2.3), comprising four main components: Design Principles, Technology, User, and Target Outcome. The validated model is aimed to serve as a guideline by the application developers in developing a solution to enhance controllability awareness on mental health-related issues.

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