Review Article

A Comparative Analysis of Design Principles for Integration in Wearable Persuasive Multimedia

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Abstract: Many studies, to varying degrees, have confirmed the importance of persuasive approaches in wearable technology. Meanwhile, there are also a growing number of studies in persuasive multimedia, particularly in promoting awareness. Also, many studies reported on wearable multimedia, especially in game-based and VR/AR applications. Given the increasing emergence of these technologies, there is a need to integrate existing diverse research endeavours and consolidate them for improved planned effects on human attitude and behaviour, including one's awareness. However, a similar attempt to incorporate a triad of persuasive, multimedia and wearable design principles toward improved controllability awareness lacks empirical evidence. Here, this study explores the design principles of persuasive, multimedia and wearable technologies that can be leveraged into an integrated design model, especially in promoting controllability awareness of mental health issues. Moreover, this study believes exploring the potential integration of the design principles would significantly impact the application's effectiveness. Therefore, this study conducted a comparative analysis which involved 20 relevant studies pertinent to wearable design principles, persuasive design principles, and multimedia design principles. Furthermore, all identified studies were reviewed regarding the domain, the technology used, target outcomes, and utilisation of the design principles. As a result, this study discovered that many studies were on integrating persuasive and multimedia design principles and persuasive and wearable technologies. Therefore, the outcome of this study could be leveraged to incorporate all three design principles (i.e., wearable, persuasive technology, multimedia) into a conceptual model. The conceptual model is expected to produce a more effective result, especially in enhancing controllability awareness in the mental health domain.

Keywords: ***Multimedia Technology; Persuasive Technology; Wearable Persuasive Multimedia; Wearable Technology***

1. Introduction

The domain of computer and persuasion forms an acronym "Computer as Persuasive Technology (PT)", better known as Captology [1]. Captology refers to persuasive technology used to change human attitudes and/or behaviour. Recently, many studies have been working on more than one technology to assess different outcomes besides attitude and/or behaviour. The advancement of multimedia technology unfolds more chances for researchers to innovate ways for users to learn, acquire information, and elevate their knowledge [2]. However, the emergence of wearable technology integrated with sensors has changed the function of multimedia. These days, multimedia represents the combination of different media types and their means for communicating, cooperating, and monitoring various aspects of everyday life [3]. Thus, the possibility of integrating the technologies will also give technology designers a new challenge in consolidating those technologies' designs.

Additionally, wearable technology has been reported as a promising means of assisting people in

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developing awareness [4]. Moreover, the wearable is also identified as a persuasive technology capable of building motivation by increasing health awareness via on-time feedback [5]. Several studies [6-8] have outlined the design principles for wearable technology and persuasive technology [9-11] regarding design principles consideration. Also, from the multimedia and user interface perspective, works by [12-14] have proposed many design principles used by many over the last two decades.

However, one of the findings of this study also proves that the information on wearable, persuasive and multimedia integration is limited and not widely discussed in previous studies. Nevertheless, it is possible to explore further the integration of principles that can be applied in wearable persuasive multimedia, as this study also found evidence of the effectiveness of persuasive multimedia integration in past studies. Therefore, this study aims to unfold the possible integration of the three facets of design principles: wearable, persuasive, and multimedia, that could be leveraged in various domains and technologies, especially mental health and wearable, respectively.

2. Design Principles

2.1. Wearable Design Principles

In designing wearable technologies, the important key features are; i) size, ii) dimension of the devices, iii) device position, iv) power source, v) heat, vi) weight, vii) durability, viii) washability, ix) enveloping, x) functionality, xi) usability, xii) sensation, and xiii) connectivity [11]. Unfortunately, guidelines to study human influences and qualitative factors to support researchers during the designing phase are unavailable [8]. There is also evidence of a shortage of research outcomes that could assist designers in improving wearables' acceptability [15]. In consequence, a few researchers, as listed in Table 1, have put forward principles that can be considered when designing the wearable or its application in it.

Table 1. Wearable Design Principle

Author	Design Principle
Samsung Developer[1]	Watch Design Principles
Godfrey A, Hetherington V, Shum H, Bonato P, Lovell N. H., and Stuart S	A – Z Guide
Sumin Helen Koo, Kim Gaul, Susan Rivera, Tingrui Pan, and Dan Fong	Design Factors for Autism Spectrum Disorders
John Jones, Catherine Gouge Gauge, and Mariah Crilley	Health Wearable Design Principle
Vivian Genaro Motti and Kelly Caine	Wearability Design Principle

Samsung Developers disclosed user-centred design principles for their smartwatch product. The principle encompasses Scannable (Central Theme, Readable Screen Design), Easy to Follow (Intuitive Interaction, Consistent Theme), Responsive (Natural Feedback, Easy to Use Components) and Desirable (Benefits Over Features, Stylish Screen Designs). Meanwhile, Koo et al. [7] analysed and came out with a list of 12 design factors for wearable technology, which are i) Safety, ii) Data Accuracy, iii) Comfort, iv) Flexible Material, v) Portability, vi) Durability, vii) Reasonable Price, viii) Ease of Use, ix) Lightweight, x) Small, xi) Unnoticeable Design, and xii) Unique Design. As a result of their survey, Comfort, Data Accuracy, Durability and Portability are the four best wearable technology designs for Autistics children. Additionally, Jones et al. [6] outlined the essential design principles for health wearables, which centred around three priorities, namely Accessibility, Adaptability, and Iterability. The A-to-Z guide introduced by Godfrey et al. [16] provides the key terms that focus on a fundamental and extensive understanding of recent wearable technology development in healthcare. It is believed that more researchers will suggest various design principles that best suit the wearable as this technology is increasingly evolving.

2.2. Persuasive Design Principles

The most utilised conceptualisation of Persuasive Technology (PT) is presented as a design principle [1]. Table 2 summarises the roles of persuasive technology and the strategy or principle related to it.

Table 2. Strategies of Persuasive Technology[1]

Computer Function	Strategy/Principle
Role: Tool	Conditioning
	Tunnelling
	Reduction

[1] https://developer.samsung.com/one-ui-watch-tizen/principle.html

	Suggestion
	Tailoring
	Surveillance
	Self-Monitoring
Role: Media	Rehearsal
	Cause and Effect
	Virtual Rewards
	Simulation in Real-World Context
Role: Social Actor	Similarity
	Authority
	Praise
	Reciprocity
	Attractiveness

However, the functional triad model and the presented design principles lack a clear explanation of converting the recommended design principles into software requirements that could be employed as features of a real system [11]. Therefore, in their work, Oinas-Kukkonen *et al.* [11] proposed to consider persuasion principles as the main requirement for software qualities. Henceforth, they adopted and modified Fogg's model into the Persuasive Systems Design (PSD), comprised of 28 design principles grouped into four categories, as shown in Table 3.

Table 3. Categories of PSD [11]

Primary Task	**Dialogue Support**	**System Credibility**	**Social Support**
Self-monitoring	Liking	Authority	Cooperation
Rehearsal	Reminders	Expertise	Competition
Tailoring	Rewards	Surface-credibility	Normative influence
Tunnelling	Suggestion	Third-party endorsements	Social learning
Reduction	Similarity	Trustworthiness	Social facilitation
Simulation	Social Role	Real-world feel	Social comparison
Personalisation	Praise	Verifiability	Recognition

On the other hand, Lockton *et al.* [10] introduced the Design with Intent Method (DwI), which includes inspiration and prescription modes. The intent in the DwI field is usually linked to commercial benefit compared to other persuasive technology research that concerns persuasion with intended social help, such as encouraging exercise and reducing energy use. Table 4 sums up the persuasive design principles that have been discussed.

Table 4. Persuasive Design Principles

Author	**Design Principle**
BJ Fogg	Persuasive Technology Strategies
Harri Oinas-Kukkonen and Marja Harjumaa	Persuasive Systems Design
Dan Lockton, David Harrison, and Neville A. Stanton	Design with Intent (DwI)

2.3. Multimedia Design Principles

An interactive media application that intends to persuade people towards behaviour change and attitude can be an effective persuader if well-designed [1]. Accordingly, a few multimedia design principles are suggested by a few known researchers in multimedia, as described in Table 5.

Table 5. Multimedia Design Principles

Author	**Design Principle**
Nielsen Jakob and Molich Rolf	Cognitive Theory of Multimedia Learning (CTML)
Mayer Richard E	Nielsen's Design Guidelines
Donald A. Norman	Don Norman's Principle

Richard E [13] proposed twelve multimedia design principles to improve the presentation and learning process. Those principles are known as the principle of; i) Coherence, ii) Signaling, iii) Redundancy, iv) Spatial Contiguity, v) Temporal Contiguity, vi) Pre-training, vii) Modality, viii) Segmenting, ix) Multimedia, x) Personalization, xi) Image and xii) Voice.

On the other hand, comprising ten heuristics or design principles, Nielsen's guidelines have also been acknowledged for ensuring interactive applications serve their users as intended. The ten principles or heuristics include:

i) the status of the system is visible,

ii) the system matches the real world,
iii) freedom and user control,
iv) standards and consistency,
v) recognition compared to recall,
vi) the efficiency of use and flexibility,
vii) minimalist design and aesthetic,
viii) assist users to recognise, diagnosing and fixing the errors and
ix) documentation and help.

Another common design principle in multimedia was outlined by Norman [14]. There are six fundamental principles: Visibility Principle, Feedback Principle, Constraint Principle, Mapping Principle, Consistency Principle, and Affordances Principle.

2.4. Implication of Design Principles in Designing Wearable Persuasive Multimedia

The aforementioned persuasive design principles have been widely integrated into various persuasive applications in different contexts, such as obesity [17], truancy [18], child sexual abuse [19], stress [20], and children's dental anxiety [21]. Moreover, there are also studies on persuasive that integrate multimedia design principles in their persuasive multimedia application. For example, among the studies, Wan Yahaya *et. al* [20] integrated several multimedia principles proposed by Richard E [12] to raise stress awareness among secondary school students. In another study, Wan Yahaya and Hashim [17] integrate the feedback principle in their persuasive multimedia application to enhance primary school students' knowledge and awareness of obesity risks. Furthermore, although only a few studies are working on wearable technology, at least Ferraro *et. al* [23] incorporate persuasive and wearable design principles in their persuasive wearable system. The system is intended to motivate the workers to wear personal protective equipment (PPEs) and increase their awareness regarding work-related risks and health status.

Those past studies have proven an effort toward integrating persuasive with multimedia and persuasive with wearable design principles. In addition, by consolidating those design principles, most studies were intended to succeed in specific target outcomes. Therefore, integrating the three design principles is also believed to strengthen and improve the effectiveness of the wearable persuasive multimedia system. Hence, it is possible to explore further the integration of principles that are most impactful in wearable persuasive multimedia towards enhancing controllability awareness, especially in mental health issues.

3. Comparative Analysis

The comparative study is conducted to identify the components and define the model's elements. Before completing the comparative analysis, a thorough selection of articles was conducted using available online tools. Online databases such as the Public Library of Science (PLOS), Elsevier, Sage, PubMed, BioMed Central, ScienceDirect and IEEE Xplore Digital Library are among the databases that were used throughout the selection process. The keywords used to search the articles are "persuasive multimedia", "wearable multimedia", "persuasive wearable", and "wearable persuasive multimedia". Furthermore, the selected articles were chosen based on the following criteria:

i) The articles published in years between 2009 to 2020 from various countries
ii) The articles are related to persuasive technology, multimedia, and wearable technology in different domains
iii) The articles are related to studies that utilised persuasive with multimedia and/or wearable design principles

As a result, 20 previous studies on persuasive systems that adopted persuasive technology, multimedia and/or wearable technology were selected. The articles were selected from 2009 to 2019 since this is the period when wearable technology was recognised. All the collected articles were coded and referred to as R1 to R20. Table 6 provides the list of selected articles.

Table 6. List of Articles

Code	Author	Year	Study Context	Design Principles	Technology
R1	Wan Ahmad Jaafar Wan Yahaya and Munira Hashim	2018	Persuasive multimedia application to enhance awareness and knowledge of obesity risk among primary school students (PerMOss)	• Persuasive • Multimedia	• Computer-based
R2	Wan Ahmad Jaafar Wan Yahaya and Khairulnisak Mohamad Zaini	2018	Persuasive multimedia application on Islamic funeral topic	• Persuasive • Multimedia	• Mobile
R3	Raudzatul Fathiyah Mohd Said, Norzilah Musa, Norzehan Sakamat, and Noorazida Mohd Idris	2018	Persuasive multimedia application about circumcision preparedness in children (BraveBoy)	• Persuasive	• Computer-based
R4	Mohamad Lutfi Dohalit, Sobihatun Nur Abdul Salam, Ariffin Abdul Mutalib, Muhammad Saiful Bahri Yusoff, and Farah Nadia Azman	2018	Persuasive multimedia for rising truancy awareness (PMTA) (Kitakan Kawan)	• Persuasive • Multimedia	• Computer-based
R5	Marc Adlington, Yalin Shi, Kimberly Chong, Ewan Soubutts, and Xiaowei Li	2018	Mobile application-based behaviour change support system (HealthyMind)	• Persuasive • Gamification	• Mobile • Wearable
R6	Sumin Helen Koo, Kim Gaul, Susan Rivera, Tingrui Pan, and Dan Fong	2018	Wearable glove for an individual with autism spectrum disorders (Autisense)	• Wearable	• Wearable
R7	Venere Ferraro, Mila Stepanivic, and Silvia Ferraris	2018	Wearable persuasive system to prevent respiratory disease	• Persuasive • Wearable	• Mobile • Wearable
R8	Li-hsing Shih and Yi-cin Jheng	2017	Persuasive game to encourage energy-saving behaviour	• Persuasive • Gamification	• Mobile
R9	Sazzad M. Hussain, Liam Cripwell, Shlomo Berkovsky, and Jill Freyne	2016	Wearable persuasive to promote UV exposure awareness	• Persuasive	• Mobile • Wearable
R10	Nurtihah Mohamed Noor, Abdul Nasir Zulkifli, Mohd Fitri Yusoff, and Fadzillah Siraj	2014	Islamic Sex Education (ISE) Courseware in multimedia technology learning	• Multimedia	• Computer-based
R11	Abdul Nasir Zulkifli, Mazida Ahmad, Juliana Aida Abu Bakar, Ruzinoor Che Mat, and Nurtihah Mohamed Noor	2013	Interactive persuasive learning for the elderly	• Persuasive • Multimedia	• Computer-based
R12	Somya Sharma, Bhushan Jagyasi, Jabal Raval, and Prashant Patil	2015	Agricultural activity training using multimedia and wearable sensing (AgriAcT)	• Multimedia	• Mobile • Wearable
R13	Wan Ahmad Jaafar Wan Yahaya and Mohamed Zamri Mohd Zain	2013	Persuasive multimedia on building a positive attitude regarding abusing disabled parking	• Persuasive • Multimedia	• Computer-based
R14	Azliza Othman and Wan Ahmad Jaafar Wan Yahaya	2012	Persuasive multimedia on raising awareness toward child sexual abuse among children	• Persuasive • Multimedia	• Computer-based
R15	Mohammad Hafiz Ismail, Siti Zulaiha Ahmad, Arifah Fasha Rosmani, and Mohd Nor Liyana Shuib	2012	Interactive persuasive mobile game (Smoke shooter)	• Persuasive	• Mobile
R16	Wan Ahmad Jaafar Wan Yahaya, Siti Nor Jannah Ahmad, and Mohamed Zamri Mohd Zain	2012	Persuasive multimedia to raise awareness of stress	• Persuasive • Multimedia	• Mobile

R17	Mohd Fitri Yusoff, Abdul Nasir Zulkifli, and Nor Fadziana Faisal Mohamed	2011	Persuasive multimedia courseware for virtual Hajj learning (V-Hajj)	• Persuasive	• Computer-based
R18	Arifah Fasha Rosmani and Nadia Abdul Wahab	2011	Persuasive multimedia application for Arabic characters learning (i-IQRA')	• Persuasive • Multimedia	• Computer-based
R19	Sobihatun Nur Abdul Salam and Wan Ahmad Jaafar Wan Yahaya	2009	Persuasive multimedia learning for reducing children's dental anxiety	• Persuasive • Multimedia	• Computer-based
R20	Carmen Soler, Alejandra Zacarías, and Andrés Lucero	2009	Persuasive mobile game on raising awareness of dental hygiene and oral health (Molarcropolis)	• Persuasive	• Mobile

In line with the aims of this study, the chosen articles were reviewed and compared (pre-analysed) according to five main focuses, which are as follows:

i) the domain of the study
ii) the technology used to implement the design principles
iii) the target outcome
iv) the utilisation of design principles
v) the integration of design principles

Based on the determined focus, the studies were grouped into the same main domain, technology used, and the intended target outcome. If the studies had utilised the design principles, they would be listed, and the frequency counted. The integration of design principles is considered if the selected study used persuasive and multimedia design principles.

From the pre-analysis, it can be concluded that most previous studies were found focusing on the health [7], [20-21], [22-26], education [18-19], [21], [27-33], and environmental [34-35] context. On top of that, it was observed that the trend of technology used is computer-based [17-19], [21], [28-30], [32-33], [35], mobile [20], [22-25], [26-27], [33] and wearable [7], [23-24], [31]. Moreover, most previous studies intended to change users' behaviour with various target outcomes. Most of the previous studies also clearly highlight utilising various design principles that are not limited to persuasive and multimedia. The integration of the design principles was also identified in most of the studies [17-21], [23], [30], [33], [35], where they applied persuasive and multimedia principles. The findings of the comparative study will be further discussed in section 4.

4. Findings and Discussion

This section presents and discusses the findings of the reviewed and analysed articles depending on the criteria decided in the previous section.

4.1. Domain of study

Studies on wearable technology, persuasive technology and multimedia have been reported in various domains. It can be seen in Table 7 that half of the studies were categorised in the education or learning domain, 45 per cent in the health domain, and the rest in the environment domain.

Table 7. Domain of study

Domain	Study	Percentage
Health (promote a healthy lifestyle)	R1, R5, R6, R7, R9, R15, R16, R19, R20	45%
Education/Learning (educating/learning)	R2, R3, R4, R10, R11, R12, R14, R17, R18, R19	50%
Environment	R8, R13	5%

All the studies were classified based on the studies' intention to promote a healthy lifestyle, educate and learn, or encourage people to save the environment. For the health domain, the types can be categorised into several kinds, including mental, as shown in Figure 1. Interestingly, all the studies focused on mental health that highlighted different types of mental illness, for example, stress, anxiety, and depression. These findings strengthen the possibility of leveraging wearable persuasive multimedia in mental health issues, particularly depression.

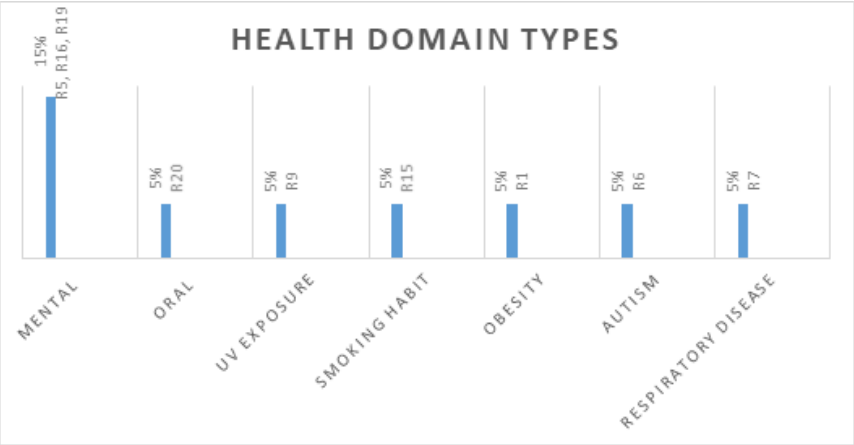

Figure 1. Health domain types

4.2. Technology used

In terms of technology used, it was found that many existing studies preferred computer-based and mobile technology, as illustrated in Table 8. Nevertheless, the use of computer-based technology is still acceptable since it is still used in recent research, R1, R3 and R4. Understandably, wearable technology utilisation is less than computer-based and mobile technology because it is still presumed new among users. However, R20 is among the earliest study that used wearable technology since the study was conducted in 2009.

Table 8. Technology used

Technology	Study	Total
Computer-based	R1, R3, R4, R10, R11, R13, R14, R17, R18, R19	10
Mobile (smartphone)	R2, R5, R7, R9, R12, R15, R16, R20	8
Wearable	R6, R7, R9, R12	4

In mental health, integrated sensing technologies in wearables can be utilised to track signals related to mental health states. The behavioural, psychological, and social cues that frequently reflect the changes in mental condition [36] might be used in designing steps of personalised treatment. For example, R6 uses the pulse sensor to monitor the heart rate (HR) and heart rate variability (HRV) to obtain precise responses regarding the emotional state of autistic children. When this information is delivered to the user through the application, it could increase the target outcome, such as awareness, which will be discussed in the next section.

4.3. Comparison of target outcomes

Following the original conceptualisation by Fogg [1], where persuasive technology is a means to change attitude and/or behaviour, some PT studies in various health and wellness domains reviewed by Orji and Moffat [37] reported targeted behaviour change and/or attitude in their research. However, instead of evaluating the expected result of behaviour and attitude, 72% of the 85 studies eventually measured their system efficacy by assessing other behaviour-related or psychological outcomes due to the actual behaviour change necessitating a more extended evaluation time [37].

The comparison clearly shows in Table 9 that apart from behaviour and/or attitude, all 17 studies targeted diverse behavioural/psychological outcomes, as revealed by Orji and Moffat [37]. Unfortunately, R6, R10 and R12 were excluded from the comparison due to those studies not applying persuasive technology. Nevertheless, R10 was also intended to increase awareness of Islamic Sex Education (ISE), while R6 reported that the most preferred function of wearable technology is awareness. In addition, many studies like R1, R3, R7, R16, R17, and R20 targeted more than one outcome.

Table 9. Target outcomes by persuasive studies

Behavioural/Psychological Outcomes	Study	Percentage
Behaviour	R3, R5, R7, R15, R17	29.4%
Attitude	R13, R17	11.7%
Motivation	R3, R5, R7, R16, R19	29.4%
Awareness	R1, R4, R7, R8, R9, R14, R16, R20	47.1%

Self-efficacy	-	-
Adherence and Compliance	-	-
Habit	R20	5.88%
Knowledge	R1, R2	11.8%
Intention	-	-
Engagement and Acceptance	R5, R11, R17, R18	23.5%
Belief and Perception	R1, R3	11.76%
Others	-	-

Table 9 also shows that almost half of the persuasive studies also targeted awareness as their outcome. Moreover, one of the studies, R16, intends to raise mental health awareness, particularly stress among secondary school students. Besides affecting their grades, mental disorders among students could also cause them to lack controllability awareness. The cause is their ability to pay attention and determine if the aspects of potential consequences are in or out of control to adapt to life events. Therefore, although none of the existing studies specifically investigated controllability awareness, this study should focus on this kind of awareness to enhance depression awareness. Besides, it can be concluded that one with greater controllability awareness can control other awareness, as summarised in Figure 3.

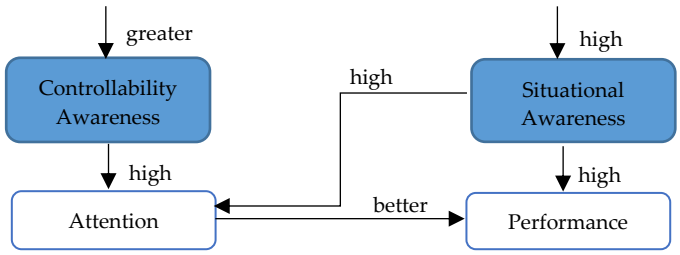

Figure 3. The relation of awareness

4.4. Design principles utilisation

For design principles utilisation, it was found that only one study, R5, does not explicitly state any principles. Meanwhile, the rest of the articles highlight at least one principle in their work. Overall, 29 persuasive principles, 13 multimedia principles and four wearable principles have been identified in all studies. Some principles (as listed in Table 10) for each design principle were commonly used in the studies. The widely used principle was determined if it was utilised in 5 studies and above. However, merely one principle was applied in two different studies for the wearable design principle.

Table 10. The most utilised principles

Persuasive Design Principle	**Total**
Cause and effect	6
Similarity	7
Suggestion	5
Attractiveness	7
Praise	5
Multimedia Design Principle	**Total**
Coherence	5
Multimedia	6
Wearable Design Principle	**Total**
Comfort	2

Some studies also leverage other design principles from wearable, persuasive, and multimedia design principles. For example, R10 applied three ISE principles to suit the study content: binding, threat, and enlightenment. Those principles were proposed by Mohamed Noor [29] for ISE topics. In addition, R5, R8 and R20 applied game design elements in their study. For example, in R8, 29 elements of the game were mapped onto 12 different persuasive strategies.

The selection of design principles in every study usually depends on the principles' suitability in helping achieve the expected intention of the study. For instance, Wan Yahaya [20] chose the cause-and-effect principle to expose students to the danger of stress. This principle was introduced through the persuasive multimedia application by showing the presentation clip of the consequences caused by stress.

In a different study, Dohalit [18] applied the coherence principle to ensure learners' attention was not distracted by the unrelated sound effects, background music and on-screen graphics in their application.

4.5. Consolidation of design principles

Figure 4 illustrates the studies that integrated the design principles in their work. It was discovered that 14 studies utilised persuasive design principles, 11 implemented multimedia design principles, and two highlighted wearable design principles. Overall, only ten of the studies were found to consolidate the persuasive and multimedia principles. Nevertheless, although R7 and R9 were working on wearable and persuasive technology, both studies did not highlight the integration of wearable and persuasive design principles. Likewise, R12 did not emphasise integrating wearable design principles and multimedia design principles. These findings reveal the absence of integrating all three design principles.

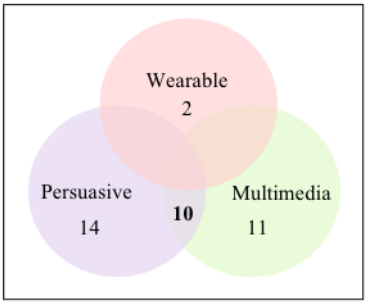

Figure 4. Total number of principles consolidation

Nonetheless, through experimental testing, it was confirmed by most of the studies that the consolidation of design principles in their work implicates the expected result. The succeeding Table 11 is the evidence of the successful outcome of the integration.

Table 11. The successful findings of the consolidation of persuasive multimedia design principles

Study	Target outcome	Findings
R1	Knowledge and awareness	Better understanding and **improved** students' awareness of obesity risk
R2	Knowledge	Students' knowledge of Islamic funerals **improved**
R4	Awareness	Students' truancy awareness **increased**
R13	Attitude	A positive attitude towards disabled people is **formed**
R14	Awareness	Children's awareness of sexual abuse **increased**
R16	Awareness and motivation	Students' motivation has a **significant** effect
R18	Engagement	Children's interest in learning IQRA **increased**
R19	Motivation	Children **motivated** for a dental visit

Based on the results, it is believed that the intention of this study in consolidating the three design principles to enhance depression awareness will also yield a positive impact.

5. Implication of Study

The study will provide a rich understanding of wearable persuasive multimedia, especially the body of knowledge on persuasive multimedia. Furthermore, it will discover the triangulation facets of the persuasive, multimedia, and wearable design principles. The revealed utilisation and consolidation of principles could benefit multimedia developers in designing and developing effective persuasive multimedia applications for wearable technology to promote controllability awareness in various domains. In addition, the consolidation of design principles in this study is anticipated to impact social well-being that could help towards the sustainable development of youth in Malaysia.

Moreover, the integrated design principles will be transformed into a conceptual model that could be the means toward more virtualisation of health promotion in the Industrial Revolution (IR) 4.0 era. The conceptual model could explicitly express the relationship among design principles. Furthermore, it is believed that the proper selection and integration of design principles could produce a reliable and robust model. Besides, the model is anticipated to be the guideline for other researchers in developing wearable persuasive multimedia applications regardless of domain and technology. For instance, this research is expected to construct a conceptual model as the guideline for developing wearable persuasive multimedia applications to enhance users' controllability awareness. The sensor embedded in the smartwatch will be

leveraged to make the user aware of the sudden increase in their heart rate, which is one of the indicators of depression occurrence.

Also, the results of this study could be beneficial to other researchers that utilise other multi-media technologies such as drones (Unmanned Aerial Vehicles, UAV). For example, in recent studies, Alsamhi *et. al* [38] and Fraune *et. al* [39] incorporated wearable and drones for search and rescue (SAR), while Garge *et. al* [40] used UAVs as on-demand QoS (Quality of Service) enablers that support multimedia applications in smart cities. Although [38-39] worked for the same domain, both studies focused on different contexts, namely game and emergency communication. In addition, Fraune *et. al* [39] also developed future wearable interfaces to support mobility and situational awareness. Therefore, this study believes the findings will give those researchers new opportunities to explore the possibility and impact of embedding integrated wearable persuasive multimedia principles.

6. Conclusion

This study reviewed various design principles in wearable technology, persuasive technology, and multimedia. This study also discovered the utilisation of the principle and how those principles were integrated. This study also revealed other design principles and game design elements as additional information. It was found that the design principles were leveraged in various domains, especially in health and education. Recently, it was discovered that design principles are also implemented in wearable technology besides computer and mobile technology. Besides the technology used, every study targeted different outcomes, with the most targeted outcome being awareness.

In terms of principles utilisation, it can be said that many studies have consolidated the design principles in their work. It is believed that the consolidation of design principles could enhance the effectiveness of a persuasive system to achieve the targeted outcome of the study. Therefore, this research raises important questions about the possibility of integrating design principles to enhance awareness, especially in the mental health domain. As a result of this research, the authors propose that it would be fruitful to pursue further research about the integration model of wearable persuasive multimedia to assess its effectiveness in enhancing controllability awareness.

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