Framework for Enhancing Learning Experience with Wearable Technology in Technical MOOC

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***Abstract*— The use of wearable technology in education can significantly help educators to engage the students more with the learning. By providing users with hands-free access to contextually relevant knowledge, wearable technologies are poised to inspire a new generation of mobile learning design. However, for educators to harness the pedagogical opportunities of wearable technologies and to implement it in MOOC platform, this paper proposes a framework for enhancing the learning experience in technical MOOC using wearable technology. In addition, we also identify the elements of wearable technology that is suitable to be implemented in teaching and learning, elements of technical MOOC to be combined with wearable technology elements and student engagement elements. The main measurement for enhancing learning experience is based on the level of students' engagement (measure through course completion) and students' skill development (measure through direct observation, interview, and questionnaire). The students reflected as fully engaged with the online course when they able to actively participate and complete the course and in contrast, when the students are unable to complete the course, this reflects that they are not engaged with the online learning. Thus, the proposed framework will work as a guideline for lecturers and educators to create effective and engaging MOOC learning design, especially for technical courses.**

***Index Terms*— Guideline; Smart Glasses; Student Engagement; Technical MOOC.**

I. INTRODUCTION

The influence of technology innovation continues expanding and impacting all industries as it evolves including in the education field. In education, the technology roles have directly and indirectly changed the design and delivery of teaching and learning process. Devices like smartphones and tablets are starting to replace conventional classroom teaching and learning system. This change has brought a paradigm shift especially in the field of higher learnings institution. This scenario affecting the teaching practices and the ways of students acquire knowledge. Thus, to be in line with the current technology change, it is a must for higher learning institutions to continuously figure out latest and innovative solutions to improve the current teaching and learning process.

One of the solutions is by adapting teaching and learning process with online learning. MOOC is one of the most rapidly growing online education based learning. Basically, the main purpose of online learning is to offer its learners with access to educational materials at their own pace and time, as well as lowering the average educational learning cost [1]. MOOC is a tuition-free course taught over the internet which allows virtually anyone to attend the course. As reported by Class Central up until December 2017, there are more than 17,000 courses being offered, which enrolled by more than 100 million students, offered by 57 MOOC platforms and adopted by more than 23 countries all over the world [2]. The courses offered cover all the fields which can be categorized into technical courses which are technical and business courses; and non-technical courses which are humanities and social science courses.

One of the key concern of MOOCs as reported by [1] and [3] in their study is a high learners' dropout rate. The study also highlighted on several sources indicating that about 5% to 15% of MOOCs participants finish the courses on average [4, 5]. The low completion rate in MOOC is a result of lack of enthusiasm in the course engagement to motivate learners toward participation. Underpinning MOOC high dropout rate and retention issue, few solutions by previous studies suggested MOOC improvement from the pedagogical criteria [6-8], technical criteria [8, 9], and to include additional engaging online elements, such as gamification [10-12], animation [13-15], and social feedback [16, 17] in order to engage and motivate the students more with the learning process

Engaging students in MOOCs environment, especially for non-technical subjects, was suit very well. However, there are few challenges for all educators in creating effective and engaging technical MOOCs. This is because technical MOOCs must able to offer practice-oriented learning for the MOOC course to be effective and engaging [9, 18, 19]. Thus, few previous studies in the field of electrical and electronics suggested to include the element of the virtual and remote laboratory in developing technical MOOCs [9,20-22]. Garcia, et al. [9] in their study explained that they included a remote laboratory platform Virtual Instrument Systems in Reality (VISIR) in their MOOC course and most of the MOOC videos focusing on handling the remote laboratory instruments. However, the authors highlighted that there is a limitation when working with the remote laboratory as it is not the same when dealing with the real circuit implementation where the lecturer existence element, showing the real circuit demonstration is a must [9, 22].

Another technical online learning field which appealed great attention recently by researchers is in the field of healthcare. Few studies [23-25] suggested to include the use of wearable technology, where in this case the researchers used smart glasses as it wearable technology, as one of the tools in helping the lecturers during the teaching and learning

process. The output from wearable technology also able to engage the medical students more with the learning process. Smart glasses are wearable computing devices in the form of computerized eyeglasses that function to add information into reality or assist people to see better [26] Smart glasses collect information from internal or external sensors, retrieve data from other instruments or computers and support wireless technologies like Bluetooth, Wi-Fi, and GPS [26]. The recording ability possesses smart glasses able to capture the first-person view and real-time video especially for training purpose [23-28]. However, the used of smart glasses especially in MOOC environment is still in the early stage due to the creation of technical MOOC involved significant challenges to support practice-oriented learning [9, 18, 19].

Due to the above issues addressed in the development of technical MOOC, the purpose of this study is to propose a framework for enhancing the learning experience in technical MOOC using wearable technology, wherein this study we are using smart glasses. The main measurement for enhancing learning experience is based on the level of students' engagement (measure through course completion and students' retention) and students' skill development (measure through direct observation, interview, and questionnaire). As per the suggestion in self-determination theory (SDT) [29, 30] when applied to the realm of education, is concerned primarily with promoting the students an interest in learning, a valuing of education, and confidence in their own capacities and attributes. These outcomes are manifestations of being intrinsically motivated and internalizing values and regulatory processes. Research suggests that these processes result in high-quality learning and conceptual understanding, as well as enhanced personal growth and adjustment [29]. The students reflected as fully engaged with the online course when they able to complete the course and when the students are unable to complete the course, this reflects that they are not engaged with the online learning. Thus, the proposed framework will works as a guideline for lecturers or educators in creating an inspiring, engaging, and emotionally-centered online learning course as well as on the same time able to enhance the student's learning experience especially in learning technical courses.

A. *Research Objective*

The purpose of this study is to propose a framework for enhancing the learning experience in technical MOOC using wearable technology.

B. *Research Question*

The main highlight research questions that guided this study are as follow:

- RQ 1: What are the elements of wearable technology that is suitable to be implemented in teaching and learning?
- RQ 2: What are the suitable elements to be used in developing technical MOOC?
- RQ 3: What is the suitable theory to improve online learner engagement and motivation?

II. Literature Review

A systematic review method has been implemented which collects and critically analyzed all required information and supporting materials to identify the suitable dimensions and elements in designing the proposed framework. The literature search was conducted mainly from the online databases which are Scopus, ScienceDirect, and IEEE Xplore. The search terms used in all online database are ("wearable technology" AND "smart glasses") and ("MOOC" AND "engagement" OR "student engagement"). Literature searches conducted in the last five years and search keywords used for all areas (including title, abstract, keywords, and full text). The literature search results are included in Table 1.

Table 1
Literature search results from the online database

Online Database	Total Result (wearable technology)	Total Result (MOOC)
Scopus	113	205
IEEE Xplore	286	30
ScienceDirect	332	176

Based on the first search on previous studies, the results were then being further screening as per below criteria:

- Studies that highlight on wearable technology elements, MOOC elements, and student engagement elements
- Studies that are focusing on wearable technology framework or model
- Studies that are focusing on MOOC framework or model
- Studies that are focusing on student engagement framework or model
- Studies that are explaining the technical MOOC design and structure

As a result of the screening stage, there are only a total of 57 paper has been selected and divided into two focus groups. The group's division are "wearable technology and engagement" with 32 main reference papers and "MOOC and student engagement" with 43 main reference papers.

III. Result And Discussion

This section presents the identified dimensions for each of the important variables that building-up the framework for enhancing the learning experience in technical MOOC using wearable technology, starting with the wearable technology dimensions, MOOC dimensions, and student engagement dimension.

A. *Wearable Technology Dimensions*

Recently, literature emerged has offered some interesting findings of using wearable technology distributed in all fields with different implementation background. However, the practice used of wearable technology mainly being supported most in these two primary areas which are in medical and higher education. Given the exciting developments in wearable technology, researchers believed that wearable technology has vast potential implication and numerous benefits for augmentation of teaching and learning environments. Some of the potential benefits offers by wearable technology are: (a) able to engage, stimulate, and motivate students to explore class materials from different angles; (b) able to teach subjects where students could not feasibly gain real-world first-hand experience; (c) enhance collaboration between students and instructors; (d) foster student creativity and imagination; help students take control of their learning at their own pace and on their own path; and

(e) able to create an authentic learning environment suitable to various learning styles [19, 25, 31].

Among the early implementation of wearable technology especially smart glasses is in the field of medical application. In the studies conducted by [25, 28] shared on how smart glasses could revolutionize medical education in areas such as surgery. By using the wearable camera, the students able to see procedures from the surgeon's perspective, instead of peeking behind the surgeon's shoulder to see the whole procedures [25, 28]. Another research by [23] integrated smart glasses into simulation-based training exercise summarized that data captured from the simulation training able to improve debriefing session and a good platform for self-reflection. The literature by [32] highlighted on the

implementation of smart glasses as one of the recording tools for evaluation purpose. The study concluded that the ability of smart glasses that able to record students' first-person perspective is very meaningful especially for faculty and student analysis and evaluation purpose. In addition, a study piloted by [33] which examined on the utilization of smart glasses in the medical industry. This study highlighted that smart glasses' features which are compatibility, ease of reminding, speech recognition, ease of use, ease of learning, ease of medical education, external influence, and privacy elements do positively affect the usefulness of smart glasses in medical.

Another field that considerable amount of literature has been published on the application of smart glasses is in education (for non-medical related application). A study conducted by [34] employed the used of smart glasses in learning frequency in physics education. The main idea behind this study is to allow smart glasses to automatically measured both the water level and the sound frequency, and incrementally generate a frequency graph in the head-mount-display. The result from the study revealed that by using smart glasses in learning is able to engage the students more with the learning process. The usage of smart glasses also being expended and used in improving the effectiveness and efficiency of teaching techniques in STEM area [35-41]. Smart glasses also have been successfully applied to a variety of setting, including in machine maintenance [42-44], e-tracking technology [45, 46], guiding disable people [47, 48], and controlling purpose [49, 50].

Table 2 summarized the identified wearable technology dimensions towards supporting teaching and learning process based on the previous studies from the year 2013 until 2016. There are 9 wearable technology dimensions has been identified based on critical literature review which is first-person view (FP), recording ability (RA), real-time interaction (RT), student assessment (SA), navigation (N), AR ability or simulation (AR), personalize learning (PL), pattern recognition (PR), and communicating with large infrastructure (CM). However, based on experts review and commendation, from 9 wearable technology dimensions, only 4 dimensions is currently suitable to be cooperated and implemented into MOOC platform, which are first-person view (FP), recoding ability (RA), real-time interaction (RT) and student assessment (SA). Table 3 lists the explanation for each of the identified wearable technology dimensions together with its suitable wearable technology activities based on previous study review.

Table 2
Review of wearable technology dimensions from the year 2013 to 2016

Author/s	Wearable technology dimension								
	FP	**RA**	**RT**	**SA**	**N**	**AR**	**PL**	**PR**	**CM**
[19]		X	X						X
[23]	X	X		X		X	X		X
[24]	X	X		X			X		
[25]	X				X	X			
[27]	X	X	X	X		X	X		
[28]	X		X				X		
[32]	X	X		X					
[39]			X		X	X		X	X
[40]		X				X	X		
[41]			X	X		X		X	
[42]		X			X		X		X
[43]		X	X	X	X		X		
[44]	X	X			X				
[45]								X	X
[46]					X	X		X	
[47]	X	X	X				X		
[49]	X		X		X		X	X	
[50]			X			X	X	X	
[76]			X			X			
[77]			X			X			
[78]			X				X	X	X
[79]			X				X		X
[80]	X	X					X		
[81]			X			X	X	X	
[82]	X	X	X						
[83]	X	X		X			X		
[84]	X	X	X	X			X		X
[85]	X	X		X			X		

Table 3
Explanation of each wearable technology dimension

WT Dimension	Definition	WT activity
First-person view (FP)	Wearable technology affords the ability to offer a first-person point of view to engage the learner more with the learning. This functionality will promote the learners to view the learning from the lecturer's perspective.	Capture first-person point of view
Recording ability (RA)	Wearable technology affords the recording ability either for video or picture recording. Few wearable technologies allow the wearer to perform recording activity with the hands-free ability (activate using voice command).	Take picture Video recording Voice recording Notes taking
Real-time interaction (RT)	Wearable technology allows the wearer to access information in real time (either to retrieve, share, or store data). Moreover, the wearer (lecturer) could also receive instant feedback during lectures from the students via local chat without question interruptions.	Live-video stream Real-time activity Received and send feedback instantly
Student assessment (SA)	Wearable technology enabled the observers to analyze the wearer's primary visual focus during the entire procedure/ activity. Using the recorded videos/ pictures, student's performance evaluation can easily be made, and feedback can be provided based on the data recorded.	For student assessment purpose – either during mockup or a real scenario
Navigation (N)	Wearable technology offers navigation or direction function to the wearer by providing visual-based instructions to follow. This function allows the learning process to be more personalized, focusing on meeting individual student's needs	Step-by-step instruction (either in the written or graphic based instructions)
AR ability/ Simulation (AR)	Wearable technology affords a simulation capability to support experiential learning. The simulation can be in the form of augmented reality by using visual, audio and location-based inputs to provide relevant information. This feature able to create much more realistic and the immersive environment when integrating with the real world (either through games or services).	Virtual reality game Simulation element
Personalize learning (PL)	Wearable technology affords the opportunity to create specific interactions to fit a user's learning preferences. The wearer also can search information through the internet. This function allows the learning process to be more personalized, focusing on meeting individual student's needs.	Set of instruction (either in the written or graphic based) Google function
Pattern recognition (PR)	Object recognition function allows the wearer to scan and display the object scanning result through visualization.	Object scanning Word translation
Communicating with large infrastructure (CM)	Wearable technology allows internet connection via wi-fi or Bluetooth setup. Once connected, the wearable technology able to communicate with large computing infrastructure (cloud computing), which can be data-mined to monitor the knowledge building process.	Searching function - google GPS Map navigation Storage element (via cloud computing)

B. Massive Open Online Learning (MOOC) Dimensions

The classification of MOOCs may vary depending upon the pedagogical interaction, learning outcomes or the learners' experience. The common literature on MOOC classified two kinds of MOOCs which are xMOOC and cMOOC [51]. This classification is based on the course content structure, expectations of students' performance and assessment methods.

The current majority of existing MOOCs are content-based MOOCs, known as xMOOCs, which present the course content through different knowledge packages and methods that assess learners' mastery of the knowledge [52]. xMOOC content usually includes short lecture videos each week, often supported by supplementary readings, and more on self-test problems. Assessments that count towards the participant's final score are provided a usually weekly basis, in the form of multiple-choice or short answer quizzes that are auto-graded, and peer-graded assignments. Online discussion forums are also included in the xMOOC content to allow participants to engage with each other and exchange knowledge and ideas, or to create a sense of community [8]. However, in xMOOC the element of the forum discussion not become the major contribution in knowledge construction.

Connectivist MOOCs, known as cMOOCs, are more fluid in structure. They focus more on an overarching instructional goal and are less directive with respect to the process. Learners in a cMOOC build their knowledge through co-creation assignments with peers. Instructors may pose initial or weekly questions and challenges together with a variety of text-based or media resources. Learners interact and cooperate with one another in completing the course activities. The success of a cMOOC is highly dependent on participant interaction via discussion forums. However, the challenges to make this interaction happen to lie at the different starting point of the prior knowledge of the learners [53]. Course outcomes are often unique products, such as blog posts, images, diagrams, or videos generated by participants using a variety of social media. The role of the instructor is to act as a facilitator by aggregating, reviewing, summarizing and reflecting on participant activity on a daily or weekly basis [8].

There are some MOOCs that fit in between an xMOOC and a cMOOC. This third type of MOOC is called pMOOC (or project-based MOOC), which is a content-based, highly structured MOOC in terms of how the course content is organized and presented, but also blends a project-based model of assessment [51]. In this type of MOOC, the task for the student is to design a project that is reviewed by peers using an articulated rubric, created by the instructor or teaching staff [51]. Course completion requirements in a pMOOC typically include submitting projects for peer grades and reviews of mini-projects designed by peers [51]. Table 4 lists the identified MOOC dimensions (based on the combination of xMOOC, cMOOC, and pMOOC) which gathered from literature review since the year 2014 until 2017. The identified MOOC dimensions are course information (CI), course resources (CR), interaction (IN), meaningful connections (MC), frequent monitoring of learning (FM), and active learning (AL). Table 5 lists the explanation for each of the identified MOOC dimensions.

Table 4
Review of MOOC dimensions from the year 2014 to 2017

Author/s	MOOC dimension					
	CI	CR	IN	MC	FM	AL
[1]	X	X	X	X	X	X
[5]		X	X		X	X
[6]	X	X	X	X	X	X
[7]	X	X	X		X	

[8]	X	X	X		X	X
[16]			X	X	X	X
[51]		X	X			X
[86]	X	X	X	X	X	X
[87]	X	X	X	X	X	X
[88]	X	X	X	X	X	X
[89]	X	X	X	X	X	X
[90]	X	X	X		X	X
[91]	X	X	X	X	X	X
[92]	X	X	X	X		X
[93]	X	X		X		X
[94]	X	X	X		X	X
[95]	X	X	X		X	X
[96]	X	X	X		X	X
[97]		X	X		X	X
[98]	X	X	X	X	X	X

Table 4
Explanation of each MOOC dimension

MOOC Dimension	Definition
Course information (CI)	Course content must include a clear statement of what the learner can hope to achieve upon successful completion. The curriculum is coherent with its content and sequencing of courses, and it's effectively defined in easily available documents including course syllabus and program description.
Course resource (CR)	Course resources/ materials must contain facts, updated information, concepts or approaches. Course materials are structured to facilitate individual study.
Interaction (IN)	Course design and delivery able to support student-student and student-lecturer interaction. Use a learning environment that is easy to handle for everyone. Use a different kind of collaboration tools such as social media, email, forum, and chat.
Making a meaningful connection (MC)	Course content and activity that able to connect the learners to the actual practice in the larger world which they could identify.
Frequent monitoring of learning (FM)	Learners' progress is monitored, and learners are provided with prompt and helpful comments on their progress in relation to learning expectation and goals.
Active learning (AL)	Course activities that involved learners in doing things and thinking about the things they are doing.

C. Online Learner Motivation Theory and Student Engagement Dimension

Motivation in learning is the art of getting the learners to perform a specific behavior to achieve specific learning goals. Existing research recognizes the critical role played by motivation element especially in developing an engaging and effective online learning course [54-57]. In addition, recent works by historians informed that another theory that has proved especially useful in analyzing motivational factors, students' engagement, students' motivation, and achievement in education is Self-Determination Theory (SDT) [55, 58]. Self-determination theory also being described as one of the most comprehensive and empirically supported theories of motivation available. Previous studies also indicate that self-determination theory can be used to foresee a variety of learning outcome, including performance, persistence, and course satisfaction [29, 30, 59, 60]. As per suggested by [29, 30, 60], the main components that build-up self-determination theory mainly comprises of three primary features which are the needs for autonomy, relatedness, and competence. The need for autonomy involves in self-initiation and self-regulation of one's own behavior to act in harmony [29]. While the needs for relatedness is more focusing on the feeling of closeness, affectionate, and belonging to a social group [29]. And the need for competence is the ability of a person to interact proficiently or effectively with the environment and desire to control and master the environment and its outcome [29]. Experience of autonomy, relatedness, and competence able to foster volition, motivation, and engagement which then able to result in enhancing in learning experienced, enhancing in learning performance, persistence, and creativity. Self-determination theory has been successfully applied to a variety of setting, including physical education [61, 62], politics [63, 64], health care [65, 66], religion [67, 68], general education [55, 69, 70], and online learning [57, 58, 71-73].

Another crucial element that resulted from students' motivation is students' engagement with the learning process. Student engagement can be defined as the extent or degree of a students' involvement in a learning activity [1]. A numerous number of models been proposed to describe the various aspects of students' engagement. However, in a major literature review by [74] identified three main aspects of engagement which are: a) behavioral engagement which refers to students participating in a learning activity such as completing an assignment, attending classes, or contributing in discussions; b) affective engagement which refers to students' emotional responses or feeling (positive or negative) toward teachers, peers, learning, and school; and c) cognitive engagement which refers to the deliberate task-specific thinking that a student undertakes while participating in an activity, including asking and answering questions, giving explanations, justifying an argument, and contributing ideas [1]. Illustrate below is a model of student engagement which being organized around self-determination theory towards online course completion as per suggested by [1] and [75] (refer Figure 1).

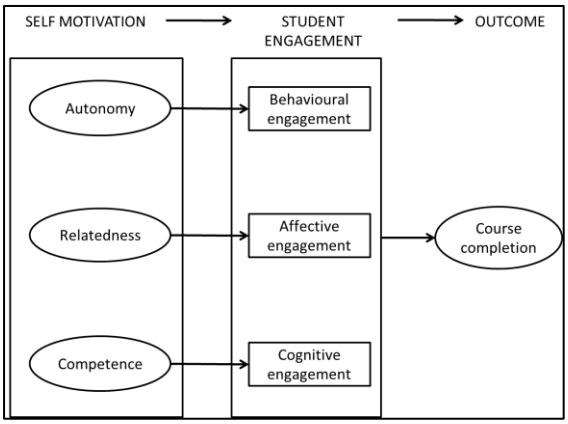

Figure 1: A model of student engagement organized around SDT by Hew (2015).

D. Proposed Framework

From the critical review of the literature, the proposed framework for this study was mainly based on the

combination of three concepts, which are: (i) wearable technology dimensions; (ii) MOOC dimensions; and (iii) student engagement dimensions. Figure 2 illustrates the proposed framework for enhancing the learning experience with wearable technology in technical MOOC. Figure 3 illustrates the theoretical framework for technical MOOCs using wearable technology.

Through the systematic literature review, we had identified the independent variables, moderating variable, and dependent variable for this study as per below explanation:

- *Independent variables (IV)* – Wearable technology construct has been identified as the IV for this study. The proposed framework for enhancing the learning experience for technical MOOC using wearable technology is measure based on the level of students' engagement (measure through course completion) and students' skill development (measure through direct observation, interview, and questionnaire). Thus, every variable in wearable technology construct is able to increase the student engagement level with technical MOOC, influencing the student to fully complete the technical MOOC course.
- *Moderating variable (MV)* – Wearable technology elements has been identified as the MV for this study. The wearable technology element merged with MOOC construct in order to strengthen the relationship between IV and DV.
- *Dependent variable (DV)* – Student engagement construct has been identified as the DV for this study. Student engagement level (measure through course completion) is depending on the effect of wearable technology construct. The course completion is depending on how wearable technology variables able to help the student to improve their understanding and enhance their learning experience for technical MOOC.

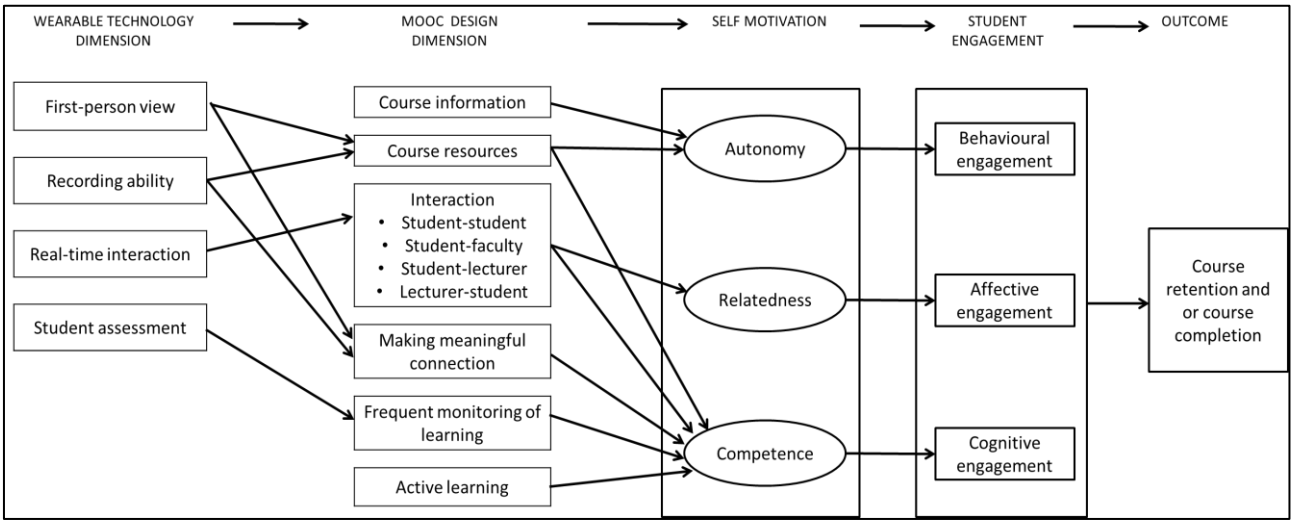

Figure 2: The finalized proposed framework for enhancing the learning experience in technical MOOC using wearable technology

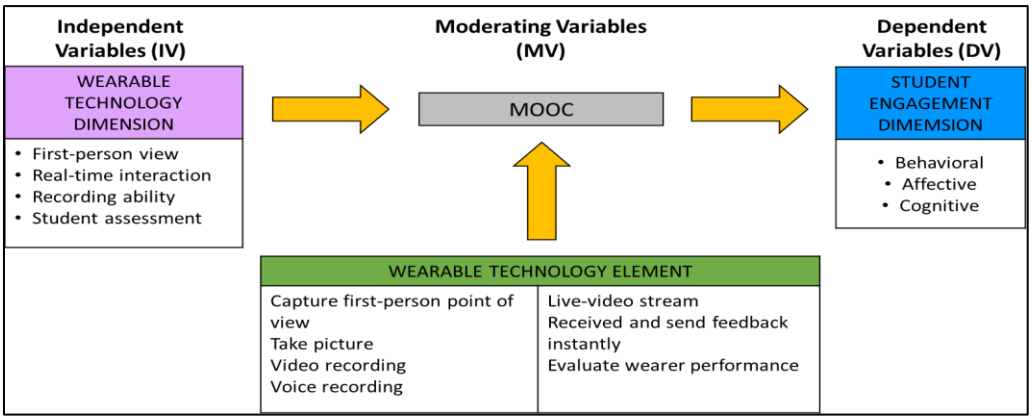

Figure 3: The theoretical framework for technical MOOCs using wearable technology.

IV. CONCLUSION

This research reviewed and discussed the construction of the framework for enhancing the learning experience for technical MOOC using wearable technology. The proposed framework design which is mainly focusing on the combination of wearable technology design framework and technical MOOC design framework with student engagement theory. From the systematic literature review, we had identified 8 wearable technology elements which are a first-person view, recording ability, real-time interaction, student assessment, navigation, AR ability or simulation, pattern recognition, and communicating with a large infrastructure. In this study, we also discussed another 6 essential elements for MOOC framework which are course information, course resources, interaction, making meaningful connections, frequent monitoring of learning, and active learning. All these elements were combined based on the identified student's engagement elements which are behavioral, affective and cognitive engagement elements. The proposed framework

aims to improve the teaching and learning process especially in designing technical MOOC structure to enhance the students' engagement and to increase the students' learning experience. In addition, the proposed framework able to contribute to the current and future lecturers the suitable wearable technology elements to be included when designing their technical MOOC course which these elements able to increase the students' levels of comprehension, motivation, and metacognition throughout the teaching and learning process.

ACKNOWLEDGMENT

The authors would like to take this opportunity to highly appreciate the cooperation and the opportunity given by the lecturers who gave their full support in this research and UTeM Zamalah Scheme for funding this research. This research is conducted by Pervasive Computing and Educational Technology Research Group, C-ACT, UTeM.

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