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Quality Attributes for an LMS Cognitive Model for User Experience Design and Evaluation of Learning Management Systems

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ABSTRACT
This paper used literature mapping and review protocol to examine associated literature sources with possible relationships that offers hints for the conceptualization of a UX cognitive model for the design and evaluation of learning management system (LMS) products. The mapping review revealed that the cognitive aspects of Bloom's learning taxonomy can be mapped into the user experience cognitive model for LMS. This model comprises of usability, learnability, understandability, ubiquity, rememberability, safety, trust and epistemic design and evaluation quality criteria. The proposed model is both appropriate for the design and evaluation of the cognitive components of LMS platforms and is therefore recommended for adoption.

Keywords: *Cognitive model, Learning management systems, Quality attributes, User experience.*

1. BACKGROUND

User experience (UX) entails all the qualities, facets and processes associated with the concept of 'experience'. However, in scope it is delimited to the interaction of users with technological artifacts. It refers to the end users' subjective experience that is formed in the course of interacting with technology [1]. It is the totality of users' feelings, perceptions, motivations, preferences, beliefs, attitudes and emotional reactions that result from their encounter or interaction with a product, system or service at a given time and context of use. Learner experience is the sum total of a learner's perceptions and feelings about his/her encounter with a learning management system (LMS) at a specified time and context of interaction. UX incorporates the more subjective view of users' feelings, emotions, attitudes, values, and motivations etc. [2]. This is formed via their interaction with digital products [3-4]. While discussing the concept of UX, there is the need to distinguish between 'an experience' and 'experiencing.' Hassenzahl [5] posits that whereas 'experiencing' happens every moment, 'experience' is a judgment or evaluative perception of past events. This judgment is the result of the meaning the users derives from or the sense they make out of the event(s) or the way the users interpret the effect of the events on them. In the context of UX, experiencing is a continuous 'stream of perceptions, interpretations of those perceptions, and resulting emotions during an encounter with a system' [6]. 'Experience' does happen constantly like a stream. It occurs in our continual involvement in the process of living, perceiving, sensing, feeling and thinking. "An experience" happens when a temporally identified activity is ended. Experience and its associated perceptions, interpretations, sensations, reflections, and emotions are subjective [4-5].

UX is an emerging research area that is still immature and, in its infancy [7]. It forms the fifth generation of the human computer interaction (HCI) domain which have shifted focus, since the 2000s, toward designing and measuring user experience [8]. UX research has often been criticized for the lack of a commonly agreed definition of the notion of experience. Though, there are several definitions of UX [9-19], these definitions however, do not agree as they reflect the individual background and interest of the respective authors [20].

Nonetheless, among the several definitions of UX, the ISO 9241-210 [15] definition is the most accepted, profound, and the commonly used in the UX community. It states that UX is “a person’s perceptions and responses that result from the use or anticipated use of a product, system or service.” This definition among others is however deficient as it does not incorporate context and time of interaction. UX does not occur in a vacuum. It happens within a given context, i.e., within a specific time and space (place). The context could be product, demographic, and/or cultural etc. In addition, UX researches agree that UX is not static, but dynamic, temporal and changes over time [4] [21-23]. These two parameters should be part and parcel of the UX definition as it will determine and affect the way UX is understood, designed, evaluated and modeled. Modifying the ISO 9241-210 to capture context and time, the UX can be defined as “a person’s perceptions and responses that results from the use or anticipated use of a specified product, system or service in a specified time and context of use”.

UX is also dynamic, temporal, emerging and evolves over time [4] [21-23]. It changes over time. Thus, an experience is unique, very likely to change over time, and cannot be replicated. Most prior studies of user experience with products were limited to first time interactions or to short interactions episodes [1] [24], but how users’ experience interactive artifacts and how their subsequent evaluative judgments develop over a longer period of time have not been adequately explored and addressed

Learner experience (LX) is user experience (UX) in the learner’s context. It is the way the learner interacting with a virtual learning environment (VLE) perceives of the environment and reacts to the learning activities on the VLE and how he/she makes sense of the events and entire learning activities on the platform [25]. An LX encompasses the learner’s encounters, reflections and responses to the cognitive, psychomotor and affective organismic stimuli that arise while learning on or interacting with the VLE platform. This study is restricted to the cognitive domain of interaction and engagement. An instance of a VLE is a learning management system (LMS) [25]. An LMS is a web-based VLE that is hosted on cloud or a server that enables instructors and learners to interact together and provide an avenue for students to interact with each other, with learning contents and actively learn on their own [26]. LMS allows a virtual classroom interaction between students and between students and their teachers [27]. It is used to manage and deliver instructional contents and to monitor the learning process and pace of each individual learner [28].

The use of LMS has become widespread and common as the platform has been adopted by several institutions of learning in several countries across the globe [29-30]. Learning is a complex activity with several intertwined and interwoven aspects [31]. It is associated with the learner’s thinking/reasoning process in the acquisition and retention of knowledge (cognitive) [2] [32-34]. Every VLE (the LMS inclusive), must enable the provision of these aspects of learning experiences. Unfortunately, the LMS fall short in providing this holistic learning package and experiences to learners and its teaming users. For an LMS to meet the cognitive learning needs for its users, such platforms must have the qualities of personalization and individuation [35-36]. It must be flexible enough to be tailored to or adapted to the holistic but individual learning needs of each user-learner with respect to enhancing their cognition [37]. A personalized LMS [38] will meet the cognitive (knowledge) needs of users/learners. Personalization is an umbrella quality that encapsulates all the other qualities of an LMS to propel an enriching user/learner experience. However, as important as this design quality is, it is deficient in LMS platforms. These platforms do not offer adequate personalized services and do not take into account the aspects of individuation that support the knowledge, interest, aspirations, emotions, motivations, and goals of each user-learner [39-40]. Interestingly, though this design issue is inherent in LMS platforms, no UX cognitive model has been developed yet for the evaluation of the effect of LMS on learner’s cognition [25].

The UX cognitive model for the design and evaluation of the UX of LMS platforms was conceived and developed from the cognitive component of the Bloom’s taxonomy of learning [41]. The increasing technological applications in educational processes to enhance teaching and learning has given rise to researchers embracing Bloom’s Digital Taxonomy (BDT). Accordingly, BDT supports all levels of cognitive domains, allowing for learners conceptual understanding of the learning contents [71-72]. In the light of BDT, UX model explains the cognitive organismic being of users of/learners on LMS. As this organism is influenced by design stimuli, it elicits and propels corresponding experiential responses from users of the LMS platforms [42]. Learners’ cognition is important as the level of difficulty, complexity, and stress encountered in the learning process on the LMS can affect learners’ cognitive (mental) faculty. This can also increase the cognitive workload of learners. The cognitive model explains a learner’s cognition while interacting with LMS following his/her stimulation by a number of stimulating attributes (design quality factors or criteria). These stimuli are as follows: i) usability [38] [43-52]: the ease of use or difficulty rate of an LMS’s interface or learning content affects the cognition of learners, their cognitive workload and the success rates in their learning endeavors [43] [53-55]; ii) learnability [38] [43-45]: the ease of learning the or with the LMS can affect the cognition of learners on or users of the platform; iii) understandability [38]: if the LMS platform or its content cannot be clearly understood, this infringes on the cognitive faculty of the user; iv) simplicity [38] [43] [46]: if the platform is complex, learners cannot achieve/accomplish their learning objectives/goals as they cannot carry out learning tasks. This will hamper their cognitive level.

Other stimuli include: v) readability: the LMS interface and learning contents that are readable will positively affect the learner's cognition [38] [54]; vi) ubiquity [54] [56-57]: learning is not limited by time and place. Any LMS that limits learning to a specific time and location and do not provide for anywhere, anytime learning will certainly inhibit the cognition of users of the learning environment; vii) accessibility [38] [45] [54] [56-59]: the LMS platforms that do not support persons with disability or certain category of users will affect the cognition of such persons; viii) effectiveness [38] [57] [60]: LMS platforms that do not enable learners accomplish their learning goals successfully will affect their cognition; ix) efficiency [38] [43-44]: learners time and efforts are valuable to them. Therefore, the LMS that does not enable them to achieve their learning goals with minimal efforts and time will surely impose some levels of cognitive stress on such learners; x) reliability [56] [57] [59] [61]: LMS platforms that are error prune and that do not support good recoverability will frustrate and disappoint its users and the learners on the platform. This frustration increases the learners' burden and hampers their cognition; xi) recallability [62]: the LMS platform that do not enable users/learners to easily recognize, retain, recall or remember their interaction on it will not support the cognitive process of the users; xii) safety [57] [59] [63]: LMS platform where users/learners do not feel safe or secured or where they fear being harmed or hurt, will affect their cognition since they will not feel free or relaxed with such platform [56]; xiii) trust [56] [70]: the LMS platform that users do not trust usually affects their cognition. Usually, they will not rely or depend on such platform as it is not open, transparent and trustworthy [64]; xiv) epistemic [57]: LMS learning contents are meant to deliver meaningful knowledge. If these platforms fail to do so, the learners' cognition will be affected; xv) intuitiveness [54]: LMS platforms that are intuitive support and enhance the cognition of learners/users [31] [56]. The above design factors (criteria) lead to learners' cognitive response to an LMS learning environment. A survey of prior works shows that there is no prior UX cognitive model for the design and evaluation of the effect of LMS on its users and learners. This study therefore proposes a UX cognitive model for the design and evaluation of LMS products.

2. METHODOLOGY

A literature review method was employed to examine prior literature with a view of finding out the dimensions and quality attributes that can be used to develop a conceptual UX cognitive model. A UX cognitive model is a model that enhances the cognition of users/learners as they interact with and learn on the LMS platform. The procedure used in the study is as follows: i) the downloading of literature materials that facilitate the conception of a UX cognitive model; ii) the analysis of the downloaded materials; iii) the extraction of relevant information associated with the development of a UX cognitive model; iv) the conceptualization and proposing of the model. Figure 1 indicates the procedure employed in this study.

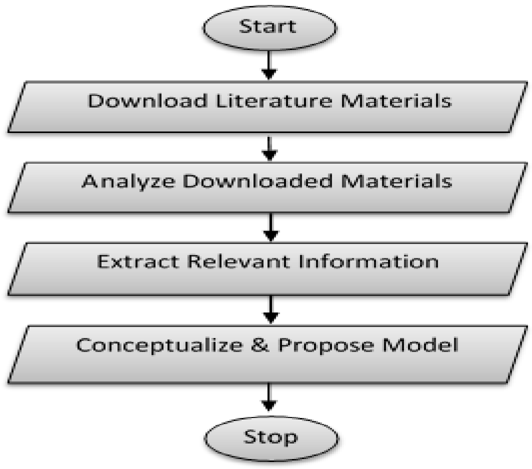

Figure 1 Study procedure

3. RESULTS

In this study, a literature review analysis was made and the result reveals that firstly, there is no user experience cognitive model in existence in prior works. Secondly, the study reveals that a UX cognitive model can be mapped from Bloom's learning taxonomy. Thirdly, the findings of the study show that usability, learnability, understandability, ubiquity, rememberability, safety, trust and epistemic factors determine or affect the cognition of users of and learners at learning management system platforms. Figure 2 and Table 1 illustrate and show the various attributes that influences the cognition of learners on LMS platforms.

Table 1. Dimensions and Quality Attributes of UX Cognitive Model for LMS Design and Evaluation

Model	Quality Attributes/Dimensions
Cognitive [65-66][71]	Usability [67]
	Learnability [67]
	Understandability [68]
	Ubiquity [64]
	Rememberability [62]
	Safety [67-68]

	Trust [69-70]
	Epistemic [1][71]

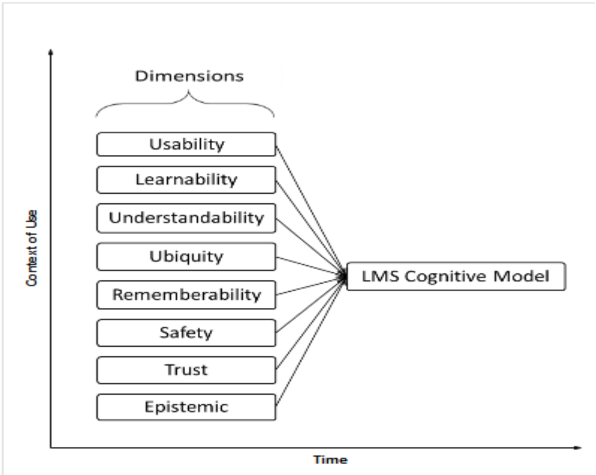

Figure 2 LMS Cognitive Model

Cognitive model: This model consists of qualities that reflect the thinking, intellectual, rational, reasoning process and decision-making capacity of learners on learning management system's platform. They are task-driven and goal-oriented qualities [73] . This model deals with the product and targets at the do/task goals of the users/learners. It is an instrumental, ergonomic, utilitarian and pragmatic model and includes attributes such usability, understandability, ubiquity, rememberability, safety, trust and epistemic [74-77]. The cognitive model of LMS platform can be measured as follows:

I. Ease-of-Learning: This quality measures how easy or difficult it is to learn on/with an LMS platform. This defines the cognition of LMS users/learners.

II. Knowledge Discovery: This quality measures the level at which an LMS platform supports learners to independently learn and construct their own knowledge through sense-making. This explains how cognitive an LMS platform is to learners [78].

There are eight attributes that determine the cognitive model, they include:

1. Usability: This is the users' perception that the LMS platform interacted with is easy to use and that their tasks and learning activities can be carried out and accomplished effectively and efficiently with minimal or no errors and that where error occurs, they can easily recover from it. This quality defines how difficult and challenging the LMS is to users/learners. Difficult and complex LMS affect the cognitive level and perception of learners. An ideal LMS should be simple, intuitive and easy to use and learn with.
2. Learnability: This quality describes how learnable or easy to learn the LMS platform is. The interface and content of the learning management system (LMS) are expected to be learnable and intuitive and simple [79]. If an LMS is not easily learnable, requiring lengthy time, more effort, and much tutorial to learn, the cognition of the users of or learners on such platform will be hampered as it will increase their stress level and constitute a burden to them.
3. Understandability: This attribute describes the extent of how understandable or comprehensible an LMS platform is to users/learners [80]. It defines its clarity, perspicuity, and lucidity. If the LMS interface and/or contents are difficult to understand, the cognitive faculty of users/learners will be affected.
4. Ubiquity: As learning cannot be limited by time and space (location), learning management systems (LMS) supports everywhere anytime learning. Ubiquity measures the anywhere anytime characteristics of learning situations. Therefore, if an LMS does not have this quality, users are likely to be frustrated and disappointed as they expect to interact and learn with LMS anywhere anytime. This frustration affects their cognition [81].
5. Rememberability: This attribute explains the extent to which users/learners can recognize, recall and retain what they learn on a learning management system (LMS) platform [82]. If an LMS does not have the capacity to support users/learners to recognize/remember what they learnt on the platform, it means such platform has negative cognitive support.
6. Safety: Users/learners want to interact with or learn on platforms they consider safe, secured and conducive for learning. Users/learners do not feel free to use or learn with learning management system platforms that they feel are harmful or that do not protect them. It should also enhance their health [83]. The learning ecosystem should be physiologically and ergonomically safe for learning. Cognitively, learning on such platforms is challenging and difficult for users/learners.
7. Trust: Users and learners generally depend or rely on platforms that they trust. On such platforms they invest their attention, reasoning, and intellectual faculties. Learning management systems that users/learners do not trust affect their cognitive faculty. Trust criterion comprises of qualities that stimulate trustful perceptions in users before, during and after interaction with LMS platforms and thus, LMS should be open, credible, transparent, dependable, available and reliable.
8. Epistemic: Learning platforms like the learning management systems (LMSs) are expected to deliver meaningful, sensible, comprehensive and intuitive

knowledge to learners. Any LMS that do not deliver epistemic quality hampers the cognitive faculty of learners [84-86].

With this model conceived, this study therefore proposes a UX cognitive model with usability, learnability, understandability, ubiquity, rememberability, safety, trust and epistemic qualities as design and evaluation criteria.

4. CONCLUSION

In sum, this study examined related literature for possible associations that provide clue for the conception of a UX cognitive model for the design and evaluation of LMS. The mapping study found that the cognitive component of Bloom's taxonomy of learning can be mapped into the UX cognitive model. This cognitive model consists of usability, learnability, understandability, ubiquity, rememberability, safety, trust and epistemic design and evaluation criteria, The model is both suitable for the design and evaluation of the cognitive aspects of learning management system platforms.

AUTHORS' CONTRIBUTIONS

All authors contributed to the content and quality of the article.

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