

Assessing the Impact of Multimedia on Concept Transfer by Examining the Interplay between User Experience and Felder-Silverman Learning Style

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ABSTRACT

Multimedia content due to its inherent audio-visual capabilities plays a significant role in transferring complex/ mystical concepts into the learners. Its effectiveness, is mostly concerned with goal-oriented narration of the story from one side and the level of engagement and understanding of concept by learners from the other side. In this respect, presenting a framework to organize an e-book to facilitate the effective transmission of complex /mystical concept is the focal concern of this article. Furthermore, the proposed framework incorporates rigorous user experience (UEQ) methodology, employing established metrics and qualitative feedback mechanisms to evaluate learners' satisfaction across a comprehensive range of UEQ scales, including attractiveness, hedonic and pragmatic quality in general. Empirical results, derived from experimental studies utilizing this framework, demonstrate a statistically significant and practically noteworthy impact on the learners' ability to grasp and articulate the core meaning embedded within complex and mystical concepts, thereby validating the efficacy of this innovative approach in promoting accessible and meaningful learning experiences. In this regard, the correlation between UEQ scales with learners' learning style model based on Felder-Silverman was investigated. The assessment of the results concerning the relationship between the UEQ scales and the Felder-Silverman learning style dimensions reveals that the multimedia e-book was evaluated as more engaging and innovative by learners whose learning styles, as classified by Felder-Silverman, were characterized as intuitive and visual. This confirms that the e-book's design resonates particularly well with these learning preferences. Moreover, the User Experience Questionnaire (UEQ) results for the presented e-book, when compared to benchmark data from other products assessed using the same standardized UEQ, indicate a positive multimedia potential. Specifically, the e-book demonstrates favorable scores across dimensions such as Attractiveness, Efficiency, Stimulation, and Novelty as well, which well express the potential of proposed multimedia e-book in transferring complex/mystical concept.


Keywords— *Concept Transfer, Felder-Silverman Learning Style Model, Multimedia, E-Book, User Experience Questionnaire (UEQ).*

1. Introduction

Designing and providing efficient methods to make education much more enjoyable, easier and desirable, has been being experimented for many years [1]. Evolution of technologies, tools and medias for content organization such as multimedia [2], augmented reality [3], virtual reality [4], metaverse [5], AI-chatbots and large language models [6] have a significant role in this respect.

Among them, multimedia, which hires almost all aspects of learning contents including, text, sound and music, pictures, videos and animations, etc., promote a better understanding of complex concepts and enrich the learning experience as well as enthusiasm in learners by allowing information to be visualized and thus employed in various technologies and tools for learning purposes [7,8].

Multimedia content offers a powerful avenue for conveying complex or mystical concepts to learners

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due to its inherent audio-visual capabilities. By leveraging the combined impact of imagery, sound, and potentially interactive elements, multimedia can transcend the limitations of purely textual explanations. Complex concepts become more tangible and engaging, fostering deeper understanding and improved retention. Multimedia and its derivatives, allows educators to create immersive experiences that resonate with learners on multiple sensory levels, ultimately facilitating a more profound grasp of nuanced or challenging subjects and concepts as well [9].

Hence, transferring complex and mystical concepts through multimedia content, seems to be influential in understanding the embedded messages within the concepts especially for learning purposes.

Obviously, based upon the complexity of a concept and the subject overriding this concept, results of understanding and interpretation may become more complicated. Taking this point into account, scenario making and organizing an appropriate multimedia content including informative animation based upon that scenario seems to be so impactful. The other important role makers' factors in transferring and understanding the complex/ mystical concepts are analyzing the user experience (UEQ) and user modeling as well. In this case, assessing the user experience demands a thorough understanding of the complex concepts involved and the hidden message behind them that need to be studied [10]. In addition, providing personalized multimedia content based on learner's user model is another significant factor which facilitate and enhance understanding of complex/ mystical concepts [11].

In this article, main goal of the proposed framework is to figure out how much a multimedia content, which is here a multimedia e-book, can be effective in transferring the meaning of considered mystical concept of "SPIRIT" to the learners from the angle of user experience and user modeling analysis method.

The organization of this article is as follows: in "Related work" section, the literature review on existing researches are provided. It is followed by "Proposed Framework of Creating Multimedia E-Book to Transfer Concept" section which present the modular components of organizing a multimedia e-book and its interaction with learners. In next section, experimental results based on user experience and its correlation with users' model are evaluated and analyzed. The article ends with "Concluding Remarks and Future Prospects" section.

2. Related Work

Learning as a process of knowledge acquisition and building skills, abilities, capacities, attitudes, behaviors etc. is subject to change and development over time [12].

The evolution in technologies and tools of organizing educational contents have a significant role in learning process especially in transferring complex or mystical concepts. To figure out the meaning of a complex concept, it is essential to choose appropriate way of transmitting it through text, sound, music, video, animation, game, augmented reality, concept mapping and multimedia as well [13]. Actually, learning from text signifies a reader's deliberate engagement with written material, driven by the desire to comprehend the embedded message. This necessitates decoding the author's intended meaning, extracting relevant information, and critically analyzing the content presented [14].

Educational media has undergone a significant evolution, with sound, video, and animation emerging as key drivers of enhanced learning experiences. While traditional pedagogical approaches often relied on text-based instruction, the integration of these technologies offers a potent combination capable of fostering concentration, stimulating creativity, and ultimately making learning more engaging. "Sound" for instance, possesses the ability to focus a learner's attention, fostering creativity by invoking specific emotions and triggering imaginative thought processes. While, "video", by synergistically combining images, motion, sound, and text, presents a multifaceted learning tool allowing the presentation of complex information in an understandable format. Animation, extending the capabilities of video, offers the advantage of visualizing abstract or complex concepts and simulating phenomena not easily observed in reality [9].

The combination of all the above mentioned concept transfer medias are integrated in multimedia content which has the potential of verbal and pictorial concept transfer at the same time and can be employed in game, augmented reality, virtual reality and metaverse- based learning as well [15, 16].

From another point of view, some researches focus on assessing the impact of multimedia e-content on learners' learning performance and satisfaction level. Regarding that, user experience evaluation methods and questionnaires have shown to be beneficial [17, 18]. For instance, evaluating the impact of employing multimedia content for learning English language, and the preference of learners based on User Experience Questionnaire (UEQ) and System Usability Scale (SUS) showed

successful learning performance [19]. Another research work was presented for Quran Tajwid learning which was evaluated by user experience experts and practitioners based on UEQ+ as a modular extension of UEQ method [20]. Moreover, what is observed in new emerging technologies especially for educational purposes is their interactive, emerging and immersive potentials which can affect cognitive and psychomotor skills of learners [21]. Referring to the above mentioned points, and based upon the degree of concept complexity, it would be necessary to employ an appropriate media for concept transmission.

Taking the above points into account, multimedia content due to its multi-modal nature is encouraging evidence that learner's understanding of complex concepts can be enhanced [22], especially when the multimedia content be adapted to the learning style model of learners. There exist various methods for user modeling purposes in different contexts such as: Felder-Silverman [23, 24], Kolb [25], Myers-Briggs (MBTI) [26], etc. [27].

Investigating some literatures on Felder-Silverman learning style from 2019 to 2023, reveals that majority of learners (mostly among college or university students) were sensing, active, visual, and sequential learners [24]. This learning style model is particularly popular in engineering and technical education and highlights how students perceive and process information [28, 29].

While, Kolb learning style is an appropriate method to assess unique individual approach to learning and investigate experiential learning theories. Thus, it seems to be suitable for problem-based Learning especially in laboratory-based courses [25].

Another model is Myers-Briggs (MBTI) which is a representative indicator of personality diagnosis in psychology, which indeed can also have significant role in learning [26].

In general, understanding and catering to individual learning styles has become an important focus in education, aimed at enhancing student engagement, retention, and achievement by aligning instructional methods with learners' preferences.

Taking the above points into account, in this paper, the impact of multimedia on concept transfer is considered to be evaluated from user experiences point of view and its correlation with learners' models based on Felder-Silverman due to its appropriateness for modeling engineering/technical students [24, 28] and covering wide and comprehensive dimensions comparing to other kinds of models [29]. For these same reasons, in this research, Felder-Silverman learning style is chosen

to model the participants, who were students of Computer Engineering and IT and its standard questionnaire was employed for this purpose [30, 31].

3. Proposed Framework of Creating Multimedia E-Book to Transfer Concept

Many contents and concepts may in general be ambiguous in their nature to the extent that a unique meaning of them can be hardly conceivable [32]. Such an ambiguity is mostly due to the complex and mystical nature of the semantic entities embedded in a content and their usages as well. To effectively demystify complex concepts, establishing a framework for multimedia content generation is essential. This framework must incorporate varied components, including the semantic roles of words, requisite background knowledge, and anticipated perspectives, ensuring effective conceptual transfer within specific learning scenarios.

In our proposed framework, we make use of animation, text and sound to organize a multimedia e-book in order to transfer a mystical concept in Persian literature called "SPIRIT" from the viewpoints of great Iranian poets. In this regard, the generated multimedia e-book was evaluated by learners via user experience standard questionnaires (UEQ) based on learners' learning style model [17, 18]. This standard questionnaire allows a quick assessment of the user experience for any interactive product. In our case an interactive multimedia e-book is employed for this purpose. The scales of the questionnaire are designed to cover a comprehensive impression of user experience and supports the user response to immediately express feelings, impressions, and attitudes that arise when they use our e-book.

3.1. Modular Components of Proposed Framework

In this section, major components of proposed framework to organize the multimedia e-book is presented and shown in Figure 1 [32]. As mentioned before, the main purpose of this framework is to illustrate how to design and generate an appropriate multimedia e-book to transfer the meaning of a mystical concept of "SPIRIT" from the viewpoints of great Iranian poets and how to access the impact of this e-book through learners' interaction experience considering their learning styles.

As it is seen, the major modular components for making each part of final multimedia e-book within the proposed framework are: "Text", "Sound", "Animation", "E-book Generation", "User Modeling" and "User Experience Evaluation". Various software designing applications such as Adobe Photoshop (Ps), Adobe Illustrator (Ai), Adobe After Effects (Ae), Adobe Premiere Pro (Pr),

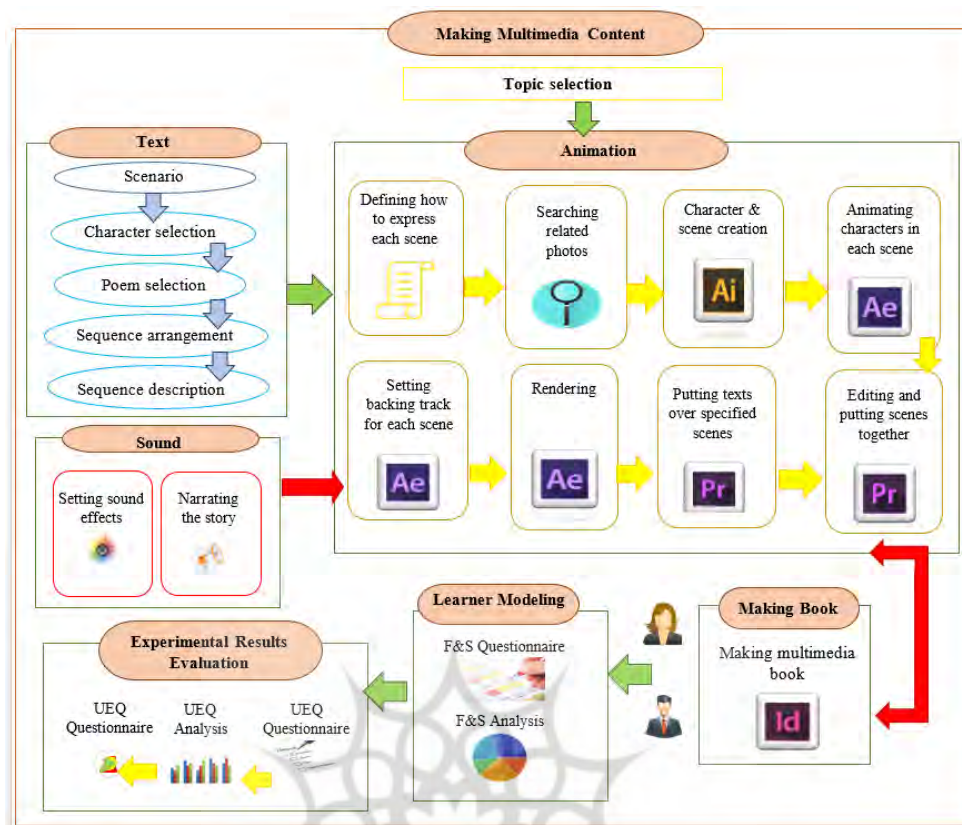


Figure 1. The Proposed Framework of Creating Multimedia E-Book To Transfer Concept [30]

and Adobe InDesign (Id) are applied for making each component.

In the first step, an appropriate topic (in this case a mystical concept) should be chosen based on which, the rest of the work have to be organized. As stated before, the concept of “SPIRIT” was considered for this purpose.

In the second step, it is essential to write a scenario in a way that describe the chosen mystical concept very well. Here, a scenario was written to describe the concept of “SPIRIT” from the viewpoint of great Iranian poets Ferdowsi, Mevlana and Sa’adi. Designing and animating the characters of these great poets to express the contents and verses within written scenario was the next step. Then the scenes of whole scenario were planned and designed and respectively sequence arrangement and description were performed. Following that, sounds and narrations were added to the designed animation. Figure 2 illustrates the environment of designing the animation of “Symphony of Spirit”.

The articulation of the written narrative, accompanied by a suitable auditory backdrop, significantly enhances the comprehensibility and overall impact of the story. Meanwhile, as this animation is related to the Persian literature and poem verses, it is imperative to engage narrators

who can articulate each verse with appropriate emotional depth in order to effectively convey the narrative and enhance the conceptual transmission.

After adding all the essential elements to each scene, it was needed to put all these scenes together to construct the entire animation. Then, it was turn of creating the multimedia e-book entitled “Symphony of the Spirit”, using text, sound & animation to tell the whole story for transferring the mystical concept of “SPIRIT”, which is shown in Figure3.

The last two remaining modular components in the proposed framework were learner modeling and experimental results evaluation. As discussed before, there exists various kinds of user modeling methods which can be employed based on the learning objective. As in this research work, assessing the impact of multimedia e-book on transferring the meaning of SPIRIT concept was under consideration and the test population were B.Sc. students in computer science field of study, thus Felder- Silverman learning style modeling method seemed to be the best choice among the existing user modeling methods. Subsequently, it was essential to assess the learners’ user experience in interacting with e-book. In this respect the test population were asked to read and interact with the e-book, then fill in UEQ questionnaires and finally

the results and their correlation with various scales of learners' model based on Felder-Silverman were analyzed.

4. Analysis of Experimental Results

4.1. Learner Modeling

One of the significant modules in the proposed framework is learner modeling module which investigates the learners' model based on Felder-Silverman learning style method. This method includes major aspects of processing, perception, receiving and understanding, each covering dimensions of active/ reflective, sensing/ intuitive, visual/verbal, and sequential/ global, respectively [33]. Among the user modeling methods, Felder Silverman learning style method due to its specific features, aspects, dimensions and targeted test population seemed to be the best choice for learner modeling in our case.

The test population of learners who involved in this research work, were 32 B.Sc. computer science female students at "English Technical Language" course in Alzahra University. They were all in the same range of ages with no familiarity with the meaning of "SPIRIT" concept from mystical point of view. Firstly, they were asked to fill in the Felder-Silverman learning style method questionnaire.

Then, they were asked to interact with English version of e-book of "Symphony of SPIRIT" for 60 minutes and then fill in the original English version of user experience questionnaire for about 30 minutes. The experiments were conducted in a face-to-face classroom setting, within a session lasting two hours. Figure 4 illustrates the status of test population based on the major dimensions of Felder-Silverman learning style model [33].

As it is seen in Figure 4, with respect to Active/ Reflective dimension, there exists a comparable distribution between Active and Reflective learners, with a slight predominance of Active learners. This observation suggests that our learners exhibit a significant enthusiasm for acquiring knowledge through collaborative endeavors. Another dimension refers to Sensitive/ Intuitive points of view which shows that sensible information is notably larger, due to the female gender of test population. The most important dimension correlated with the inherent of investigating the impact of multimedia e-book is the dimension of Visual/Verbal. The population of Visual learners is considerably greater than that of Verbal learners. Consequently, it is anticipated that the learners will find themselves at ease when engaging with concepts presented in our multimedia e-book. Finally, in the dimension of Sequential/ Global, once again, there is a marginally larger representation of Global learners compared to Sequential learners. Which means that they prefer to



Figure 2. An Animation Design Environment



Figure 3. The Multimedia E-book of "Symphony of the Spirit"

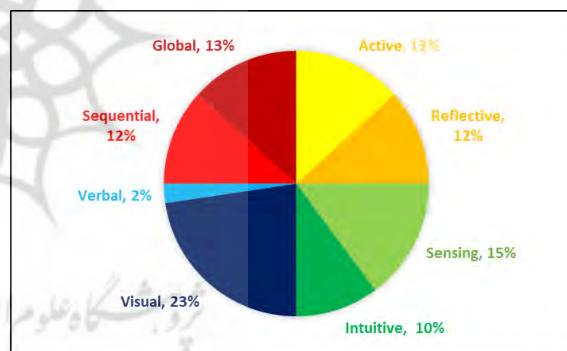


Figure 4. Test Population Status based on Felder-Silverman Dimensions

receive the overall view of content instead of step by step linear form.

In summary, the predominant number of learners align with the Visual modality, while the smallest representation corresponds to the Verbal modality, a trend that may serve as a salient predictor of their subsequent interaction with the presented e-book.

4.2. Assessment of Learner Experience Engaging with e-Book

To assess the learner experience engaging with presented e-book, a well-known user experience assessment method and its correspondent standard User Experience Questionnaire (UEQ) was employed [17, 18]. It is worth noting that the reliability and validity of the UEQ scales which

were investigated in several studies on high number of participants and various languages showed that reliability of the scales was sufficiently high with good construct validity [34], [35].

Based upon this standard UEQ, the following six scales were evaluated:

- **Attractiveness:** General impression towards the presented multimedia e-book and the concept which is considered to be transferred. Do learners like or dislike it?
- **Efficiency:** Is it possible to use the multimedia e-book fast and efficient? Does the user interface of multimedia e-book looks organized and efficient?
- **Perspicuity:** Is it easy to understand how to use the presented multimedia e-book and get familiar with the meaning of considered concept which is presented as a story in this e-book?
- **Dependability:** Does the learner feel in control of the interaction? Is the interaction with the presented multimedia e-book secure and predictable?
- **Stimulation:** Is it interesting and exciting to use the multimedia e-book? Does the user feel motivated to further use this e-book?
- **Novelty:** Is the design of the multimedia e-book innovative and creative? Does it grab learners' attention?

These six scales can be grouped into three categories of "Attractiveness", "Pragmatic Quality" and "Hedonic Quality", which can be considered as three generic aspects. Attractiveness covers some features that reflects the attractiveness of the e-book. While, Pragmatic Quality due to its goal-oriented nature encompasses Perspicuity, Efficiency and Dependability. In addition, Hedonic Quality because of its non-goal-oriented nature, comprises Stimulation and Novelty [17, 18]. Each of the mentioned sub-categories consists of various correspondent features. It is important to note that the analysis of the User Experience Questionnaire (UEQ) does not yield a cumulative score for the user experience; therefore, its findings are examined independently for each item, scale, or quality aspect. That is due to the structural design of the UEQ. To have a better insight over the impact of suggested e-book on learners' understanding of transferred mystical concept, the analysis on UEQ's scales mean value is shown in Figure 5. As it is seen, learners found the e-book attractive and novel which reflects a very good feedback that confirm the attractiveness of e-book's design and animation as well. While from the dependability point of view, as the e-book was not interactive and under learners'

control, thus they have given low score to this item. Moreover, learners' idea about efficiency and perspicuity were almost the same and positive. It is remarkable that, the e-book was interesting and stimulated. Additionally, as stated before, there is another way of categorizing the UEQ items into three groups of "Attractiveness", "Pragmatic" and "Hedonic Qualities". Indeed, Figure 6 illustrates the mean values per each of these three groups, which confirms the overall positive qualitative evaluation of proposed e-book based on users' experience point of view.

As it is illustrated in Figure 6, once again the presented multimedia e-book has high scores in Attractiveness and Hedonic Qualities, which reflects the success of the multimedia e-book for attracting learners' attention, being innovative and valuable in transferring the mystical concept of "SPIRIT" into the learners. From Pragmatic Quality point of view,

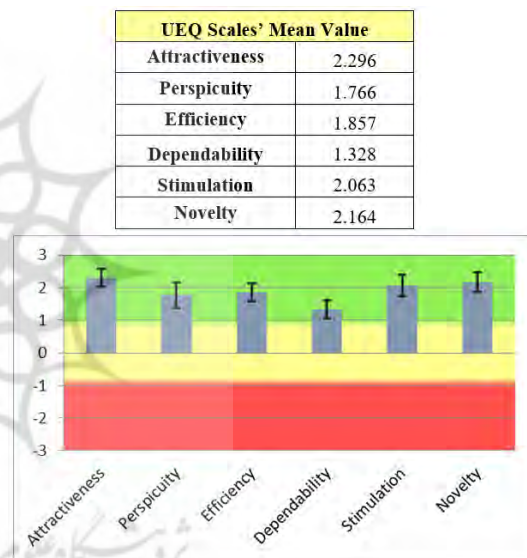


Figure. 5. Mean value per six scales of UEQ

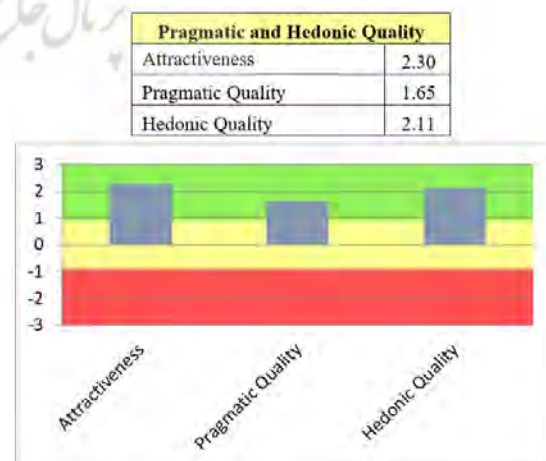


Figure. 6. Mean value per three Grouped scales of UEQ

the multimedia e-book was well organized and efficient in making the concept of “SPIRIT” understandable and easy to learn but as the e-book was not interactive in a way that receive and answer the questions of learners in real time, it has received lower score from dependability scale comparing to other scales of UEQ.

It has to be mentioned that, the benchmark dataset of standard UEQ contains data of 4818 persons from 163 studies concerning different products [36]. Comparing the achieved results in this research work with the data in the benchmark allows conclusions about the high quality of the evaluated multimedia e-book compared to other products from the scales of UEQ points of view which is shown in Figure 7.

As it is seen in the figure, based upon the inherent nature of multimedia e-book and the feedback of learners from questionnaire, highest scores in scales of attractiveness, novelty and stimulation respectively comparing to the benchmark under study is seen.

4.3. Relation between UEQ and Felder-Silverman User model

In this section, the relation between some of the Felder-Silverman dimensions with user experience (UEQ) aspects are discussed. One of the significant scales of UEQ is “Attractiveness”. As illustrated in Figure 8, from the viewpoint of relation between Attractiveness (as a scale of UEQ) and Felder-Silverman learning style dimensions, ratings revealed distinct preferences based on learning style. It is noteworthy that, the intuitive learners, who appreciate creative and meaningful content/concepts, evaluated the product favorably, suggesting the animation's narrative and visuals resonated with their learning style. While, verbal learners perceived the multimedia animation product as weak, aligning with their preference for text-based information. Visual learners rated the attractiveness as intermediate, which is expected given the product's visual nature. Another achieved result from investigating the relation between UEQ's Novelty scale and Felder-Silverman dimensions which is depicted in Figure 9, shows that the weak evaluation again belongs to the Verbal learners. As they are not generally interested in learning via visual effects. Sensing learners showed an intermediate evaluation, suggesting that the multimedia book's animation positively influenced their sensory learning experience. Intuitive learners gave a good evaluation, indicating that the animation effectively conveyed the intended mystical concept in an innovative manner.

An overview of the results from correlating all UEQ's scales with all Felder-Silverman dimensions which is shown in Figure 10, reveals that the

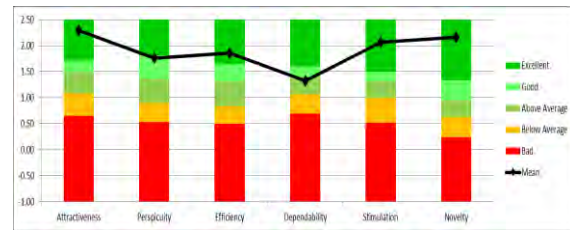


Figure 7. Mean value per three Grouped scales of UEQ

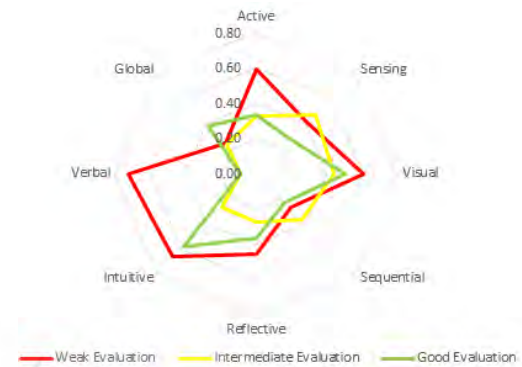


Figure 8. Relation between UEQ's Attractiveness scale and Felder-Silverman Learning Style Dimension

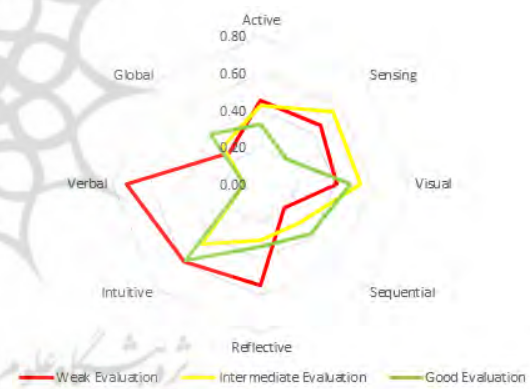


Figure 9. Relation between UEQ's Novelty scale and Felder-Silverman Learning Style Dimension



Figure 10. Relation between UEQ's total evaluation and Felder-Silverman Learning Style Dimensions

intuitive learning style exhibits the highest levels of attractiveness and acceptance for users in terms of Attractiveness, Efficiency, and Novelty. While from the Verbal learners' point of view the above mentioned scales were on the lowest level of acceptance due to the nature of verbal learners' style of learning which is based on written descriptions.

Furthermore, the achieved result shows that the multimedia e-book was successful in transferring the mystical concept of "SPIRIT" to the learners who were not familiar with the meaning of this concept and they found it innovative and attractive. So, our multimedia e-book has almost reached its goal for being as efficient as possible.

5. Concluding Remarks and Future Prospects

In this paper, a framework was proposed to reveal the impact of creating multimedia content on transferring complex/ mystical concept to the learners in an appropriate way.

Within this framework, various modular components are presented, each plays a significant role in creating an innovative multimedia e-book with the aim of attracting the learners' satisfaction via UEQ scales. Also, enhance learners' understanding of complex/ mystical concepts based on their Felder-Silverman learning style.

As it was discussed in the paper, a well-established user experience assessment method with its correspondent User Experience Questionnaire (UEQ) was employed for assessing learners' satisfaction who were engaging with multimedia e-book. Findings from the experiment revealed that the inclusion of multimedia effects within the e-book with the aim of transferring complex/ mystical concept, led to predominantly positive evaluations from learners.

It is noteworthy that assessment of the outcomes pertaining to the correlation between the dimensions of the UEQ scales and the Felder-Silverman learning style dimensions, indicate that the presented e-book was perceived as more appealing and innovative by learners whose learning style, as defined by Felder-Silverman, were characterized as intuitive and visual.

Taking the above points into consideration reveals that correlation between UEQ's scales and Felder-Silverman dimensions, seems to have a significant role in organizing adaptive multimedia contents for concept transfer personalization purposes especially for complex/ mystical concepts. This may lead into further and future research works in this domain. Moreover, using generative AI capabilities to produce more engaging multimedia content that is consistent with the user's learning style model could also provide a new direction for future research in this area.

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Authors' contributions

MTM: All sections.

Conflict of interest

The author declare that no conflicts of interest exist.

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