Design an Adaptive Mobile Scaffolding System According to Students' Cognitive Style Simplicity vs Complexity for Enhancing Digital Well-Being

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Abstract—The widespread use of mobile applications in scaffolding students' learning emphasize the importance of developing these applications in ways to be compatible with students' characteristics and needs in order to be more effective. Several studies indicated that the students experience via mobile applications was not stimulating wellbeing or learning due to its incompatibility with students' characteristics. Therefore, the current study aimed to design an adaptive mobile scaffolding System (AMSS) to provide educational scaffolding to students that is compatible with their cognitive style simplicity vs complexity (CSSC), and to measure the effectiveness of the model in enhancing digital well-being (DWB) of the students in the Faculty of education, Jeddah University. Semi-experimental design of two groups was used: the first experimental group received unified mobile scaffold regardless of their cognitive styles. The second experimental group received mobile scaffold that was organized and directed to the students based on their characteristics related to their CSSC. Both experimental groups received mobile scaffold as a complementary component to the lectures delivered for the Technological Innovations in Education course in the General Diploma in Education. The study sample consisted of (71) students who met the requirements and they were randomized to two experimental groups. To examine the effectiveness of the AMSS, a DWB scale was developed. Kelly's scale of CSSC was used to identify students who fell within the scope of this style. The results showed the effectiveness of the proposed model of AMSS in developing the students' DWB compared to the unified scaffold model.

Keywords—Adaptive mobile scaffold system (AMSS), Cognitive style simplicity vs complexity (CSSC), digital will-being (DWB)

1 Introduction

The current research aims to develop a MASS so that the contents and the learning procedures are adapted to match the characteristics of the students with CSSC to enhance their DWB. The knowledge society of today's students requires a flexible learning environment that facilitates students communication via a variety of learning strategies that enable them to gain ongoing support, as well as sharing and using resources in a friendly and flexible ways [1]. However, most of the traditional learning strategies do not scaffold this friendly and flexible learning feature. Thus, it seems to be necessary for educational institutes to move toward implementing mobile learning systems that scaffold students' learning and facilitate flexible learning strategies [2, 3].The trend towards providing scaffold to students via mobile systems stems from the fact that the traditional educational environments may impede students from understanding the learning content. Therefore, depending on mobile scaffold to provide learning scaffold may have a positive impact on students' knowledge and skills [4].

While mobile scaffold studies are important, more studies should be directed toward adjusting the use of mobile devices technologies to suit students' characteristics and cognitive abilities. Mobile devices must meet students' needs and daily activities related to learning processes [5]. Given this, a stream of studies has attempted to establish the notion of adaptive mobile scaffold. For example, Razek and Bardesi [6] aimed to design a adaptive mobile scaffold system based on artificial intelligence technologies that were used to scaffold students with learning objects based on their needs in order to train them on some educational skills. Nguyen and Pham [7] study aimed to develop a personalized context-aware mobile learning system for scaffolding students learning of English as a foreign language in order to prepare them for TOEFL test. Chen [8] study designed a framework based on cognitive and motivational aspects of learning to develop an adaptive e-learning scaffold system. In addition, Balasubramanian and Anouncia [9] study developed a mobile adaptive scaffold model based on the students' cognitive skills and the improvement of knowledge competency level. Hubalovsky, et al. [10] study also focused on developing an adaptive e-learning system in accordance with the Bloom's Taxonomy for primary school students.

Therefore, it seems that there is a need for more studies on adaptive mobile scaffold, especially ones regarding the cognitive style of students as to ensure the success of the students through mobile scaffold systems, students, characteristics and capabilities must be identified. Cognitive style can be used to explain the differentiation between individuals in cognitive processes [11]. The more individuals are distinct in their cognitive structure, the more they can respond distinctly in different situations, while those who are less distinct in their cognitive structure are less responsive and more interconnected [12]. The difference in cognitive style does not only refer to the differences in individuals' ability to learn or remember but it indicates the individual's preference for cognition and information processing [11]. CSSC is an important cognitive style that can impact the effectiveness of adaptive mobile scaffold systems in developing diverse learning outcomes [13]. This cognitive style is related to the differences between individuals in their tendency to interpret the world in a complex and multidimensional way [14] Individuals who are characterized as having a complex cognitive style can deal with the variables of multiple social situations and are able to perceive the surrounding analytically and are able of dealing with abstract ideas [15]. On the other hand, those who are characterized as having a simple cognitive style are less capable in the above-mentioned fields and need to deal with perceptual and tangible things [16].

Accordingly, the research problem of the current study focuses on bridging the research gap in terms of the absence of adaptive studies targeting individuals with CSSC, and consequently determines the most important adaptive characteristics suitable for this cognitive style. Then design an adaptive model for content according to the students' cognitive styles, and determine its effect on students' DWB.

The current study therefore attempts to answer the following main question:

(RQ1) What are the main characteristics of the CSSC that should be considered when designing AMSS?

(RQ2) What is the proposed model for AMSS according to the CSSC?

(RQ3) What is the effectiveness of the AMSS according to the CSSC in the development of DWB among students?

The current study also tries to validate the following hypothesis:

(H1) There was no statistically significant difference at (0.05) between the mean scores of the 1st experimental group using (uniformly oriented mobile scaffold for all students) and of the 2nd experimental group using (AMSS) according to students CSSC in the post-implementation of the DWB scale.

The current study comprises a set of sections covers all aspects of the topic, as it includes: literature review, theoretical framework, methodology, finding, discussion, limitation, and conclusion.

2 Literature Review

This section is concerned with reviewing the literature focusing on employing mobile applications in learning process and adaptive scaffold. The review also covers the most important characteristics of individuals with CSSC, and DWB.

2.1 Adaptive Mobile Scaffold System (AMSS)

Several studies have geared towards examining the use of mobile applications in scaffolding the teaching and learning processes. Recently, studies have focused on determining the factors that must be considered in designing mobile applications in order to be adaptive to students' characteristics [17].The studies also focused on using educational applications as effective educational tools instead of just using them as electronic documents [18, 19]. Moreover, the focus of these studies includes the necessity of linking the learners' needs with the features of the applications [20]. It seems important to have powerful tools to examine the effectiveness of educational applications so that they are suitable for the students [21].The studies concluded that there is a need to restructure educational applications to be adapted to the characteristics and cognitive styles of the students [22, 23]. Despite the plethora of the studies that examined the effectiveness of adaptation according to the students' cognitive style on learning, these studies did not address adaptation according to CSSC and they did not explore their impact on the students' DWB [24-27]

According to van de Pol, et al. [28] Some researchers view scaffolding as a metaphor describing a special method of teaching that takes place in an educational setting which involves sharing tasks between the teacher and the learner. Educational scaffolding is essential to guide students to construct knowledge in student-cantered learning contexts

[29]. Moreover, educational scaffolding identifies the situation in which students receive some scaffold while trying to construct their own knowledge [30]. This means that the scaffold is based on the knowledge provided to students to assist them to fill the gaps between what they already knew and what they seek to know or what they don't know [31]. It also concentrates on the temporary support needed for learning during the knowledge construction process [32, 33].

AMSS assumes that each student has own characteristics, which must be observed within the learning environment as what seems appropriate for one student may not be appropriate for another [34]. Therefore, it exploits the student's characteristics in order to enhance their learning outcomes [35, 36]. The importance of AMSS stems from its ability to provide each individual with unique learning experiences based on his/her personality, interests and performance in order to improve their learning and enhance their satisfaction with the learning process [37, 38]. Thus, we can say that AMSS is modified according to the characteristics and needs of the students and depends on mobile devices to provide scaffold and guidance to students which eventually lead to compatibility between students and their educational environments. Such features of AMSS makes it a motivating tool to create personal learning environments, as all what is presented to students is based on to their characteristics, needs, knowledge and experiences [3, 34].

2.2 Cognitive Style Simplicity vs Complexity (CSSC)

CSSC is the student tendency to employ numerous cognitive dimensions in realizing stimuli and making clear distinctions between them [15]. A highly complex cognitive student has a more numerous and differentiated cognitive system to perceive his world, and can make more distinctions between his/her perceptions, while the less complicated student has less cognitive system and differentiate between his/her perceptions in less level [14]. In addition, the CSSC is defined as the tendency of individuals to explain what goes on around them, as the one who is characterized by simplification of knowledge deal with sensation in a better way than abstractions and have less ability to understand everything analytically [15]. The one who is characterized by complexity becomes more capable of dealing with multiple dimensions of situations analytically and can deal with what he/she realizes in all ways. It is a system of constructs that is highly differentiated. Differentiation refers to a student capability to use a large number of independent cognitive dimensions when considering many elements [39].

On the other hand, a cognitively simple student has a system of constructs with a low capacity for multidimensional construing. Although complex construing generally might be considered to be a better system, in a simple situation, simple construing would be more adaptive and prove to be efficient [39]. A construct system which provides poor differentiation among persons is considered to be cognitively simple in structure [15]. In contrast to cognitive simplicity, individuals with cognitive complexity usually involve in social relations with others. They are also inclined to make many friendships with different types of people and integrate into large gatherings of other individuals. In addition, it has been confirmed that environmental attitudes have a significant impact on the level of complexity and can therefore be greatly affected by social communication [14]. They also have high ability to interpret and comprehend other people messages, and they are able to interact in effective ways [40]. Individuals with cognitive complexity usually have greater skill and social competence than cognitively simple students, which enable them to easily adapt to unexpected events. Moreover, individuals with cognitive simplification lacks the ability to distinguish between stimuli, they make decisions without considering the available information, and they feel threatened by uncertainty [39].

2.3 Digital Well-Being (DWB)

The purpose of this study was to investigate the effect of the AMSS on students' DWB. The pursuit of DWB is the goal of human existence, and it is one of the main variables of the human personality. Thus, the availability of a system that makes individuals feel happy will likely lead to the improvement of other variables such as achievement and motivation. The feeling and expression of well-being vary from one individual to another, and from one age level to another, and the sources of well-being vary among individuals [41]. Furthermore, DWB is a set of behavioral indicators signifying high level of individual satisfaction with the digital learning environment that can be identified in six main factors including autonomy, environmental mastery, personal growth, positive relations with other, purpose life, and self- acceptance [42-44].

Lyubomirsky [45] argues that exploring the triggers that may lead to an individual's sense of well-being or not is of great importance and it is necessary to direct theoretical and applied studies towards examining these triggers. In a similar vein, Alhalafawy and Zaki [46] explained that focusing on the factors that lead to the individuals' sense of well-being is essential, especially when developing digital applications so to achieve the best design for students' well-being. They added that such a process have many advantages that are likely to be reflected in the students' learning outcomes.

According to the studies that have focused on the concept of happiness and psychological happiness, DWB can be identified as one of the behavioural indicators signifying high levels of individual's satisfaction with their lives in digital environments, and it can be identified in six main factors as follows [42-44]:

- Digital autonomy: Refers to the independence of the learners and their ability to make decisions, resist social pressures, control and regulate personal behaviour while interacting with others through digital environments.
- Environmental mastery: The individual's ability to be able to regulate the conditions and control various activities. This includes benefitting efficiently from the surrounding conditions.
- Personal growth: Learners' ability to develop his/her capabilities, effectiveness, and competency in various aspects, and maintain optimistic feelings during digital learning practices.
- Positive relations with others: Learners' ability to make friendships and social relationships with others based on friendliness, empathy, mutual trust, understanding, influence, friendship, give-and-take.
- Purposeful life in digital environments: Learners' ability to define their goals in life, and to have a clear goal and vision guiding their actions, and behaviours, with perseverance and determination to achieve his/her goals.

- Self- acceptance: It is the ability to achieve self- acceptance, positive attitudes towards the self, and past life, and accepts various aspects of the self, including its positive and negative aspects in the digital learning environments.

3 Theoretical Framework

Constructivism Theory is one of the basic theories of designing an adaptive mobile scaffolding environment. Learning according to the Constructivism theory is the process that supports knowledge construction. Learning is a meaningful process that varies from one individual to another depending on the nature of the interaction between the individuals and the learning environment. The higher the interaction between the student and the mobile scaffolding environment, the better and more dynamic the learning process [47, 48]. The characteristics of AMSS are consistent with the constructive theory as students are free to construct their own concepts, whether individually or through interaction and collaboration with others [49].

Cognitive Load Theory concerns with the cases in which content that is not suitable for the cognitive method of student make him/her exert extra effort to convert this content to a way that is compatible with his/her manner and this leads to drain his effort in the conversion process rather than allocating that effort to understand and react with content [50-53]. Undoubtedly, this means that not providing the content of adaptive mobile learning in a way that is appropriate to the level of CSSC of the student may lead to increase in the student cognitive load as a result of conversion he/she does to comprehend the scaffolding content. Such situation means that mobile scaffold systems must be adaptive to the student's characteristics.

Vygotsky's social development theory argues that learning occurs through sharing and social interaction with others, and that the interaction of students with more knowledgeable or influential people affects their way of thinking and interpretation of different situations. Vygotsky reasons that a student learns more when he/she is given hints, guiding information and help to think more than if left alone to explore new concepts and knowledge [54, 55]. Social development theory is considered a base to understand how educational scaffolding works and the reason they are used for. Social development theory emphasizes that a student can acquire knowledge if he/he is assisted to construct a structure in which he/she puts new information.

4 Methodology

AMSS is designed according to the instructional design phases. Kelly's scale of CSSC was used to identify students who fell within the scope of this style. The DWB was built within the general context associated with learning from AMSS as well as previous studies that have focused on the study of wellbeing. A quasi-experimental approach was used to determine the effectiveness of AMSS in improving students' DWB. This section will explain the methods used in more detail.

4.1 Design

Semi-experimental approach with two experimental groups was used. Both experimental groups were taught in regular classes, however, while they were grouped according to their CSSC, the 1st experimental group received generic mobile scaffold that was uniformly routed to all members of the sample. On the other hand, the second experimental group received adaptive scaffold that was organized and directed to students according to their CSSC. Table 1 illustrates the experimental design of the study.

Table 1. The Experimental Design of the Study

Experimental Group	Independent Variables	Dependent Variables
First Group	Unified General Scaffold for all the members of the sample	DWB
Second Group	AMSS according to CSSC	

4.2 Sample

The study sample consisted of (71) students who were studying Technological Innovations in Education course. The selection of the sample was based on two criteria: the first one was on students owning mobile phones with suitable properties. The second criterion was associated with classification and differentiation between students according to their CSSC. Based on these criteria, the sample members were randomly selected and grouped on the two study groups, the 1st experimental group consisted of (35) students, (16) students were within the scope of cognitive complexity, (19) students categorized within the scope of cognitive simplification. The 2nd experimental group included (36) students, (19) of whom were in the scope of cognitive complexity, and (17) in the scope of cognitive simplification.

4.3 Measures

The measure of CSSC: To categorize the study sample according to their CSSC, Social Role Inventory Scale which was created by [13] and adapted to the Arabic language by [56] was used. The validity of the scale was calculated by calculating the validity of the assumed composition by the coefficients of correlation between the overall degree of students and the ten roles of the scale on which the scale depends on identifying students who fall into the scope of simplicity or complexity. The coefficients' correlation ranged between (0.69 to 0.77). These coefficients are accepted and statistically significant at the level of (0.5) which confirms the consistency of the scale with the total sum of its scores. Stability has been assessed through re-measurement method in similar circumstances to the first application then calculates the coefficient correlation, the correlation coefficient was found to be (0.73).

DWB scale: Designing the DWB scale required a set of stages and steps as follows:

- The scale aimed to identify DWB indicators among the students of Education faculty at Jeddah University.
- The scale axes were determined based on a review for a number of psychological wellbeing scales [42-44], and on many interviews that were conducted with some experts. Hence, the scale axes have comprised of (6) axes, which are: Digital autonomy, Environmental mastery, Personal Growth, Positive relations with others, Purposeful life in digital environments and Self- acceptance.
- Indicators of DWB for each axis were developed. Each of those axes encompassed (6) statements with (3) positive and (3) negative statements. Thus, the total number of statements on the scale was (36) statements
- Scoring of the scale was established on a Likert's scale style (completely agree, agree, somewhat agree, disagree, completely disagree) from (5) to (1) for positive statements, and (1) to (5) for the negative ones.
- The initial form of the scale was presented to a group of arbitrators, and their feedbacks resulted in modifying some of the scale's phrases to be more related to wellbeing through adaptive applications.
- The scale reliability coefficient was calculated by Cronbach α method on the pilot sample. The reliability of each statement was calculated separately. The values of the reliability coefficients ranged between (0.773-0.811).
- The average response time for the scale was (20) minutes.
- The final draft of the scale included (36) statements distributed over six axes, and the maximum, minimum and neutral scores of the scale were 180, 36 and 108, respectively.

4.4 Procedures

Analysis phase

- **Needs assessment**: The nature of some traditional education settings imposes providing additional assistance for students which makes the orientation towards the educational scaffolding development one of the most important trends, especially with the availability of mobile devices in students' hands. However, the development of any scaffolding system should take into consideration the characteristics and cognitive style of these students, in order to achieve the optimal benefit from this system. So, the current study is aimed to develop a model of adaptive mobile scaffold according to the cognitive style of the students.
- **Analysis of the educational tasks**: The current study is based on fundamental task which is enhancing students DWB.
- **Analysis of students' characteristics**: Students' characteristics were analyzed according to three factors as follows:

– Using mobile technology: Students usage for mobile devices and its applications were analyzed. The results showed that 100% of the study sample have Android mobile phones and that 93% of students use their phones to access the internet.

– Categorizing students according to their CSSC which has been performed to determine the cognitive style of the study sample. Such process showed that there were differences in the students' learning styles. After determining the highest and lowest test results, it was found that there were (35) students who could be sorted in the cognitive complexity dimension and (36) in the cognitive simplification dimension.

Design phase

- **Planning learning goals**: Learning goals, for the current study are associated with educational technology and learning resources course especially the innovations of educational technology. The goals focused on enhancing students DWB. via adaptive mobile scaffold applications.
- **Defining the main features of the scaffolding system**: The AMSS is designed so that the characteristics of the materials and tools of the scaffold are to be compatible with the cognitive characteristics of the students in both dimensions of CSSC, as shown in table 2 clarifying the characteristics of this scaffold.

Table 2. The characteristics of the AMSS according to CSSC

Scaffold Variable	Complexity Students	Simplicity Students
Scaffold style	Collaborative scaffold	Individual scaffold
Scaffold size	Enlarged/magnified	Miniature
Scaffold media	Multi-audio (visual)	Single (text)
Scaffold sources	Various sources	Limited sources
Organizing scaffolding content	Total organization	Partial organization
Scaffolding strategies	Strategies associated with discovery	Strategies associated with direct supply
Interaction sessions	Synchronous	Asynchronous
Membership pattern	Membership as leader within communities	Membership as an individual within the learning communities

- **AMSS design:** The suggested model of AMSS depends on designing a mobile phone application made available via which the AMSS is managed. The designed application includes the following tools:

– Registration: It is the main tool through which the students register their data that include name, email, and phone number.
– My cognitive style: This tool was designed through a database which has been developed according to the scale of cognitive style used in current study through which the two sides of the CSSC are determined. Before completing the registration process, each student is required to respond to a scale items to identify his cognitive style and save it in the student's database. so, the content is generated, and any operations are managed according to the student's cognitive style.
– Scaffold materials: According to the determined study topics, scaffold materials were organized according to each of the five content fields, mobile learning, multimedia, virtual reality, virtual museums. The content of the scaffold for each

field was designed and presented in the form of multimedia to suit each category of the students' CSSC. As shown in table (2).

- Search: Through the search tool the student can search the available scaffolding materials that have been archived within the databases included in the application.
- Share: Through this tool, students can share learning materials in relation to the content being taught.
- Scaffold me: This tool is designed so that students can submit any request or inquiry regarding their learning needs.
- Seminars: Through this tool students can participate in seminars whether synchronously or asynchronously according to the characteristics of their cognitive style.
- Call us: It includes all the means to contact the teacher.
- Evaluate the application: Through this tool students can express their opinions in the application and its different components.
- Application guide: Provides a clear explanation of how to use the application and its different tools.
- Academic advisors: Clicking on this tool opens an application called "Academic Adviser" which was developed as a personal interface for the teachers to provide a variety of academic counselling processes.
- My courses: Clicking on this tool leads to an application called "My Courses" for the teacher which was developed as an interface of the courses that are taught by teachers and through it scaffolding is provided to students.
- The main page: Clicking on it leads the student to return to the home page.

Figure 1 shows the main interface of the application, including the main tools.

Fig. 1. The main interface for the adaptive mobile scaffold application

- **Content Design and its organizing strategies**: The scaffolding content was designed in the form of digital objects that are presented in conjunction with the contents of the learning that are presented in the normal learning situations, taking into account organizing the content in ways (as a whole/part) to suit the characteristics of the students' cognitive styles.
- **Identification of learning and learning strategies**: Various strategies have been used, including: collaborative learning, inquiry learning, problem solving, e-lecture, tutorial, and brainstorming.

Development phase: The development process included the design of the databases, and the selection of the multimedia related to the subjects of learning. And the production and editing of the digital learning objects which represent the contents of the scaffold presented in diverse patterns to match the two dimension of the students' CSSC. This phase also included the production of feedback messages, alert messages, and symbols that will be used to communicate with the students in the search sample and save them on the mobile phone. It also involved the production of the application's links.

Implementation phase: At this phase pre-implementation of the motivation scale for learning via mobile scaffold applications was launched. Following this, the learning process, the implementation of the tasks and learning strategies was launched via the application. After this, the post-implementation of the motivation scale for learning via the application.

5 Findings

5.1 Findings related to the characteristics of CSSC

The focus of this section is to answer the first study question; characteristics of the cognitive styles were identified. For example, cognitively complex individuals are more accurate in judgment and evaluation of the differences between themselves and others. They are also distinguished by their active search for information, the ability to generalize, abstraction, the ability to synthesize), and the use of information in a large and new classifications and contexts. They were also more capable of understanding the auditory, predicting the behaviour of others, more social, having an active role in regulating their environments, and having a multi-faceted system to understand the behaviour of others. Cognitively complex individuals were able to process information, and to distinguish between stimuli.

Based on these characteristics, cognitively complex students prefer the scaffold to be collaborative, enrich with multimedia and sources, magnified, fully organized, synchronous, based on discovery. On the other hand, cognitively simplistic students prefer scaffolding that is individualized, mono-media and limited, miniature sources, and asynchronous.

5.2 Findings related to the design of AMSS based on the students' CSSC

The design phases of this study have resulted in the development of a model for adaptive mobile scaffold application that include (13) various tools, and they are registration, cognitive style identification, scaffolding material, search, share, scaffolding request, Seminar, communication, application evaluation, application guide, academic advisor and my courses. The proposed model has also depended on (8) basic characteristics of scaffolding according to the cognitive style, which are the characteristics relating to the pattern of the scaffold, size of the scaffold, the means and sources of the scaffold, the organization of the scaffolding content, the scaffolding strategies, interaction sessions, membership style, and (7) learning strategies that fall within the strategy of presentation and discovery and (3) patterns of interaction with the students, and the scaffolding content, and two strategies of instruction, one is individualized and the other one is in small groups, in addition to the general strategy of instruction and learning, which is relied upon in the development of DWB through AMSS. Figure 2 illustrates the proposed model of AMSS according to the CSSC.

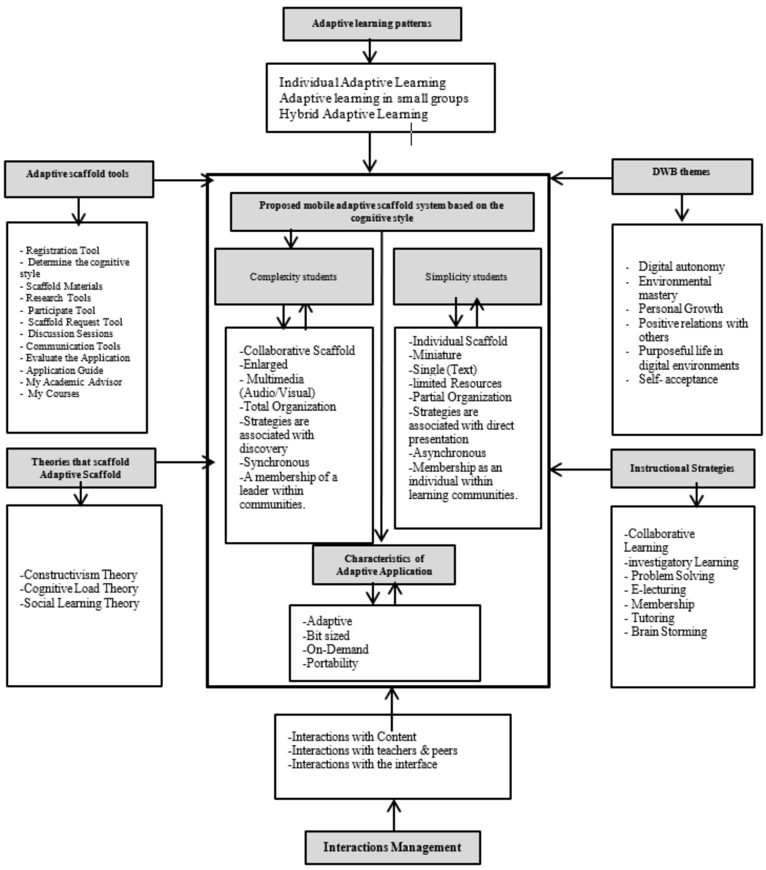

Fig. 2. The proposed model of AMSS according to the CSSC

5.3 Findings related to the effectiveness of AMSS in enhancing DWB

To validate the first hypothesis, comparing the 1st experimental group that used the mobile digital content application that was developed without consideration of students' cognitive style, and the 2nd experimental group that used the proposed model for adaptive mobile scaffold applications based on the analysis of the students' cognitive styles, in terms of DWB. T-test was used to identify the differences between the 1st experimental group and the 2nd experimental group. Table 3 shows the results of the t test for the sample of the two study groups.

Table 3. The mean and the standard deviation and the values of the t for the two groups

Group	N	Mean	SD	t	DF	Sig
1st experimental group (Unified scaffold)	35	114.71	4.72	58. 23	69	0.000
2nd experimental group (AMSS)	36	171.56	3.38			

As shown in Table (3) above, there are statistically significant differences between the 2nd experimental group that used the AMSS (M= 171.56, SD=3.38), and the 1st experimental group that used AMSS (M=114.71, SD=4.72), (t=58.23), (p=.000), Therefore, the hypothesis can be modified to be "there is a statistically significant difference at a level (0.50) between the average grades of the 1st experimental group that uses (Mobile scaffold is uniformly directed to all students), and the average scores of the 2nd experimental group that uses AMSS according to the characteristics of the students' CSSC in the measurement of the DWB in favour of the second group; which can be attributed to the impact of adaptive mobile scaffold according to the cognitive styles.

6 Discussion

The findings, which indicated the effectiveness of the AMSS in developing students' DWB compared to non-adaptive scaffold. Such a result can be linked to the effect of the AMSS that contributed to enhancing DWB indicators among the sample of the current study. As the AMSS assisted in increasing the students' motivation which contributed to putting the students in a state of continuous activity and motivation that pushed them towards actively practicing in all the tasks independently and controlling the application's digital environment. Moreover, the increased motivation that the student's exhibit has empowered them to overcome the educational challenges that confronted them during their use of AMSS, which in turn contributed to their personal growth in the skills related to learning topics. Besides, in their endeavour to successfully complete the learning tasks, students managed to build positive relationships with their peers in the learning groups, which was mainly the result of the adaptive scaffold provided to them. Those positive relationships were reflected in the students' ability to set interim goals and achieve them, which ultimately created self-satisfaction. All the above factors were reflected on the overall digital well- being of the individuals who have obtained adaptive mobile scaffold based on their cognitive style. The result of the current study was consistent with numerous studies that indicated to the effectiveness of the characteristics of the digital applications in enhancing DWB, contentment and learning engagement among individuals who have learned through these applications [46, 57]

Also, this result may due to attributed to the fact that the adaptive scaffold gave the students the ability to control the learning situation, and that the learning situation became more flexible and meeting their needs and characteristics which help in keeping the students in continuous active role searching for information. Likewise, this granted students responsibility of their learning which eventually reflected on their motivation to learn. Such findings can also be linked to the fact that the scaffolding materials and activities provided in the adaptive mobile scaffold application was more consistent with the characteristics of students' cognitive style compared to the ones provided in mobile scaffold application that was uniformly directed to all the students. This has contributed to the high motivation of the students and their consciousness of the learning process and assisted the students to have high expectation of success in their learning tasks which contributed significantly in increasing their motivation to learning. The result of the current study is consistent with the literature that indicated that the student's control over the learning situation, taking active role during the learning processes, the recognition of success as they progress, and the suitability of the learning environment for their needs contribute to the students' high achievement rates. As well as the collection of learning is the motivation of the students and not to mention that motivation to learn is connected to the achievement, and the higher the achievement, the higher the DWB becomes [58, 59].

The findings also attest the idea that scaffolding is not just aids or information materials directed and given to the students, but it is very much related to the students' perceptions. As in some cases, good information materials are provided, but the students were unable to absorb them. Therefore, the 2nd experimental group who used the adaptive scaffold surpassed the 1st experimental group, who received a unified general scaffold, since all the information aids that were provided to the 2nd experimental group came in line with their cognitive style characteristics, which increase their motivation towards learning. Cognitively complex students received scaffolding contents that were organized as whole, in a social context, as well as in audio and visual format, which was compatible with their characteristics. Cognitively simple individuals have received a scaffolding content that was individualize, organized in part, broadcasted in small sizes, and most of it was textual content, which is consistent with their characteristics. The given adaptive content was reflected on students' acquisition of cognitive aspects which trigger them to learn more effectively compared to 1st experimental group who received a generic mobile scaffold that was uniformly routed to all members of the sample without any consideration as to how the students are going to receive and process the information.

This finding is consistent with previous studies in terms of proving the factors that enhance DWB through educational applications. among these factors is the learner's empowerment of the learning environment [60]. Furthermore, if the learning environment is flexible and adaptive, it stimulates students and enhances their wellbeing [61]. Unrestricted learning environment promotes wellbeing [62], as when learning environment matches the needs and characteristics of learners, it stimulates them and enhances their wellbeing [63]. Studies also indicated that digital resources can be considered wellbeing enhancers, but when they compatibility with the characteristics of the learners [64].

7 Limitations

The development of AMSS was based on the characteristics of the students' cognitive style (CSSC). Given that, enhancing DWB indicators in this study was limited to the learning context through the AMSS which was developed according to the students' CSSC associated with the application; more studies can be conducted to enhance DWB indicators according to the characteristics of other cognitive styles in the contexts related to other tools of adaptive scaffolding.

8 Conclusion

The current study is one of the studies that focused on the design of adaptive mobile scaffold systems according to the students' cognitive styles. The study aimed to determine the relationship between AMSS based on the characteristics of the students' CSSC and DWB. Applications based on adaptive mobile scaffold have been found to surpass mobile scaffold applications that do not include any adaptive mobile system.

Through the current study, it was possible to answer the research questions, and identify the main characteristics of (CSSC) that need to be considered when designing (AMSS). These characteristics are including (Scaffold style, Scaffold size, Scaffold media, Scaffold sources, Organizing scaffolding content, Scaffolding strategies, Interaction sessions, Membership pattern). The proposed model was also designed, which was based on the characteristics of the cognitive style, CSSC, as well as the tools available for adaptive scaffold within the application. In addition, to the most important strategies that support the promotion of DWB and managing interactions according to the student characteristics. The proposed model has been validated against models without adaptive scaffold.

It can be said that the most important implication of the current study includes the teachers use AMSS in designing stimulating environments that can enhance DWB which eventually can improve their students' learning. Teachers can also benefit from the characteristics of the cognitive style CSSC in designing digital content and educational activities that are compatible with their students' characteristics.

The study team believes that future studies related to the use of AMSS across e-learning environments could be oriented more towards the development of adaptive social network and assessing its effectiveness in some learning outcomes, and the effectiveness of the adaptive scaffold according to students' cognitive and learning styles in the development of critical thinking, as well as examining the impact of adaptive mobile scaffold in the learning of students with special needs.

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