A User Experience Model for Designing Educational Mobile Application

Kiranjeet Kaur, Khairul Shafee Kalid[(✉)] [iD], and Savita K. Sugathan

Department of Computer Information Sciences, Universiti Teknologi PETRONAS,
Seri Iskandar, Malaysia
{khairulshafee_kalid,savitasugathan}@utp.edu.my

Abstract. The use of mobile application facilitates an interactive and innovative learning experience for students. While there are many studies emphasizing on the use of mobile application but less focuses on the student's experience in using those applications. Mobile application designers tend focus on user interfaces but neglects user experience (UX) as their approach in designing educational application for children. Thus, this paper aims to present a model called EduMobile UX model, a user experience model that designers can adopt when designing educational applications for children. To develop the model, an extensive literature was performed to determine the dimensions for the model. The elements for each dimension of the model were identified through semi-structured interviews and observation respondents from two public school in Tronoh, Perak. This study contributes to the development of a UX model that designers can use to develop education mobile applications based on UX principles.

Keywords: User experience · Children educational application · Cognitive skills

1 Introduction

According to the Ministry of Education of Malaysia, the Science, Technology, Engineering and Mathematics (STEM) in Malaysia aims to develop students with necessary skills which could face the challenges of science and technology [1]. Thus, it is important for Malaysia to focus on producing enough qualified graduates in STEM [2, 3] though the student's interest in STEM is gradually declining [4]. The Minister of Science, Technology and Innovation Ministry stated further that low number of STEM student is worrying [5]. There are many studies that have been conducted to investigate the factors that lead to declining number of student's enrolment on STEM education. One of the factors that contributed to these concerns with student's learning experience. Reference [6] conducted a study on the factors affecting effective instructional practices in teaching mathematics stated that classroom culture is the most important factor in teaching mathematics in STEM education. Thus, it is important for teachers to understand the elements that makes teaching of STEM more interesting to the students so that teachers can facilitate the student's learning. To enhance student's learning experience on STEM, the use of technologies such as mobile application, virtual reality, augmented reality, and

others to support teaching and learning seem to be an opportunity. In addition, with the COVID-19 outbreak, the use of these technologies has becoming more prevalent than before. Mobile devices and applications enhance student's engagement by transforming the way educational content is being delivered. There are many studies that demonstrate the effectiveness of mobile devices in teaching and learning on student's performance [7] but there seems to be limited number of studies on children's user experience in using mobile devices and applications for learning. It is argued that existing mobile applications were designed based on a one-size-fits-all user interface design and not based on user experience (UX) principles. Children that use these applications that are design based on user interface design principles are accustomed to the behavior of the application because they are familiar with the placements of the icons and activities that the applications provide [8]. This could be attributed to the tendency of mobile application designers in using a 'one-size-fits-all' approach in which the same interface design principles are used for both children and adult users. It is argued in this paper that existing educational mobile application are designed without taking into consideration the user's experience.

Thus, this study explores the concept of UX in designing educational mobile application. The objective of this paper is to present a UX model called the EduMobile UX model that guides mobile application designers to design educational mobile application based on user experience principles.

2 Literature Review

2.1 Overview of User Experience

User Experience (UX) is a well-defined consequence of presentation, functionality, system performance, interactive behaviour, and assistive capabilities of an interactive system for hardware as well as software [9]. UX has evolved into one of the core concepts of human computer interaction (HCI) where wide range of disciplines' researchers and practitioners daily work on these concepts. Despite several attempts of understanding, defining and scoping UX, no secured consensus has been reached on this concept [10]. Donald Norman coined the term "User Experience" to describe all the person's experience aspects with a system he believed "usability" to be narrowed deeply for representing a holistic vision of HCI [10]. According to Jacob Nielsen and Don Norman, UX encompasses "all aspects of the end-user's interaction with company, its services and its products" [11] yet not all associated with UX have agreed on this definition [12]. Generally, developers who are interested in UX design, not only focuses on what the product does but on how the users tend to interact with it. Thus, a positive experience requires substantial benefits to users and a negative experience entails frustration and failure [13]. The UX approach in mobile application development in Malaysia is still limited. Mobile application development companies often focus on product-oriented metrics [14]. For example, pre-defined product goals are referred on creating operational goals and functional achievement.

2.2   The Role of UX

The role of UX in user interface design is of paramount importance. The interaction between a user and the application leads to a unique experience in different context of use [15] which includes users perceptual and emotional aspects [9]. It also portrays a paradigmatic shift of how a user anticipates about the interface [12] and the results will then represent usability of a system, product, or service [16]. Furthermore, user interface design is the key factor to produce the best interaction of beauty [14] for users to accept the application because their dislikes could lead to anxiety or discomfort [17]. The function of the application is important for anticipating the usage of the application through a user's perception and responses [16] for maintaining an experience full of engagement and fun [18]. Reference [19] conducted a review on UX design principles in education contexts. The authors stated that the purpose of UX implementation in STEM education is to design educational experiences such as redesigning curriculum and pedagogy and the design of educational tools such as online repository, productivity tools, interfaces, and others. Most of the studies on UX implementation in STEM settings is on designing educational experiences but lack on designing educational tools. Therefore, the adoption of UX to improve innovation has the unique contribution to STEM education researchers.

2.3   UX Dimensions

There are existing UX models such as [20], UI/UX model [21] and Experience-Centered Web Design Model [22]. Each model composed of its own dimension. From all three models, the Experience-Centered Web Design model's dimensions are clearly understood and suitable with the educational context of this study. Furthermore, user experience concerns with the feelings of the users in using the mobile application that is triggered by the properties of the app and the context of use as cited in [23]. The Experience-Centered Web Design model includes all the necessary dimensions for user experience. Table 1 shows the description of each of the dimension of the Experience-Centered Web Design model.

Table 1. Dimensions in the Experience-Centered Web Design Model [20]

Dimensions	Description
Emotional	The emotional dimension relates to a person's feeling, response, and sentiment on the application
Functional	The functional dimension refers to the functionality and usability of the application's
Aesthetic	Aesthetic dimension contributes all visual attributes of the interface such as colours, texture, images, and graphic composition

2.4   The Cognitive Dimension

The existing UX model focuses on experience. Children's user experience in using mobile application is crucial but the learning aspect must not be neglected thus, for an

educational mobile application, the learning aspect needs to be part of the design of the application. The cognitive dimension is based on Piaget's theory of cognitive development. Piaget's theory focuses on the children's progress by referring to the development stages qualitatively [24] namely sensorimotor stage (birth–2 years), preoperational stage (2–7 years), concrete operational stage (7–11 years) and formal operational stage (12 years–adult). The scope of study is for primary school children aged 10–12, therefore this study focuses on the concrete operational stage of Piaget's theory. Children at this stage tends to be very concrete, they grow to be more logical and sophisticated in their thinking in this stage. This stage includes genuine exercise of logic, resolving difficulties, reasoning, problems and undergo hindrances in a logical way. Children in the concrete operational stage practice solving logical problems in their mind.

3   Methodology

This study is an extension of a study by [25]. The previous study focuses on a school in which the analysis of the data is a within case analysis. This study extends that by conducting another case study and compare that with the previous case study in which the analysis of the data is cross-case.

The methodology of this study consists of two main parts. The first activity is the development of the proposed EduMobile UX model. The main dimensions of the proposed model were based on the Experience-Centered Web Design Model [22] and Piaget's theory of cognitive development [24]. The dimensions are emotional, functional, aesthetic, and cognitive. The elements for each of the dimensions were identified through a systematic literature review in educational mobile application. The second part is the identification of the elements for each of the dimension in the EduMobile UX model through two case studies. Two schools in Tronoh, Perak were selected as for this case study which is named as Case Study 1 and Case Study 2 respectively. For Case Study 1, five students participated in the study and six students participated in Case Study 2. The data collection stage was conducted in 2019 before the pandemic and the movement control order was implemented. Thus, the approval to conduct interview and observation sessions in the schools was obtained from education department and a letter of consent was prepared for the parents to grant their permission to invite their children as participants. An educational mobile application was chosen for this study. The application was used by the participants to see their reaction in terms of user experience. The application, "Environment Current Affairs 2018" is an Android-based educational mobile application that contains materials and assessments on topics related to the environment. The focus is not on the content of the application but on the user's experience of the school children in using the application. The device used was a smartphone.

The interview questions were developed based on the four dimensions of the EduMobile UX model and reviewed by an experienced qualitative researcher to ensure that the questions are reliable and easily understood. The data from the interview sessions were transcribed and analyzed based on qualitative data analysis principles using Atlas.ti, a qualitative data analysis software. The data analysis process follows the steps outlined by [26]. Using these steps, the data is codified and categorized according to the four dimensions. The transcripts and observation notes were prepared after each completed

data collection session. From these transcripts and notes, the coding process commenced. The coding process are based on the steps outlined by [27]. The coding process consists of two cycles. In the first cycle coding process, the student's emotion, feelings, and perception were observed. The output of the first cycle coding is the regarded as open codes. These open codes are then synthesized in which that the occurrence and meaning of the codes were observed. Based on this synthesis, the codes were put through the second cycle of coding. In this cycle, patterns and core categories were observed and identified. The analysis is done for within case and cross case analysis. For cross-case, the similarities, and differences between the two cases are observed. The outcome of the second cycle coding is the categories which are the grouped into the dimensions of the UX model. From the analysis, the elements for each of the dimensions in the EduMobile UX model were identified.
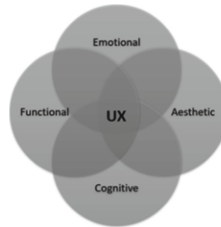
3.1   Case Study 1

The first case study involves a school in Tronoh that consist of 237 students and 20 teachers. There are also Orang Asli and Indian students registered in the school, but majority consists of Malay students. Due to the student's examination was around the corner the researcher was only allowed to conduct the data collection for 1.5 h with each participant. Furthermore, the data collection could only be conducted in the morning on Tuesday(s) and Thursday(s). Thus, looking into the school's conditions the researcher decided to limit the observation period to 5 min and the rest of the time was utilized for interview session. The researcher would reach at the venue 10 min earlier for setting up the data collection tools to avoid wasting the allocated time. The observation session was video recorded, and interview was voice recorded for analyzing purpose. The data collection was completed once the researcher could find the saturation of data from the participants answers and through the observation pattern. Hence, the data collection was conducted with 5 participants where 3 of them were standard 5 students and 2 of them were standard 4 students. 4 of them were female and only one participant was male.

3.2   Case Study 2

The second case study involves a vernacular school in Tronoh. This school consist of 53 students and 11 teachers. All the students were only Hindu. The research data collection was not allowed to be held during school hours thus, it was conducted during extra-curricular hours on Wednesday(s) from 1.30 pm to 3.00 pm. Firstly, the observation session was held for 5 min, and video recorded for analyzing. Later, semi-structured interview session was conducted with the participants upon their experience with the mobile application. Since, the participants native language was Tamil thus, the researcher was appointed a translator to communicate with the participants during the interview session. The translator later would also transcribe the voice recording into script document for researcher to analyze. The researcher found the data saturated after collecting data from total of 6 participants. 3 of them were standard 4 and the others were from standard 5. There were 3 female and 3 male participants.

4   EduMobile UX Model

Figure 1 shows the proposed EduMobile UX Model. This model is based on the Experience-Centered Web Design model with an additional dimension named Cognitive. The Cognitive dimension signifies the learning aspects of the model. The cognitive dimension refers to the children's thinking skills while using the mobile application.

Fig. 1.   EduMobile UX model

Interview sessions and observations were conducted in both Case Study 1 and Case Study 2 based on the dimensions of the EduMobile UX model. The outcome of the two case studies has revealed the elements for each of the dimension. Table 2 shows the elements for each of the dimension.

Table 2.   EduMobile UX model dimensions and elements

Dimension	Elements
Emotional	Attractiveness, pleasure, satisfaction, enjoyment, motivation
Functional	Technology fit, effective, efficient, convenience, gesture interaction
Aesthetic	Text, audio, animation, colour, layout, video
Cognitive	Learnability, memorability, complexity, discoverability

5   Results and Discussion

The findings identified the important elements for each of the four dimensions of the EduMobile UX model. The emotional dimension claims to be the first dimension to be designed because the user experience will be conceived here [20]. The most individual and often idiosyncratic of human phenomena are probably emotions [21]. Overall interaction with mobile application is the focus of the study and the experience should be re-created, modified and amplified in real world. This dimension focuses on the user interactivity which enhances users' motivation through better participatory activity. Children's helping behaviour emerges early in concrete operational stage, suggesting that pro sociality is rooted deeply in human nature [25].

5.1 Emotional

For the emotional dimension, the data collection activities demonstrate the participant's emotion towards using the educational mobile application. The application "Environment Current Affairs 2018" does not give the participants the utmost user experience. Participants believed that the user interface was not attractive due to the style of the content being presented to them. Participants did not feel the enjoyment from using the application because they feel that the content is dull with lack of interaction with the user. This affects the motivation of the user to continuously use the application for learning as participant 3 from Case Study 2 stated.

> *"The colours are also very like not so attractive or like dull cause it uses only one colour and too small words makes me hard to read so I don't get motivated to read more" [19:45 CASE_2 INTERVIEW 3].*

The emotional aspects seem to be related with other dimensions. For example, aesthetic dimension elements such as content layout, use of colours, animation and others could impact the emotions of the user.The two case studies indicate the use of colours affect the participant's emotion. Colours have been seen as a source of attraction for the students to use the application in both case studies. The use of colours in the application impacts the participants somehow. For example, participants of Case Study 1 felt that colorful design delivers enjoyable experience to them whereas participant in Case Study 2 commented that colours motivates them in using the application. Both case studies show similar findings on the impact of colours and content design towards user experience. The findings from the Case Study 1 and Case Study 2 indicated that interesting and multiple content style with colorful design provide pleasure in using the educational mobile application.

The findings from the two case studies also indicates the elements of interactivity and engaging experience in delivering meaningful knowledge brings satisfaction the participants. This can be seen from the two case studies in which the participants felt that interactive feedbacks and design would satisfy them as it enhances their learning abilities. Interactive activities in the application provides enjoyment feeling to the children. The study by [28] corroborate this finding. The study, despite not using in any specific mobile application, indicates that the experience of using educational mobile application should be fun and motivating. This could be achieved through activities with good usability factors.

5.2 Functional

The functional dimension concerns with the features and functionality of the application and the usage of the application itself by the user. Mobile application needs to operate fast, provide reliable content, contain all workable user interface elements, enables the user to personalize learning, provide both open and secured access, able to adjust the content according to the new settings and perform all relevant task or functions without any manner of interference. As one participant stated,

"Here there is only one icon back button so, it is nice and clear. The size is also just nice for the button not so big and not so small so with this size is just nice to see it clearly" [18:1 CASE_2 INTERVIEW 2].

Moreover, educational mobile application should be delivering high quality standards to keep pace with the growing mobile technology. The navigation of the application needs to be economical and convenient. The findings indicated that children find touch/gesture interaction of the mobile application to be easily detected and performed softly. This is due to children prefer performing gesture using their own method rather than following instructions [29], which delivers accurate single/multitouch gestures since, they are regularly using smart gadgets at home.

The findings of the two cases have shown that the school children prefer mobile application that is laden with the latest features which would help them in completing a task easily and faster. The participants of this study are regarded as Gen Z which has been exposed to mobile devices and applications. Thus, designers should be aware of all the technological features which are necessary to be included in designing the application for children. Nonetheless, the mobile application design for school children cannot to be too complicated. A less complicated design makes the application more effective. Participants in Case Study 1 and Case Study have different views regarding the effectiveness of the "Environmental Current Affairs" mobile application. Participants in Case Study 1 defines effectiveness as when all the interface elements are easily visible. Participants in Case Study 2 views speed, responsiveness and non-interfered task as the elements that makes an application to be effective. The efficiency of the mobile application, however, relates to how convenient the user performs a task in the mobile application. Participants for Case Study 1 focus on gesture interaction on how easy for them to navigate the application. Thus, the mobile application should consist of all the latest gesture interaction as children are aware of all the available gestures and can perform without any assistance. Participants for Case Study 2 commented further that the efficiency of an application is depending on how organized the layout of the application is. An application with an organized layout design would ease the children in navigating the application and perform any tasks within the application faster. Overall, children mobile application designers should take into consideration the layout design of the application to enhance the children's experience in using the application. The designers should ensure the mobile application is designed to produce responsive, errorless, and fast tasks but with simple as well as highly noticeable presentation. The challenge in developing mobile application for learning is on how to balance between information and the display size, navigation, and storage [30].

5.3   Aesthetic

Aesthetic dimension contributes all visual attributes of the interface such as colours, texture, images, and graphic composition. This aesthetic dimension represents the other two dimensions of UX. Picturing the concept and functionality may interest the user for experiencing the design [22]. In this paper, it is important that visibility, text, colour, images, audio and animation can contribute a big portion to interactivity since, human respond better to visual arrangements. Research has confirmed that images prove to

interest, create emotion, and stimulate curiosity. Text needs to integrate with images since text create the meaning of the image. The use of colors and audio not only enhance the mobile application aesthetically but also improves student's overall satisfaction in using the application [31]. The use of appropriate font size and colours is crucial for delivering clear readability. Thus, the two case studies have uncovered that font which are big and clear would be easy to read and understand the content. The animation is useful believed to catch the users' attention. The use of animation could eliminate boredom when using the application but in Case Study 2, the participants claimed that too many and animation in reading content would distract children. However, in Case Study 1 animation are appreciated as it contributes to the content awareness more seriously. Moreover, participants in Case Study 2 find animation which are used for guidance interest them in using the application more. Participant from Case Stud 1 stated,

> *They should present (the information) the animation in way where the water is like clean and beautiful but suddenly changes to dirty and polluted. (The use of) animation will make us realize that the nature is getting polluted. [2:9 | 2 CASE_1 INTERVIEW 2]*

Therefore, inclusion of animation should be done carefully as its misplacement and amount could disrupt children's loyalty towards the application. Nonetheless, it can be agreed that animation plays an important role in sustaining their fun while maintaining their seriousness in understanding the content.

The use of sound helps in setting the mood of the user however, it should appropriate and not overused as it could affect the users focus on learning. The use of colors affects the student's interest in using the application. Colours play an important role in content visibility as found from Case Study 2. On the other hand, children in Case Study 1 believed that colours play a role of excitement which intrudes them in choosing bright colours. As the following participants commented,

> *That loud music will make me irritated, and I will get distracted"* [1:26 CASE_1 INTERVIEW 1].
> *Sound is a tool that will keep us alert. Like example when we are pressing something like button, with the help of sound we will be aware of what we are pressing"* [17:33 CASE_2 INTERVIEW 1].

It can also be seen that the participants are prefer objects such as icons, pictures, and others to be well-organized. A well-organized layout allows user to find information more easily. From Case Study 1, the participants prefer layout arrangement that focus on the visibility of the interface elements. Participants from Case Study 2 mentioned about a well-organized layout that contributes to effectiveness of the application. Therefore, mobile application designers should ensure the layout are best to fit with mobile application screen that ensures clear visibility, help in doing task correctly and could provide comfortable environment. Pictures should be included in the application to contribute in relevant visual information. The pictures and text should be presented clearly as these contributes to learning and avoiding misinterpretation of information.

5.4 Cognitive

The cognitive dimension is the learning dimension of the model. The findings from Case Study 1 and Case Study 2 indicate that school children could use mobile application for learning if the content is aligned to the student's level of understanding and comprehension. Children could learn better if the derived knowledge is easily understandable. The participants feel that the content of the application is too complex for them. Thus, it is important for an educational mobile application to have content that suited the user's level of capabilities. Content complexity affects the student's learnability. One participant stated,

> *This information is not for my age kids can understand and work. So, better like in our textbooks they show and then which I can do like in book I got read that there must be 3 bins to throw rubbish so this I can do at home also" [18:50 CASE_2 INTERVIEW 2].*

One of the approaches to make the content less complex is to make it bite-sized which means avoiding long sentences or presenting the content using mind maps. The aesthetic dimension affects the cognitive dimension. The use of animation, videos and sounds in education mobile application impact student's learning. According to [28], the excitement created through animation, virtual objects, sound, and video could improves children memory. The use of technologies such as 3D animation, multimedia are able to enhance student's understanding on science subjects [32]. Reference [31] studied the use of mobile application with augmented reality capabilities in learning of the topic Solar System called AR-SiS. Their findings show that students perceived could improve their understand and knowledge on the solar system using augmented reality mobile application. Interactive activities promote memorability in children as discovered from Case Study 1 and Case Study 2. Additionally, these two case studies have also uncovered that child tend to remember content better when it is highlighted using colours and unique fonts.

6   Conclusion

This study proposed a UX model called the EduMobile UX for education mobile application for school children. The dimensions of the model were proposed based on the Experienced-Centered Web Design model and Piaget's Theory of Cognitive Development. The model consists of four dimensions namely emotional, functional, aesthetic, and cognitive. The elements for each of the model were identified through a single case study. This study presents this model as the first step towards developing a UX guideline for education mobile application. Overall, this study contributes to the mobile application industry, children, and the education system. From a practical standpoint, the EduMobile UX model can be adopted by mobile application designers to design education mobile application for school children using UX principles.

References

1. Recsam, S.: Curriculum reform: the Malaysian experience. https://home.kku.ac.th/crme/Filepaper/apec2016/MALAYSIANEDUCATIONSYSTEM.pdf (2016). Accessed 06 Sept 2021
2. Ramli, N.F., Talib, O., et al.: Can education institution implement STEM? From Malaysian teachers' view. Int. J. Acad. Res. Bus. Soc. Sci. **7**(3), 721–732 (2017)
3. Shahali, E.H.M., Halim, L., Rasul, M.S., Osman, K., Zulkifeli, M.A.: STEM learning through engineering design: impact on middle secondary students' interest towards STEM. EURASIA J. Math. Sci. Technol. Educ. **13**(5), 1189–1211 (2016)
4. Krajcik, J., Delen, I.: How to support learners in developing usable and lasting knowledge of STEM. Int. J. Educ. Math. Sci. Technol. **5**(1), 21–28 (2017)
5. Bernama: Low number of STEM students worrying - Khairy. https://www.bernama.com/en/general/news.php?id=1899173 (2020, November 09). Accessed 14 Nov 2020
6. Rasid, N.S.M., Nasir, N.A.M., Singh, P., Han, C.T.: STEM integration: factors affecting effective instructional practices in teaching mathematics. Asian J. Univ. Educ. **16**(1), 56–69 (2020)
7. Sung, Y.-T., Chang, K.-E., Liu, T.-C.: The effects of integrating mobile devices with teaching and learning on students' learning performance: a meta-analysis and research synthesis. Comput. Educ. **94**, 252–275 (2016)
8. Ruiz-Iniesta, A., Melgar, L., Baldominos, A., Quintana, D.: Improving children's experience on a mobile EdTech platform through a recommender system. Mob. Inf. Syst. **2018**, 1374017 (2018)
9. Pucillo, F., Cascini, G.: A framework for user experience, needs and affordances. Des. Stud. **35**(2), 160–179 (2014)
10. Lallemand, C., Gronier, G., Koenig, V.: User experience: a concept without consensus? Exploring practitioners' perspectives through an international survey. Comput. Human Behav. **43**, 35–48 (2015)
11. Normman, D., Nielsen, J.: The definition of user experience (UX). https://www.nngroup.com/articles/definition-user-experience/. Accessed 06 Sept 2021
12. Mullins, C.: Responsive, mobile app, mobile first: untangling the UX design web in practical experience. In: Proceedings of the 33rd Annual International Conference on the Design of Communication, pp. 1–6 (2015)
13. Park, S., Oh, D.-S.: An exploratory study on the content design of mobile edutainment for preschool children. Int. J. Softw. Eng. Appl. **8**(11), 55–66 (2014)
14. Wong, C.Y., Chu, K., Pauzi, M.A.M.: Advocating UX practice in industry: lessons learnt from UX innovate bootcamp. In: 2016 4th International Conference on User Science and Engineering (i-USEr), pp. 204–209 (2016)
15. Nagalingam, V., Ibrahim, R.: Finding the right elements: user experience elements for educational games. In: Proceedings of the 2017 International Conference on E-commerce, E-Business and E-Government, pp. 90–93 (2017)
16. Nagalingam, V., Ibrahim, R.: A review of user experience (UX) frameworks for educational games, June, pp. 134–143 (2015)
17. Al-Khalifa, H.S., Garcia, R.A.: Website design based on cultures: an investigation of saudis, filipinos, and indians government websites' attributes. In: International Conference of Design, User Experience, and Usability, pp. 15–27 (2014)
18. Ariffin, S.A.: Needs and potentials for studying local malaysian culture through mobile learning. In: Proceedings of the 3rd International Conference on Human-Computer Interaction and User Experience in Indonesia, pp. 60–66 (2017)
19. Minichiello, A., Hood, J.R., Harkness, D.S.: Bringing user experience design to bear on STEM education: a narrative literature review. J. STEM Educ. Res. **1**(1), 7–33 (2018)

20. Stern, C.: CUBI: a user experience model for project success | UX Maga-
    zine. https://uxmag.com/articles/cubi-a-user-experience-model-for-project-success (2014,
    September 25). Accessed 06 Sept 2021
21. Herasymenko, A.: UX design for beginners: what is UI/UX Design? | by Andrey Herasy-
    menko | UX Collective. https://uxdesign.cc/ux-design-for-beginners-what-is-ui-ux-design-
    89bc4da54cbf (2019, January 15). Accessed 06 Sept 2021
22. Fadel, L.M.: Experience-centered web design model. In: International Conference of Design,
    User Experience, and Usability, pp. 92–103 (2014)
23. Yang, B., Liu, Y., Liang, Y., Tang, M.: Exploiting user experience from online customer
    reviews for product design. Int. J. Inf. Manage. **46**, 173–186 (2019). https://doi.org/10.1016/
    J.IJINFOMGT.2018.12.006
24. Feldman, D.H.: Cognitive development in childhood: a contemporary perspective. In:
    Handbook of Psychology, vol. 6, Second edn. DEF publishers, Champaign, IL (2012)
25. Kaur, K., Kalid, K.S., Sugathan, S.: Exploring children user experience in designing educa-
    tional mobile application. In: 2021 International Conference on Computer Information Sci-
    ences (ICCOINS), pp. 163–168 (2021). https://doi.org/10.1109/ICCOINS49721.2021.949
    7234
26. Erlingsson, C., Brysiewicz, P.: A hands-on guide to doing content analysis. Afr. J. Emerg.
    Med. **7**(3), 93–99 (2017)
27. Saldaña, J.: The Coding Manual for Qualitative Researchers. Sage, Thousand Oaks, CA
    (2021)
28. Ariffin, S.A., Yatim, M.H.M., Daud, F.: Identification of usability impact of mobile learn-
    ing STEM in a local university context. In: Proceedings of the 5th International ACM
    In-Cooperation HCI and UX Conference, pp. 106–115 (2019)
29. Hussain, N.H., Wook, T.S.M.T., Noor, S.F.M., Mohamed, H.: Multi-touch gestures in multi-
    modal systems interaction among preschool children. In: 2017 6th International Conference
    on Electrical Engineering and Informatics (ICEEI), pp. 1–6 (2017)
30. Abd Samad, M.R., Ihsan, Z.H., Khalid, F.: The use of mobile learning in teaching and learn-
    ing session during the covid-19 pandemic in Malaysia. J. Contemp. Soc. Sci. Educ. Stud.
    (JOCSSES)(E-ISSN 2785-8774)**1**(2), 46–65 (2021)
31. Zaki, N.A.A., Zain, N.Z.M., Zanilabdin, A.: AR-SIS: augmented reality application to
    encourage STEM teaching and learning. Int. J. Multimedia Appl. **10**(6), 1–13 (2019)
32. Lok, W.F., Hamzah, M.: Student experience of using mobile devices for learning chemistry.
    Int. J. Eval. Res. Educ. **10**(3), 893–900 (2021)