Article

Validation of a Tool Evaluating Educational Apps for Smart Education

Journal of Educational Computing Research
0(0) 1–16

DOI: 10.1177/0735633115571923
jec.sagepub.com
SAGE

Jeong-Sook Lee[1] and Sung-Wan Kim[2]

Abstract

The purpose of this study is to develop and validate an evaluation tool of educational apps for smart education. Based on literature reviews, a potential model for evaluating educational apps was suggested. An evaluation tool consisting of 57 survey items was delivered to 156 students in middle and high schools. An exploratory factor analysis was then used to ascertain the importance of the criteria. Four exploratory constructs and eight subfactors were extracted from the data collected: Factor I was labeled as "Teaching & Learning," Factor II, "Screen Design," Factor III, "Technology," and Factor IV, "Economy & Ethics." Each factor has two subfactors, respectively. Reliability estimates using Cronbach's alpha indicated that the evaluation tool had good internal consistency. The overall results of the analyses suggest that this evaluation tool is highly instrumental for evaluating educational apps.

Keywords

educational apps, evaluation criteria, reliability, validity, factor analysis

Introduction

To cope with the convergence and diffusion of new technologies and to prepare for the shift into creative learning society, educational authorities of each

[1]Sohwa Elementary School, Suwon, Korea
[2]Center for Teaching and Learning, Korea Nazarene University, Cheonan, Korea

Corresponding Author:
Sung-Wan Kim, Center for Teaching and Learning, Korea Nazarene University, Cheonan 331-718, Korea.
Email: kimstar52@kornu.ac.kr

country have made a variety of effort such as Savannah project in UK, InnoSchool project in Finland, Charles River City project in USA, SMART education plan in Korea, and so forth. Although they use different terms to define education which utilizes smart devices, all of them have pursued *smart* education. Smart education system seeks to strengthen the skills of 21st-century learners by offering an intelligent and customized learning solution and has the goal of self-directed, motivated, adaptive, resource-enriched, and technology-embedded learning (KERIS, 2012). The necessity for smart education arises from the need to develop technological learning environments for modern learners who benefit from both technology and learner-centered instruction. These young *digital native* learners are setting technology both in school and out of school. They are innovative users of technology who are constantly adopting new technologies to support their learning and their lifestyles (Solomon & Schrum, 2007). Unlike past generations, these youth actively develop and project themselves in the virtual their own spaces such as social networking services, blogs, and twitter. These new learner characteristics in combination with increasingly more affordable computing devices (PCs, tablets, and smart phones) as well as the development of new technologies (icloud computing, big data, and web 3.0) have begun to make the shift from teacher-centered instructional design to learner-centered more feasible. Especially pivotal to this effort is the development of educational applications (hereto referred to as apps).

It is expected that educational apps being utilized on these smart devices will contribute to the realization of self-directed, learner-centered, and creative learning environments. Apps are considered as important and growing medium for providing educational contents to young learners both in terms of their availability and popularity (Shuler, 2012). Apps on multiple devices can help automate current classroom processes or present new ways to learn that previously had been unexplored (Zwang, 2011). As of 2013, there are currently more than 1,000,000 apps available through the Apple Store, which indicated enormous growth of apps when comparing the number (566,165 apps) of apps in 2011 (Rogers, 2013; Walker, 2011). As of August, 2011, educators had their choice of more than 40,000 educational apps from which to choose. When including books, reference tools, utilities, and productivity apps, the total is more than 166,000 apps (Walker, 2011). The sheer volume of these current apps would preclude any one teacher from being able to choose what is valuable for his or her students let alone thinking about the fact that there are always more and more apps added daily. Educators need a concrete and simple evaluation tool for educational apps that is more than just a general guideline how to choose them. An evaluation tool of this type would empower teachers, facilitate communication of these decisions between teachers, as well as guide the development of educational apps in future.

Until now, a variety of studies related with educational apps have been completed with respect to design and development (Ching & Hsu, 2013; Falloon,

2013; Jeong et al., 2010; Lee, 2012; Lee & Choi, 2012; Lee & Park, 2012), practical application and adoption (Chiong & Shuler, 2011; Goodwin & Highfield, 2012; Hedman & Gimpel, 2010; Kim, Han, & Choi, 2011), and evaluation (Brian, 2011; Jang, Park, & Lim, 2012; Lee, 2012; Vincent, 2012; Walker, 2011; Yang, 2011). However, most of existing studies are closely related with the design and development of educational apps, but there has been very little research conducted on the evaluation of apps for the purpose of quality control (Shuler, 2012). Additionally, the existing method of intuitively extracting evaluation criteria has the weakness of focusing limited amount of technical aspects and has no process for validating them at the research level (Vincent, 2012; Walker, 2011). And it focused on providing evaluation rubric to help teachers and parents evaluate educational apps for their young learners and children. But it had the limitation of indirectly considering students' own needs.

Accordingly, research for developing and validating an evaluation framework for educational apps is very much needed at the perspective of students, that is to say, consumers of educational apps. This study aims to develop a reliable and valid evaluation model for assessing and selecting educational apps to aid educational practitioners in various fields of smart learning. Research questions are as follows: (a) What is the theoretical criteria model for evaluating educational apps? (b) What is the final criteria model revised by statistical validation?

A Criteria Model for Evaluating Educational Apps

When selecting potential factors for evaluating educational apps, it was considered that criteria should be based on instruction as well as technology. As such this study focused on educational game apps ranging from drill and practice type apps to apps focused on creativity, higher order thinking, and problem solving. Analysis and synthesis of previous research studies and literature guided us to a potential criteria model for evaluating educational apps. In this point, we selected four areas (Teaching & Learning, Screen Design, Technology, and Economy & Ethics) for evaluating educational apps (Figure 1).

All of the aspects are closely related to each other, although each aspect seems to be separate. In order for "Teaching & Learning" area to be performed smoothly, other areas such as "Screen Design," "Technology," and "Economy & Ethics" are necessary. In this sense, they are four interrelated domains.

"Teaching & Learning" evaluates the educational value of apps from the perspective of the apps level of motivation, self-directedness, curriculum connections, authenticity, and cognitive development. First of all, educational apps should be interesting (Chiong & Schuler, 2011; Jang et al., 2012; Vincent, 2012; Walker, 2011). Motivating and sustaining a learner's drive participating in a learning activity is the representative instructional strategy for successful learning. Apps should be designed to engage learners by making them laugh and to provide incentives (Chiong & Schuler, 2011). Human interactions including

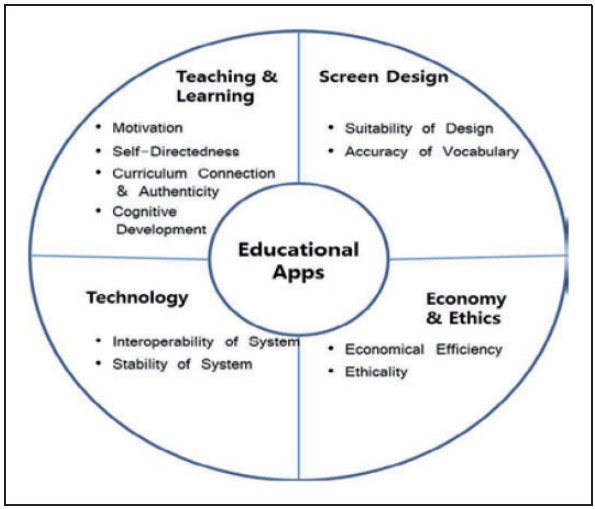

Figure 1. A potential criteria model for evaluating educational apps.

team play, which mainly consists of cooperation and competition, should be present in apps since they are highly motivating to learners. Additionally, educational apps should be designed toward ensuring learner self-directedness (Goodwin & Highfield, 2012; Kim & Lee, 2012). It is recommended that educational apps should give learners the option to personalize. Personalization has great potential as a way to engage learners and help them develop digital participation skills that are valuable in the long term (Chiong & Schuler, 2011). Curriculum connections and authenticity (Walker, 2011) also need to be considered when evaluating educational apps. For example, apps should strongly correlate to a targeted skill or concept from learner's curriculum and effectively embed those skill/concepts into authentic learning experiences. Authenticity is defined as the extent to which students are engaged in genuine learning problems but authenticity also has to do with helping learners connect new learning with their prior knowledge. Furthermore, educational apps that are developmentally appropriate should be created for learner's cognitive development including reasoning skill, thinking skill, and creativity.

The *screen* of an app should be designed to have appropriateness of design and accuracy of vocabulary. This criterion is strongly related with ease of use. For instance, the color of a screen should have a good feel and look. Also, the elements of a screen such as buttons and icons should be designed to enhance intuitive user access through simplicity and consistency (Vincent, 2012). The more a learner uses an app intuitively, the higher the level of user friendliness (Walker, 2011). An app's design structure should appropriately reflect the characteristics of the app. Moreover, successful communication

between the user and the app itself is contingent upon the accuracy of grammar and spelling, clarity of direction, and absence of confusing jargon or slang.

"Technology" incorporates interoperability and system stability (Delimarsky, 2011). Educational apps should be operable across platforms (e.g., Android, Apple OS, WP7) and devices (e.g., smart phone and pad). System stability should ensure quick interactions (fast loading times) and error-free functionality. Of course, there are times in which apps that might need unusually large amounts of data at startup; nevertheless, the applications had better not let the process velocity be noticed by the user.

The final area to be considered for app evaluation is "Economy & Ethics." This section incorporates criteria, such as economical efficiency and ethicality. The price of the app may be linked to its quality (Malone & Peterson, 2013), but it should be appropriate for buying it. And advertisements in an app are unnecessary for using it (Falloon, 2013). In case of pay apps, the procedure of payment needs to not be too simple in order not to pay by mistakes. An app should not contain morally biased or violent and lascivious contents, because in some cases it could be used as an alternate form of a textbook. Of course, it should also encourage learners to continue to study via an app without the fear of data spill (Raymer, 2013).

Method

Participants

The 156 students completing the survey had experiences using apps at one middle school (53 respondents) and two high schools (103 respondents). The evaluation group was composed of 85 males (55%) and 71 females (45%). Ninety percent (90.4%) of participants used an Android operating system and 9.6% used Apple OS. Seventy-six percent (76.2 %) of participant utilized educational apps more than three times per week.

Instruments

Initially, a total of 56 evaluation items were developed based on the potential criteria framework, and the items were examined and revised by four graduate students majoring in educational technology and two in-service teachers. Finally, an educational technology faculty member reviewed the face validity of the evaluation items three times. The final potential criteria framework comprised 43 items: Teaching & Learning (16 items), Screen Design (11 items), Technology (7 items), and Economy & Ethics (9 items). A 5-point Likert-type scale was used. By using data from 156 respondents, a factor analysis was carried out. By considering means ($M \geq 3.0$), the number of items was reduced to 33, which was the result of deleting nondiscriminant and redundant items.

Procedures

To develop a potential model for evaluating educational apps and to validate the evaluation model, an evaluation criteria framework was created based on a literature review. In total, 43 survey items were developed to assess the four criteria represented by the proposed evaluation model. The 43-item survey was administered to 248 students from middle and high schools in Korea to ascertain the importance of each item in the evaluation of apps. Data were collected by visitation. One hundred and eighty-six survey responses were collected initially. However, after data cleaning (removal of incomplete survey), this number was reduced to 156 respondents. These 156 surveys were used for factor and reliability analyses that confirmed the fitness of the criteria framework.

Data Analysis

To derive a concise list of explanatory constructs from the 156 responses[1] collected, exploratory factor analysis was performed. In the initial factoring step, principal component analysis was employed to extract initial factors and the varimax of orthogonal rotation in the rotation step. Reliability was assessed to confirm the internal consistency of the selected items.

Results

The scores from the 43-survey items regarding the importance of items for evaluating educational apps ranged from 2.34 to 4.76. As mentioned above, 10 items having means below 3.0 were deleted. The means and standard deviations of 33 items are like below (Table 1).

To examine the validity of the evaluation criteria framework, a factor analysis of survey responses was conducted. Exploratory factor analysis was used because the links between the observed and latent variables were unclear. The minimum factor-loading criterion was set to 0.30. To determine the number of factors to be extracted, factor interpretability was considered the most important, although screen test and Kaiser criterion results were also considered. Initially, a four-factor model (Model I in Table 2) was suggested, as the first four factors accounted for 51.36% of the total variance. The items were roughly clustered into four categories: Teaching & Learning (Factor I), Screen Design (Factor II), Technology (Factor III), and Economy & Ethics (Factor IV). As a result of the second exploratory factor analysis, which were carried out again by each category as separate factor analyses, a two-factor model (Model II in Table 3), a two-factor model (Model III in Table 4), a two-factor model (Model IV in Table 5), a two-factor model (Model V in Table 6) were also suggested, as the factors from each models accounted for 52%, 62%, 71%, and 68% of the total variance, respectively.

Table 1. Mean and Standard Deviation for the Variables.

	Item	*M*	*SD*	Item	*M*	*SD*
Teaching & Learning	A1	4.11	.984	A8	4.10	.961
	A2	4.20	1.070	A9	3.54	.953
	A3	3.97	1.016	A10	3.59	1.156
	A4	3.61	1.160	A11	3.61	1.231
	A5	3.56	1.208	A12	4.22	.982
	A6	3.67	1.175	A13	3.60	1.216
	A7	3.80	1.101			
Screen Design	B1	4.48	.708	B5	4.34	.912
	B2	3.98	1.054	B7	4.32	.908
	B3	4.16	1.127	B7	4.33	.857
	B4	4.30	.946	B8	4.76	.500
Technology	C1	3.20	1.060	C4	3.01	.953
	C2	3.46	1.094	C5	3.00	.688
	C3	3.42	1.128	C6	3.01	.807
Economy & Ethics	D1	3.44	1.235	D4	3.25	1.090
	D2	3.41	1.178	D5	3.69	1.109
	D3	3.35	1.150	D6	3.95	.985

Internal consistency reliability was analyzed to test the correlation among items. The Cronbach alpha statistics for the evaluation tool was .93, and its scores for Factor I, Factor II, Factor III, and Factor IV were .88, .85, .82, and .80, respectively. These results confirmed the adequacy of the internal consistency of the app evaluation model.

It was interpreted that Factor I, Factor II, Factor III, and Factor IV, respectively, comprised two subfactors (Factor I: motivation·self-directedness·authenticity, cognitive development; Factor II: suitability of design, accuracy of vocabulary; Factor III: interoperability, stability; Factor IV: economical efficiency, ethicality).

Based on the aforementioned results, the final revised criteria model shown in Figure 2 maintains appropriate construct validity and reliability.

This model consists of four factors (Teaching & Learning, Screen Design, Technology, and Economy & Ethics). Factor I comprised 13 variables. All of these items deal with suitability of motivation·self-directedness·authenticity and cognitive development. Eight of the 32 items loaded on Factor II. Factor III captured six variables. All of these items deal with interoperability and stability of apps. Factor IV is most highly saturated with six variables. All of these items measure the economical efficiency and morality.

Table 2. Result of Factor Analysis for Four-Factor Model (Model I).

Item	Factor I (Teaching & Learning)	Factor II (Screen Design)	Factor III (Technology)	Factor IV (Economy & Ethics)	Cronbach α
A13	.67	.13	−.08	.36	
A8	.66	.12	.10	.20	
A10	.66	.23	.30	.01	
A6	.61	.30	.02	.04	
A5	.59	.26	.25	.05	
A4	.59	.26	.24	.05	
A11	.56	−.09	−.01	.31	.88
A7	.56	.04	.25	.35	
A1	.55	.33	.26	−.01	
A2	.52	.40	.15	.05	
A9	.47	.27	.44	.06	
A3	.45	.39	.26	.02	
A12	.42	.37	.03	.39	
B5	.30	.74	.21	.08	
B3	.30	.73	.15	.02	
B4	.21	.70	.10	.27	
B6	.26	.67	.10	.23	.85
B1	.30	.64	.10	.26	
B7	.20	.59	.08	−.03	
B2	.18	.51	.14	.41	
B8	−.07	.35	.05	.10	
C1	.24	.04	.80	.01	
C4	.14	−.08	.79	.12	
C2	.21	.19	.78	−.15	.82
C3	.26	.23	.64	.08	
C6	−.09	.07	.59	.23	
C5	−.12	.18	.45	.31	
D4	.13	.22	.20	.73	
D2	.17	.02	−.03	.68	
D3	.39	−.09	−.11	.63	.80
D1	.13	.32	.23	.63	
D5	−.02	.37	.23	.59	
D6	.27	.34	.33	.35	
Eigenvalue	10.17	2.70	2.09	1.99	
Variance explained (%)	30.80	8.19	6.35	6.02	
Cumulative proportion of total variance (%)	30.80	39.00	45.34	51.36	

Table 3. Result of Factor Analysis for Two-Factor Model (Model II).

Factor	Item	Factor II-1 (motivation self-directedness authenticity)	Factor II-2 (cognitive development)
Teaching & Learning	A1	.76	.08
	A5	.69	.23
	A8	.68	.27
	A9	.65	.18
	A2	.64	.21
	A4	.63	.29
	A3	.63	.17
	A6	.62	.27
	A7	.49	.41
	A11	.05	.82
	A13	.32	.74
	A10	.31	.72
	A12	.26	.67
Eigenvalue		5.47	1.31
Variance explained (%)		42.08	10.09
Cumulative proportion of Total variance (%)		42.08	52.17

Table 4. Result of Factor Analysis for Two-Factor Model (Model III).

Factor	Item	Factor III-1 (suitability of design)	Factor III-2 (accuracy of vocabulary)
Screen Design	B4	.83	.11
	B3	.80	.01
	B5	.79	.25
	B6	.77	.21
	B1	.67	.23
	B2	.66	.09
	B8	.02	.91
	B7	.24	.62
Eigenvalue		3.98	1.01
Variance explained (%)		49.78	12.59
Cumulative proportion of total variance (%)		49.78	62.38

Table 5. Result of Factor Analysis for Two-Factor Model (Model IV).

Factor	Item	Factor IV-1 (interoperability)	Factor IV-2 (stability)
Technology	C1	.87	.15
	C2	.84	.13
	C4	.78	.23
	C3	.75	.18
	C5	.11	.87
	C6	.26	.81
Eigenvalue		3.16	1.08
Variance explained (%)		52.63	18.07
Cumulative proportion of total variance (%)		52.63	70.70

Table 6. Result of Factor Analysis for Two-Factor Model (Model V).

Factor	Item	Factor V-1 (economical efficiency)	Factor V-2 (ethicality)
Economy & Ethics	D1	.84	.18
	D2	.83	.17
	D5	−.01	.79
	D3	.22	.78
	D4	.20	.73
	D6	.20	.73
Eigenvalue		3.05	1.00
Variance explained (%)		50.90	16.73
Cumulative proportion of total variance (%)		50.90	67.63

Discussion and Conclusion

This study aimed to generate a useful model for evaluating educational apps. To this end, factor and reliability analyses were conducted, and the implications of their results may be interpreted as follows.

The statistically confirmed evaluation model consisting of four elements, which include Teaching & Learning, Screen Design, Technology, and Economy & Ethics, may be useful for evaluating educational apps. The educational app evaluation tool generated herein is based on a different format than any existing technology-centered and intuitive-type evaluation framework. This

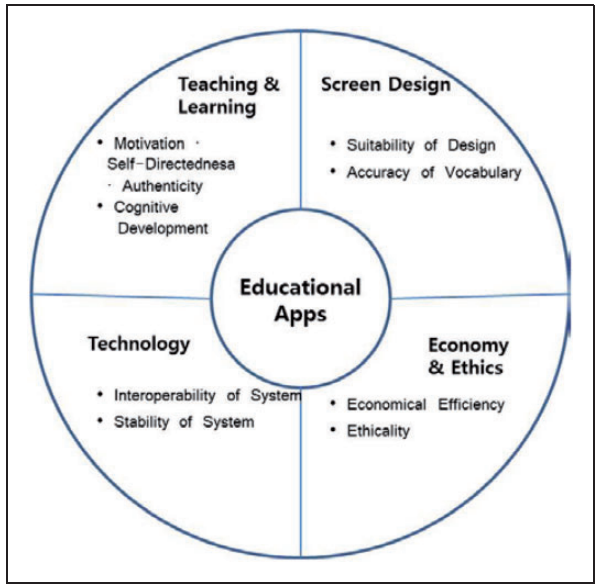

Figure 2. Final revised criteria model for app evaluation.

study focused on instruction as well as technology and statistical validation of evaluation tool for apps. It corresponds with Walker's opinion (Walker, 2011) that when evaluating apps for educational use, technical aspects of criteria are only the bare minimum; practitioners need to take a more focused look at the educational benefits for their students. So this approach may be usefully applied to evaluating educational apps despite of the rapid emergence of information technologies. The study of validation will be helpful to overcome "the pendulum syndrome in which educational innovations seem doomed to follow a cycle of unrealistically optimistic expectations followed by disappointment, disillusionment, and abandonment" (Maddux, 1986, p. 27). This study is a pragmatic approach and might be a practical guideline for classroom level, which will finally overcome the obstacle of a lack of penetration of research findings at the classroom level. The results of this evaluation criteria for educational apps in many ways parallels those of Falloon (2013), which contrasted content and design features which support learning (e.g., scaffolds, some types of feedback, some types of instruction) with those features that impede learning (e.g., pop up and banner advertisement). Moreover, these results have the potential of guiding the design of new apps with the intent of improving their quality. In conclusion, these results aid in the attainment of the goals of smart education which are to create self-directed, motivated, adaptive, resource-enriched, and technology-embedded learning.

These four factors should be evaluated synchronously because each factor is not independent but interdependent. When deciding what makes an app good, the four criteria identified by this study should be considered systemically. Even if there is another opinion that the price of app may not be linked to the quality of the app (Walker, 2011), the economy aspect of the app is very important especially to the decision makers related with buying the app. As Pope Francis said, "Internet is a gift from God, but the obsessive desire to stay connected can actually isolate people from their friends and family," the evaluation tool of educational apps also should consider two sides of the coin, that is, impediments (e.g., advertisement, buying content, immorality) as well as affirmative factors (e.g., pedagogical scaffolds). By considering concerns that instruction and technology should be more focused, however, it can be recommended that score criteria should reflect more weighted value in the area of instruction and technology rather than economy and ethics.

In summary, four factors for evaluating educational apps (Teaching & Learning, Screen Design, Technology, and Economy & Ethics) can greatly benefit those engaged in smart learning as they seek theoretical guidance for their practices and transactions in real-world situations. The factors were thus developed to assess the effectiveness and efficiency of educational apps in support of smart learning, rather than focusing on the functions and features of apps. Consequently, despite the limitations of the present study in sample size and the relatively narrow room for generalization imposed by the limits of convenience sampling, the evaluation model herein proposed can play an instrumental role in assessing educational apps' effectiveness. There were other limitations identified within the research. First, this study does not consider fully the learners' physical and educational capabilities. Therefore, adjustments are needed for the evaluation tool to be fully effective in the target population. Second, the educational apps as an object of the evaluation tool in this research, only pertain to *game apps* although there are various kinds of apps such as tutorial, game, augmentation, search and process information, watching video, and so forth. That is why it is impossible to develop a tool for evaluating all kinds of educational apps, which have different characteristics respectively.

Future research needs to focus on the empirical validation of the evaluation tool. It is recommended that future studies duplicate these results of this study by applying this evaluation tool to similar and not so similar student population and applications. This will lead to more elaborate models specific to educational apps. Additionally, various types of learning objectives should be developed for educational application at each the class level. There is also the need to conduct research with teachers and developers to compare this study's results with students for improving the evaluation tool generated herein.

Appendix: Evaluation Criteria for Educational Apps

Factor	Subfactor	Item	
Teaching & Learning	Motivation self-directedness authenticity	A1	Does an app provide rewards properly after the learner solves problems given?
		A2	Is an app funny and interesting?
		A3	Is an app exciting and imaginative?
		A4	Does an app provide cooperation, competition, and approval?
		A5	Does an app offer proper opportunity for user to access correct answer despite of trial and error?
		A6	Does an app include an advance stage?
		A7	Does an app have the function identifying user's present progress?
		A8	Can user change the app according to his or her own preference?
		A9	Does an app provide a guideline about it?
	Cognitive development	A10	Is the content of an app applicable to real life?
		A11	Is an app helpful for improving user's cognition?
		A12	Does an app provide new knowledge?
		A13	Does an app promote reasoning, thinking and creative skills?
Screen Design	Suitability of design	B1	Does its color of a screen have a good feel and look?
		B2	Is its design simple and consistent?
		B3	Is its icon designed intuitively?
		B4	Is its style of picture and letter evident?
		B5	Does an app's design structure reflect the characteristics of app?
		B6	Is the arrangement of operating buttons appropriate?
	Accuracy of vocabulary	B7	Is its grammar and spelling accurate?
		B8	Is its direction clear?
Technology	Interoperability of system	C1	Is an app operable at other operating systems?
		C2	Is an app operable at other devices?

(continued)

Continued

Factor	Subfactor	Item	
		C3	Is the loading time of an app appropriate?
		C4	Can user manage an app according to his or her intention?
	Stability of system	C5	Does an app provide the velocity of progress?
		C6	Does an app have any error?
Economy & Ethics	Economical efficiency	D1	Does an app include unnecessary advertisement?
		D2	Is the cost of an app appropriate?
	Ethicality	D3	Does an app include morally biased contents?
		D4	Does an app include violent and lascivious contents?
		D5	Does an app keep the copyrights?
		D6	Is an app free from the fear of data spill?

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Note

1. One of the most conservative approaches, regarding sample size, has been proposed by Boomsma (1982), who has recommended that a sample size of at least 200 be collected before any attempt at factor analysis. However, a more liberal estimation of appropriate sample size includes the formula a $N-n-1$ greater than or equal to 50, where N is the sample size and n is the number of variables (Kim & Lee, 2008; Ledakis, 1999). In this study, N is 156 and n is 33 (items). Consequently, the sample size of the present study can be justified from the viewpoint of a liberal approach.

References

Boomsma, A. (1982). The robustness of LISREL against small sample sizes in factor analysis models. In J. Karl & W. Herman (Eds.), *Systems under indirect observation: Causality, structure, prediction* (pp. 149–174). Amsterdam, The Netherlands: North-Holland.

Brian, M. (2011). *Mobile apps: A look at what makes a good app great*. Retrieved from http://thenextweb.com/mobile/2011/07/16/mobile-apps-a-look-at-what-makes-a-good-app-great

Ching, Y. H., & Hsu, Y. C. (2013). Mobile app design for teaching and learning. *International Review of Research in Open and Distance Learning*, *14*(4):117–139.

Chiong, C., & Shuler, C. (2011). *Learning: Is there an app for that? Investigations of young children's usage and learning with mobile learning and apps*. New York, NY: The Joan Ganz Cooney Center at Sesame Workshop.

Delimarsky, D. (2011). *What makes an app a good app—7 pointers*. Retrieved from http://dotnet.dzone.com/articles/what-makes-app-good-app-10

Falloon, G. (2013). Young students sing iPads: App design and content influences on their learning pathways. *Computers & Education*, *68*, 505–521.

Goodwin, K., & Highfield, K. (2012). iTouch and iLearn: An examination of educational apps. Paper presented at *the Early Educational and Technology for Children Conference*, March 14–16, 2012, Salt Lake City, Utah.

Hedman, J., & Gimpel, G. (2010). The adoption of hyped technologies: A qualitative study. *Information Technology Management*, *11*, 161–175.

Jang, E. J., Park, Y. S., & Lim, K. (2012). Research on factors effecting on learners' satisfaction and purchasing intention of educational applications. *Journal of Contents Association*, *12*(8):471–483.

Jeong, S. J., Lim, K., Sim, H. A., & Kim, K. Y. (2010). The analysis of trends in smart phone applications for education and suggestions for improved educational use. *Journal of Digital Contents Society*, *11*(2):203–216.

KERIS. (2012). *2012 White Paper (PM 2012–2013)*. Seoul, Korea: Korea Education & Research Information Service.

Kim, D. E., Han, W. C., & Choi, T. Y. (2012). *A study on the educational utilization of smartphone*. Paper presented at 2012 Summer Conference of the Korea Society of Computer Information, Seoul, Korea. *19*(2), 421–422.

Kim, S. W., & Lee, M. G. (2008). Validation of an evaluation model for learning management systems. *Journal of Computer Assisted Learning*, *24*(4):284–294.

Kim, S. W., & Lee, M. G. (2012). Utilization of digital textbooks in Korea. In T. Goh, B. C. Seet & P. C. Sun (Eds.), *E-books and e-reader devices for e-learning* (pp. 90–125). Victoria, New Zealand: Victoria University of Wellington.

Ledakis, G. (1999) *Factor analytic models of the Mattis* Dementia Rating Scale in Dementia of Alzheimer's type and vascular dementia patients. (Unpublished doctoral dissertation). Drexel University, Philadelphia, PA.

Lee, J. S., & Choi, J. H. (2012). Implementation of application for vocabulary learning through analysis of users needs using smart phone. *The Journal of Korean Association of Computer Education*, *15*(1):43–53.

Lee, M. S., & Park, D. H. (2012). A game to learn mathematical formulas based on android for G-learning. *Journal of Computing Practices and Letters*, *18*(11):768–773.

Lee, W. H. (2012). A practical use of touch interface design for educational applications—Focus on smart phone apps for children. *Journal of Korea Society of Design Forum*, *36*, 379–388.

Maddux, C. D. (1986). The educational computing backlash: Can the swing of the pendulum be halted? *Computers in the Schools*, *3*(2):27–30.

Malone, M., & Peterson, M. (2013). Is there an app for that? Developing an evaluation rubric for apps for use with adults with special needs. *The Journal of BSN Honors Research*, *6*(1):39–56. Retrieved from http://archie.kumc.edu/handle/2271/1177

Raymer, M. (2013, September 7). Spilling secrets via the social web. *Fortune*. Retrieved from http://fortune.com/2013/09/27/spilling-secrets-via-the-social-web

Rogers, J. (2013). *Tim Cook announces more massive App Store numbers*. Retrieved from http://isource.com/2013/10/22/app-store-mumbers

Shuler, C. (2012). *iLearn: An analysis of the education category of the iTunes App Store*. New York, NY: The Joan Ganz Cooney Center at Sesame Workshop.

Solomon, G., & Schrum, L. (2007). *Web 2.0—New tools, new schools*. Washington, DC: International Society for Technology in Education.

Vincent, T. (2012). *Ways to evaluate apps*. Retrieved from http://learninginhand.com/blog/ways-to-evaluate-educational-apps.html

Walker, H. (2011). Evaluating the effectiveness of apps for mobile devices. *Journal of Special Education Technology*. Retrieved from http://ttools.com/technology/evaluation-apps.pdf

Yang, S. Y. (2011). Analysis of usability of educational application based on UX. *Journal of Korea Design Knowledge*, *20*, 296–306.

Zwang, J. (2011, Janurary 7). 10 of the best apps for education. *eSchool News*. Retrieved from http://www.eschoolnews.com/2011/01/07/10-of-the-best-apps-for-education

Author Biographies

Jeong-Sook Lee is a teacher of Sohwa Elementary School, Korea. She taught computer at Anseong Gaon High School. She got MA in Education (Computer Education) in Ajou University.

Sung-Wan Kim is a professor of Korea Nazarene University and he was a professor of e-Learning and computer education at Graduate School of Education, Ajou University in Korea. He received a PhD in Instructional Technology from Yonsei University in Korea. His research interests are instructional design, e-learning 2.0, and diffusion of innovations.