Pedagogical and user interface usability evaluation of an educational mobile app that promotes visual literacy

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ABSTRACT

Visual is a mobile app designed and developed to use as a resource to support a blended learning course of visual literacy for in-service teachers. The main goal of the *Visual app* is to help participants to achieve better comprehension about the theoretical content by doing the app activities. Hence, as a personal learning environment, the quality of this resource should be evaluated to identify flaws and to improve the educational content and the interface if necessary. In consequence, users will learn with the app and do not waste time learning how to use it or doing activities without an educational purpose.This paper presents the results of the pedagogical and user interface usability evaluation of the *Visual mobile app.* Five judges were asked to assess the app by using a questionnaire to evaluate the quality of M-learning apps. This instrument assesses both pedagogical and user interface usability. Results confirm that the *Visual app* current version works as a minimum viable product, so it reaches the learning objectives set and has a user interface that makes easy the navigation and the usage.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); HCI design and evaluation methods; Usability testing; • **Applied computing** → Education; Interactive learning environments.

KEYWORDS

Visual literacy, mobile learning, educational apps, teacher training, usability testing, pedagogical usability, user interface usability

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1 INTRODUCTION

In today's digital era, countless educational apps flood the mobile applications market offering learners some support to their learning needs. This fact is a consequence of the growing number of mobile devices users in the world which has increased the demand for mobile apps [7]. More than half of the world's population owns a mobile device [26], even in developing countries. Thus, UNESCO has focused on mobile technology to support teachers training and help them to become effective and well-qualified teachers for learners [26].

M-learning seems to be an appropriate complementary method to other forms of course delivery [18] because mobile technology has matured and makes more efficient this model of learning [5]. However, the integration of mobile technology in the teachers training requires proper curatorship of current tools such as mobile apps, and the deepest evaluation of new ones, such as the *Visual* app. To illustrate, educational apps could look attractive, but they could not be effective in their pedagogical goal. Thus, it is crucial to assess learning tools to ensure that the educational experiences in these learning environments remain effective [22] because learning is likely tied to the task design [10].

On the other hand, educational apps could have well-developed learning activities, but not a familiar, attractive, and easy to use interface. This factor could have a deep impact on learning because aesthetics could affect the user´s perception about usability and the correlation between both remains strong after the usage [9].

Usability is a term that indicates how easy a user can use a software application [13] to achieve a defined goal effectively, efficiently, and satisfactorily [27]. The usability evaluation of educational apps is crucial because these tools are mobile learning environments that could enhance learning in any level of education [14, 18, 25], increase learner's motivation [3], and even help teachers to conduct positively their teaching practice [19]. Therefore, it is essential to consider educational, pedagogical, and usability factors to facilitate and support learning activities [21].

The Visual app was designed by the instructor of a blended learning course of visual literacy to help learners to increase the understanding of themes which were based on principles of Graphic Design [16, 17]. Visual literacy is one of the most important skills that should be developed by teachers and learners in the twenty-first century [4, 15] because new modes of communication and new literacies are much more than textual [12, 23]. In our digital and technological today's world, there a few aspects that do not have digital images and nontextual formats [20]. Hence, evaluating Visual app became a major challenge because its content core is related to effective visual communication and visual literacy improves the teaching and learning process [1]. Consequently, the

Table 1: Evaluation criteria

Score	Reference
4.5 – 5.0	Excellent compliance
3.5 – 4.49	Good compliance
2.5 – 3.49	Average compliance
1.5 – 2.49	Poor compliance
0 – 1.49	Very poor compliance

usability evaluation of the Visual app should be conducted with a tool that assesses the high quality of its essential aspects.

2 EVALUATION PROCESS

2.1 The evaluation tool

The *Visual app* usability evaluation was conducted by using CECAM, a questionnaire to evaluate the quality of M-learning apps [21]. This evaluation tool assesses the two crucial factors of educational apps: the pedagogical usability and the user interface usability. To evaluate these factors, several constructs were set and evaluated through a specific number of items.

- Pedagogical usability:
- Educational content (6 items).
- Multimedia resources (7 items).
- Educational activities (8 items).
- Social interaction (4 items).
- Personalization (4 items).
- User interface usability:
- Interface design (6 items).
- Navigation (9 items).
- Customization (6 items).
- Feedback (6 items).

The questions are closed-ended, and the respondent has to choose one option of a 5-point Likert scale to indicate the extent of agreement.

- 1 = Strongly disagree.
- 2 = Disagree.
- 3 = Neither agree nor disagree.
- 4 = Agree.
- 5 = Strongly agree.

CECAM's author indicates that each construct could have a score ranging from 0 to 5 and the criteria to judge the results are shown in Table 1

2.2 Judges Selection

Researchers took two criteria [8] into account to select the five judges who evaluated the *Visual app* over a week.

- Professional excellence: Judges should be professionals who have extensive work and research experience in the field of ICT in Education and Computer Science. Thus, they should have a high level of digital competency.
- Geographical diversity: The experts' professional development should carry out in different contexts.

Thus, the experts selected were a system engineer who performs the educational content layout and the management of virtual learning environments, two teachers who are experts in ICT in Education, one university virtual tutor, and an engineer who performs virtual training to professionals. All of them have reached a Master Degree in their field and have worked in some countries like Ecuador, Spain, Italy, and the Dominican Republic.

CECAM questionnaire was created and sent online via Google Forms. Responses were automatically collected through this tool.

3 RESULTS

3.1 Pedagogical Usability Evaluation

The general mean (4.40) of the first construct: *Educational content* is considered as *Good compliance*. Item 6 has the lowest score (3.60) in this whole block. This item evaluates if the *Visual app* has links to external resources. This specific result calls *Visual app's creator* to analyze if this functionality could enhance the learning of users while using the app. See Table 2

Table 3 shows the results of the second construct which general mean (4.60) is considered as *Excellent compliance*. Item 5 obtained the lowest score (4.00), yet it is not poor compliance. However, it will be necessary to analyze the option to download the multimedia resources.

The general mean (4.60) of the third construct: *Educational activities* is the same that the previous, so it can be also considered of *Excellent compliance*. Details are shown in Table 4

Item 8 holds the lowest evaluation (4.20), but it is not valued as deficient. This result makes *Visual app's* creator to think that the app's educational activities could be enhanced by taking advantage of the affordances of mobile devices technology.

The general result (mean=4.00) of the *Social Interaction* construct indicates *Good compliance*. Item 2 and item 3 stand out for their lower score because the app does not have a messaging service and does not allow users to share information. See Table 5

The addition of these functionalities should be analyzed carefully, specifically, the messaging service because there are powerful messaging apps that can be used at the same time when required. Thus, it will be important to analyze the option that allows users to share information through most used messaging and social network apps.

The general results of the last construct: *Personalization* indicates *Good compliance*. See Table 6

Item 4 holds the lowest score, but it is not poor compliance. However, the *Visual app's creator* should review the option that allows users the establishment of study goals.

In general, the mean values of *Pedagogical usability's* five constructs are between *Good compliance* and *Excellent compliance* as shown in Figure 1

Each item's evaluation is substantial feedback to future improvements of *Visual app's* current version.

3.2 User Interface Usability Evaluation

The evaluation results of the *Interface design* construct indicate *Excellent compliance*. Due to the evaluation of item 5, it is crucial to check that the content adapts and fits correctly in most mobile devices' screens size. See Table 7

Table 2: Educational Content evaluation results

	Educational Content	N	Mean	Sx
1	The content is organized in small modules or units.	5	5	0.00
2	Learning objectives are well defined at the beginning of a module or unit.	5	4.80	0.44
3	The required prior knowledge is made known, if necessary.	5	4.20	1.30
4	The explanation of the concepts is presented clearly and concisely.	5	4.40	0.89
5	The modules/units are organized according to the level of difficulty (from easy to difficult).	5	4.40	1.34
6	There are links to external resources related to the content and adapted for mobile devices.	5	3.60	1.67
			4.40	

Table 3: Multimedia Resources evaluation results

	Multimedia Resources	N	Mean	Sx
1	Different multimedia resources related to the learning objectives are presented.	5	4.80	0.44
2	The multimedia resources have been properly selected to facilitate learning.	5	5.00	0.00
3	The multimedia resources have a duration of less than 7 minutes.	5	4.60	0.54
4	The multimedia contents have good quality video, audio, and images.	5	4.60	0.54
5	The multimedia resources can be downloaded to the mobile device.	5	4.00	1.73
6	The multimedia resources have the appropriate size to be downloaded to the mobile device.	5	4.40	0.89
7	There is an appropriate proportion of multimedia resources.	5	4.80	0.44
			4.60	

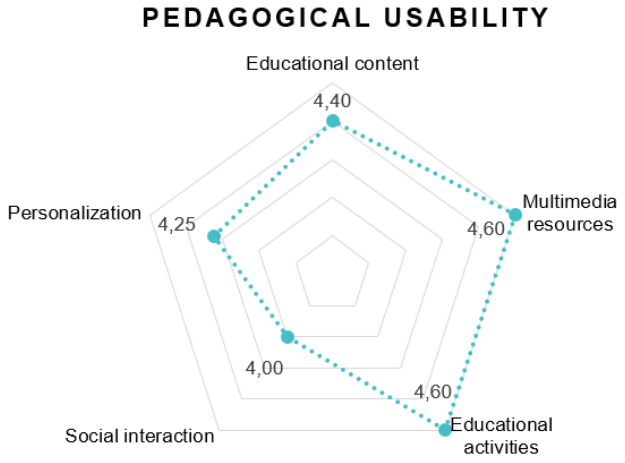

Figure 1: Global results of the Pedagogical Usability Evaluation

Over time, users' feedback will be invaluable to make improvements to this specific issue.

The general mean (4.78) of *Navigation* evaluation indicates *Excellent compliance*. Thus, this construct has the best score in the whole evaluation. Nevertheless, the result of the lowest scored item (9) uncovers the need to think about adding a search option icon to help users to find content (see Table 8).

The whole result (mean=3.00) of *Customization* evaluation is the lowest in the whole questionnaire and each item's evaluation stands out because of their low score regarding the results of previous items. Indeed, the current version of the *Visual app* requires several improvements to offer the user the different customization options that have been evaluated for each item. For example, changing the font size, changing the background color, choosing between different languages, among others. See Table 9

Finally, the results of the whole *Feedback* evaluation indicate *Good compliance* (mean=3.97). Item 6 holds the lowest score (3.00) from the judges because the current version of the *Visual app* does not allow sharing the user's achievements in social networks.

On the other hand, the item 5, which evaluates if the app allows users to accumulate points after the activities, holds a score (3.40) that calls our attention. This result suggests that the activities performed correctly should reflect a specific score, so showing the number of well-done responses could be not enough to indicate users' achievement. Details are shown in Table 10

Broadly speaking, the mean values of the four constructs of the *User interface usability evaluation* are between *Average compliance* and *Excellent compliance*. Here, there are the highest (4.78) and lowest constructs score (3.00) in the whole questionnaire, as shown in Figure 2

Table 4: Educational Activities evaluation results

	Educational Activities	N	Mean	Sx
1	Activities are proposed to acquire new skills that determine their learning.	5	4.60	0.54
2	The activities facilitate the understanding of the educational content.	5	4.80	0.44
3	The learning activities help to improve or strengthen skills.	5	4.60	0.54
4	The activities allow students to integrate new information with previous learning.	5	4.80	0.44
5	Activities reflect practices relevant to real-life or professional life.	5	4.60	0.54
6	Activities are congruent with students' abilities (not too easy, not too difficult).	5	4.40	0.54
7	Activities are available to evaluate the learning of educational content (e.g., tests, exercises, etc.).	5	4.80	0.44
8	The activities take advantage of the functions provided by the use of mobile devices (taking pictures, recording videos or audios, augmented reality, simulations, QR codes, etc.).	5	4.20	0.83
			4.60	

Table 5: Social Interaction evaluation results

	Social Interaction	N	Mean	Sx
1	There are opportunities for students to do projects or group work.	5	4.00	1.73
2	The app allows users to communicate with other colleagues or teachers to solve doubts about the contents (chat, email. etc.).	5	3.60	1.67
3	The app allows users to share information, photos, videos, or documents related to their work to discuss them (e.g., through social networks, blogs, wikis, etc.).	5	3.80	1.78
4	The system allows users competitive opportunities between them (e.g., displaying the achievements of the most outstanding students in a study group).	5	4.60	0.54
			4.00	

Table 6: Personalization evaluation results

	Personalization	N	Mean	Sx
1	The app allows students to create their learning paths.	5	4.20	1.30
2	The app allows the evaluation of the student's current knowledge and suggests contents to study depending on those results.	5	4.60	0.54
3	The app allows users to choose different levels of complexity.	5	4.20	1.78
4	The app allows students to set study goals (e.g., daily or weekly minutes).	5	4.00	1.73
			4.25	

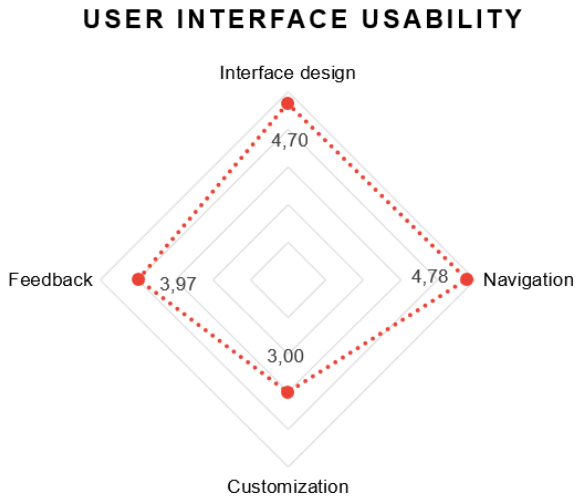

Figure 2: Results of User Interface Usability Evaluation

4 CONCLUSIONS AND FUTURE WORK

Pedagogical and user interface usability evaluation through the CECAM questionnaire has given *Visual app's* creator an excellent feedback about the functionalities that can be added to enhance the learning and improve the user experience. Not only by reviewing the lowest scored items, but by analyzing all the items.

According to judges' evaluation of the *Pedagogical usability* constructs, the *Visual app* achieves successfully its learning goal. However, some functionalities could be added or upgraded, such as links to external resources, the option to download multimedia, the exploitation of the affordances of mobile technology, and the options for sharing information and establishing study goals.

The evaluation of *User interface usability* constructs indicates slightly extreme scores. On one hand, the *Interface design* and *Navigation* constructs have the highest mean scores. However, some aspects should be checked to upgrade. For example, the correct visualization of *Visual app* in most mobile devices' screen sizes and the addition of a content search tool. On the other hand, the *Customization* construct received the lowest score because the *Visual*

Table 7: Interface Design evaluation results

	Interface Design	N	Mean	Sx
1	The interface design has a pleasant and attractive aesthetics.	5	4.60	0.54
2	The typeface, size, and tracking make the information easy to read.	5	4.60	0.54
3	The design has an appropriate number of colors and does not generate visual fatigue.	5	4.80	0.44
4	The color contrast is adequate.	5	4.80	0.44
5	The information is adjusted or adapted to the screen size.	5	4.40	0.89
6	The interface design is consistent in font style and size, buttons, colors, etc.	5	5.00	0.00
			4.70	

Table 8: Navigation evaluation results

	Navigation	N	Mean	Sx
1	The main menu and main options have appropriate visibility.	5	4.80	0.45
2	The navigation is simple, familiar, and intuitive.	5	4.80	0.45
3	The desired content or basic tasks are accessible from the home page in three or fewer clicks.	5	5.00	0.00
4	The app informs the user at any time which part of the process he is in.	5	5.00	0.00
5	The size and proximity of the touch buttons or selection controls are suitable for easy finger selection.	5	4.60	0.55
6	The location of the touch buttons or similar is reachable using mainly a single hand.	5	5.00	0.00
7	Icons or action elements are familiar and intuitive (the user knows what they represent).	5	4.80	0.45
8	The app clearly shows the option to return to the main menu.	5	4.60	0.89
9	The app clearly shows the search option to help students find content.	5	4.40	1.34
			4.78	

Table 9: Customization evaluation results

	Customization	**N**	**Mean**	**Sx**
1	The app allows users to change the size or font.	5	3.00	2.00
2	The app allows users to change the background screen color and the font color.	5	3.00	2.00
3	The app provides advanced configuration options, and they are easy to find.	5	2.80	1.79
4	The app allows users to choose between different languages.	5	2.80	1.79
5	The app allows user to choose different input and output modes (e.g., voice recognition, subtitles in videos, etc.)	5	3.00	2.00
6	The app provides basic functionalities on the content (e.g., underline or highlight text, make annotations, copy and paste, etc.).	5	3.40	1.67
			3.00	

app does not yet allow users to customize the app according to their preferences and needs. To illustrate, there are no options to change the font size, the background color or the app language. In addition, *Feedback* construct functionalities should be reviewed because it seems important that *Visual app* allows users to share their achievements in social networks and to sum points to get a score.

Nevertheless, the general evaluation of the *Visual app* indicates that the version created for participants to use during the visual literacy course has the necessary functionalities to aim the learning objective set. That is, to promote visual literacy by doing activities

Table 10: Feedback evaluation results

	Feedback	N	Mean	Sx
1	The app provides accurate feedback about system status (e.g., a status bar reporting the progress of an action).	5	4.60	0.55
2	The app shows the general progress of the student (e.g., provides information about the units already mastered and what remains to be completed).	5	5.00	0.00
3	If the student makes a mistake during self-assessments, the app offers explanations about the correct solution.	5	4.20	1.79
4	The app provides information about possible actions that may have undesired effects (e.g., warnings or confirmations to prevent errors).	5	3.60	1.52
5	The app allows the accumulation of points after participating and/or completing activities.	5	3.40	2.19
6	The app provides options to share in social networks the significant advances or achievements made.	5	3.00	2.00
			3.97	

aligned with theoretical and technical content addressed during the course. Indeed, the current version of *Visual app* is a Minimum Viable Product (MNV), which means that it carries just enough functionality to satisfy customers and to gather feedback for subsequent development with the least amount of effort and time [24].

Clearly, this version is the starting point to design and develop an app with more functionalities, activities, and themes to promote visual literacy. Some improvements will have to be made based on ongoing users' feedback and will require proper coordination with the instructor/s, the interface designer, and the developer. However, it is essential to point out that mobile technology is permanently renewed, so the number of affordances for educational purposes will be increasing every time. Hence, a single app could not integrate the multiple affordances in a single learning environment [6].

Broadly speaking, mobile technology for learning still faces the challenge [2] of being a tool to enhance learning. Therefore, educational mobile apps have to be designed, developed, tested, and evaluated based on learners' learning goals and usability. Through this experience, the authors want to reaffirm the need to evaluate the resources that will be used in the educational process. Particularly, those which have been designed by the instructor. In this case, the corresponding author was the creator and the interface designer of the *Visual* app.

Finally, *Visual app* is a remarkable contribution to the educational apps' market because there is not a tool for supporting a learning process of visual literacy. Moreover, the app is free, and it is available for users of different operative systems. Thus, future work should focus on making *Visual app* an autonomous learning resource to develop visual competency [11] and to evaluate the level reached by the users after using it. Furthermore, it will be essential that users perform the pedagogical and user interface usability evaluation with the CECAM questionnaire.

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