

A Method for Building Massive Open Online Courses for Elderly People

MOOCEP: From the User Perceptions

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Abstract— This Research Full Paper presents the user perceptions when elderly people use a MOOC which was built by using the method for building massive open online courses for elderly people (MOOCEP).

Context: Currently, the elderly population has increased in respect to the total population. According to Administration on Aging (AoA) for the year 2060, the elderly population will be double than presented in the results of the last census. Likewise, a reduced proportion of the population of elderly people is involved with technology or have a very close relation with it. However, the universal access to technology is important in the field of education and interactive systems due to the need of promoting the equality of opportunities for all. Moreover, it is considered that the effectiveness of e-Learning consists in knowing about the learning objectives of users and their needs. As a result of that, it is important to know the perceptions when users adopt any technology. The creation of a method for building massive open online courses (MOOCs) for elderly people named MOOCEP considers andragogical strategies to improve learning objects. This methodology has five tasks aligned to ADDIE method (i.e., Analysis, Design, Development, Deployment, and Evaluation). It presents a flexible and extensible solution, adaptable to any specific situation, to design and create effective MOOCs, which takes into consideration, that the e-learning process can vary considerably in complexity and size, depending on interest and needs of its target of people.

Objective: In FIE 2017, it was presented the analysis task, which is related to the learning techniques and involves different considerations (i.e., andragogy, accessibility). For this year's FIE, in order to provide evidence on the use of MOOCs built by using MOOCEP, a group of 36 subjects aged from 65 to 85 years old had participated and provided their perceptions and suggestions by means of a questionnaire that allow us to understand the acceptance of the artifacts created by using this method. The user perceptions that have been measured are related to the ease of use, usefulness and the intention to use in the future.

Method: In order to perform these tests, the Technological Acceptance Model (TAM) has been employed.

Results: The results have been favorable, and they provide insights that the method for building these artifacts allow the creation of easy to use and useful products, which can be considered as good technological elements to be employed for the education of elderly people.

Conclusions: The results are positive and concludes that MOOCEP allows the creation of appropriate MOOCs from the elderly people perceptions.

Keywords—MOOC; elderly people; software engineering; evaluation; perceptions

I. INTRODUCTION

Nowadays, the number of elderly people continues to grow at an unprecedented rate in relation to the total proportion of the population [1]. A lot of new tools have been created oriented to improve the quality of life related to the basic needs of that age group [2]. On the other hand, education is a need throughout the life of the individual. Dinevsky [3] stated that lifelong learning is an approach which provides equal opportunities to individuals by removing restrictions related to location, time, age, socio-economic status and education. Therefore, it is important to create solutions to disseminate knowledge to all targets of the population; especially to those that usually are not able to attend a specialized education center to update or acquire new learning that can improve their living conditions.

In order to improve this situation, solutions oriented to expand knowledge to a specific group of people have been created. Those tools are known as Massive Open Online Courses (MOOCs), which have been considered as a powerful environment with the capability to educate a large amount of people in a flexible way [4]. Those solutions are created and used, however most of them are oriented to a general target, without considering elderly people, their specific needs and limitations proper of their age [5]. In a previous study, it has been presented a method for building massive open online courses for elderly people (MOOCEP) [6]; however, it is necessary to validate and measure the perceptions during the

use of the MOOCs which were created by applying this method.

Like other technological solutions, MOOCs need to be evaluated in order to know their effectiveness and the fulfillment of their objectives [7]–[10]. Then, studies such as [10] assess the student participation, performance and opinions of a peer review task in a biomedical science MOOC. They evaluate data from approximately 200 students' topic summaries and 300 qualitative peer reviews of those summaries, and compare them to student demographic data (gender, age, employment status, education, national language); however, those studies do not measure the acceptance of MOOCs and the perceptions of their users. Moreover, the evaluated artifacts are oriented to general students without considering the elderly target. On the other hand, experiments related to different areas are carried out in order to measure the effectiveness of the MOOCs related to the learning. However, usability and ergonomics are not proved in detail. There are critical criteria to be considered when the group or people which the MOOC is created for, present specific needs.

Thus, measure perception through empirical validations form a great part of several studies, because the development of solutions is not only important but also necessary to prove the users' acceptance [11]. Then, Hartwick [12] emphasizes the increasing importance of theory testing for technology research, for which the evaluation of existing findings and solutions is desirable, particularly when the findings involve different technologies, and user populations contexts. Therefore, there is a Technological Acceptance Model (TAM) proposed by Davis [13], which is used to evaluate the perceived ease of use, perceived usefulness, and intention to use in the future of technological solutions when they are used by their stakeholders. In Selim [14] is presented an empirical evaluation using TAM, about the perceptions of learning online websites in a group of students. This study concludes that there is a perception of these websites as efficient learning tools. Another validation using TAM constructors to evaluate perceptions is presented in Hu [11], here the target evaluated were physicians and medical specialists to examine acceptance of telemedicine technology in treatments. This study concludes a good acceptance of methods; however, users perceived the solution as difficult to use because of a lack of an efficient connection between participants involved in the digital medical infrastructure. Therefore, TAM models can be applied in technology approaches in order to provide insights about users' perceptions to prove and therefore improve new developments.

Consequently, this paper presents an evaluation of MOOCs created by using the MOOCEP method, when used by elderly people. The measurements provide insights about the use of this method. It presents that is possible to create MOOCs that are perceived as easy to use, and which topics are useful. Also, elderly people found them interesting to be used for future learning; however, there are recommendations to be considered about the way in which they are presented. Those recommendations are being considered for future creations.

The structure of this paper is: in section 2, the related work is analyzed; section 3 presents a brief explanation about the

method and its tasks; section 4 shows the experiment design, and section 5 presents the evaluation of the MOOCs. Finally, section 6 presents the conclusion and further work.

II. RELATED WORK

Several authors have presented scientific works that relate to the topic of perceptions and evaluation from the user side when using a MOOC course. Konstan et al. [15] presented the evaluation of a course which was offered face to face to 39 students, while 4844 students were signed up online. In order to evaluate the MOOC, pre and post surveys were applied, both referred to the intention of the students on taking the class and also the knowledge about the topic. Through these surveys it was measured the usefulness of the MOOC, the interest on taking it and the level of completion of the course. There were not elders involved on this evaluation. Later, Gil-Jaurena, Callejo and Agudo [16] presented a study where they evaluated the 17 MOOC courses that were offered by the Spanish National University of Distance Education (UNED). The study was made through the application of an initial and final survey about the student's expectations for taking the course. Also, based on age, level of education, nationality, reasons for enrolling, expectations, whether it was the first time taking a course on MOOC format, the authors were able to make the profile of an average user of these courses. Finally, they were able to obtain several statistics, like number of enrolments, intention of finishing, interest on paying for a certificate, etc. It is worth mentioning that the initial survey was taken in 40768 students, while the final survey was submitted by only 5588 users. From this numbers, it was noted a small presence of elderly people, with a 1.8% from the initial group and 2% from the group that actually finished the courses. On a similar way, the authors of [10] presented the evaluation of a MOOC based on the students' perceptions and mainly on the peer review that was performed for the students on their peers as a final activity of the MOOC. Later on, these reviews were compared with the demographic profiling that was made on the students and to the answers to previous tests. The results showed that peer review as a way of evaluating performance on a MOOC still needs to prove its usefulness and reliability. Overall, the main way to evaluate a MOOC is through tests and questionnaires applied to the students, where the knowledge and perceptions about the course can be measured.

III. MOOCEP: A REVIEW ABOUT THE METHOD

Massive Open Online Courses (MOOCs) are a solution for expanding the knowledge in large scale [4]. Therefore, their public involves different kind of participants (e.g., children, young people, elderly people); however, each one of them has different needs and preferences. In order to provide improved ways of interaction with elderly people a method for building MOOCs for Elderly People (MOOCEP) was proposed in [17], and in an additional study, the analysis activity was explained in detail [18]. However, it is important to know the perception of the creation of MOOCs produced by using said methodology.

In order to clarify the main activities of MOOCEP, in this section, a brief explanation about this method and its advantages is provided.

MOOCEP presents a flexible and extensible solution, adaptable to any specific situation, to design and create MOOCs. It should take into account that the e-learning process can vary considerably in complexity and size depending on the needs of the public for which the e-learning solution is created [19]. Therefore, MOOCEP Method is divided into five main activities. Each activity is presented in Figure 1 with the artifacts and guidelines that it is formed. It is important to consider, that this method includes two different advantages for elderly people. On the one hand, the analysis activity contains andragogical techniques and strategies [18]; and, on the other hand, the design activity considers accessibility criteria oriented to elderly people [20], [21] which results on the fact that the MOOCs are easier to use.

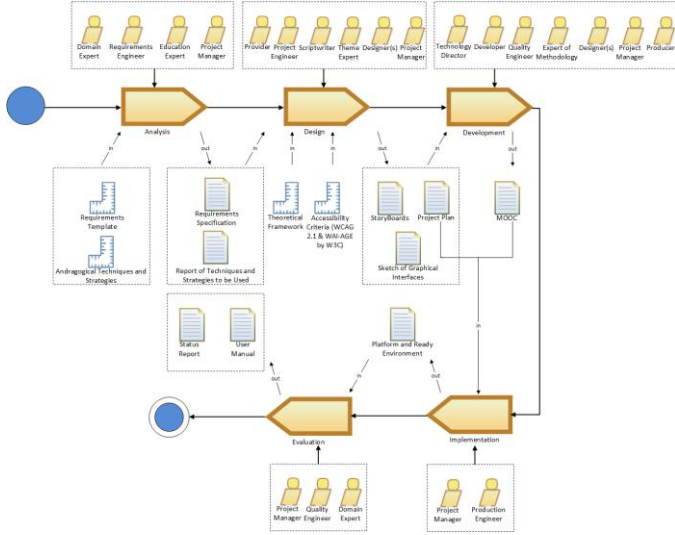


Figure 1. MOOCEP Method [17]

The analysis activity consists on: i) the course goals and needs that guide the creation of the MOOC, ii) the target audience analysis, iii) the identification and classification of the course content. Then, the design activity contains: i) the project planning using the requirements collected during the analysis, ii) the storyboards defined by the scriptwriter who writes them with the help of the theme expert, iii) the sketch of graphical interface, which is performed by the designer(s). It is important to clarify that the main difference between the analysis in this method versus traditional design is the inclusion of accessibility criteria oriented to elderly people, and the considerations obtained from the andragogical requirements stated in the analysis activity presented in [18]. Then, the development activity allows: i) the development of the content and multimedia (i.e., text, images, audios, interactions, animations, assessment, tests, and quizzes), which are selected according to the project plan, the storyboards and sketches. This development process can be guided by using any software development methodology. Then the deployment allows the delivering of the MOOC on the platform and their definitive environment. Finally, the evaluation of the activity when the MOOC is used, in order to

test the strengths and weaknesses of the final product before the definitive delivery.

IV. EVALUATION METHOD

In order to evaluate the acceptance of a MOOCEP creation, the Technology Acceptance Model (TAM), proposed by Davis [22] has been applied. This is a widely used theoretical model, which allows a measurement of the perceptions to determine the intention to use in the future of a new technology creation. TAM presents three main constructors [22] which are presented in Figure 2:

- Perceived Ease of Use (PEOU): the degree to which a person believes that using a particular method would be effort free. This constructor represents a perceptual judgment of the effort required to learn and use a technology creation; in this case a MOOC.
- Perceived Usefulness (PU): the degree to which a person believes that using a particular method would enhance his/her effectiveness doing a task, in this case, performing a learning activity. There is a causal relationship in the model which indicates that PU can be influenced by PEOU.
- Intention to Use (ITU): The extent to which a person intends to use a particular method in the future. This variable is used to predict the likelihood of a solution being accepted in practice.

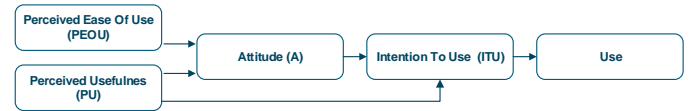


Figure 2. Technology Acceptance Model (TAM) [22]

To develop this evaluation, it is necessary to identify the hypotheses, which are focused on the constructors of the TAM.

- H1₀: The MOOC created by following the MOOCEP activities is perceived as difficult to use.
- H2₀: The MOOC created by following the MOOCEP activities is not perceived as useful.
- H3₀: There is no intention to use the MOOC created by following the MOOCEP method in the future.
- H4₀: There is not a causal connection between the perceived ease of use and perception usefulness.
- H5₀: There is not a causal connection between the perceived usefulness and the intention to use the solution in the future.
- H6₀: There is not a causal connection between the perceived ease of use and the intention to use the solution in the future.

The perception-based variables that we analyze in this experiment according to TAM model are described in the TABLE I.

Then, a questionnaire has been defined to measure the perception-based variables. These items were combined in a survey with 14 questions which are shown in TABLE II. The items were formulated by using a 5-point Likert scale, with the opposing-statement question format. Various items within the same construct group were randomized, to prevent systemic response bias. PEOU is measured by using five questions in the survey, PU is measured by using six questions in the survey, and ITU is measured by using three questions in the survey. Moreover, in order to ensure the balance of items, approximately half the questions were negated, in order to avoid monotonous responses.

TABLE I: PERCEPTION-BASED DEPENDENT VARIABLES

Variable	Description
PEOU	The extent that elderly people believe that learning through the use of a MOOC created following MOOCEP will be effort-free.
PU	The extent that elderly people believes that, using a MOOC created following MOOCEP method, will increase their knowledge.
ITU	The extent to which elderly people intent to use a MOOC created following MOOCEP method. This represents a personal judgment of the MOOC's utility.

TABLE II shows the questions applied to measure the perception-based variables, there are 14 questions, which were formulated using a 5-point Likert scale [12]. The validation process consists on denying each of the questions; five questions are used to measure the perceived ease of use (PEOU), six to measure the perceived usefulness (PU) and three to measure the intention to use (ITU), according to Figure 3.

TABLE II. SURVEY USED

Question	Statement Positive (5 points)
PEOU1	The MOOC is simple and easy to follow
PEOU2	In general, the MOOC is easy to understand.
PEOU3	The steps to complete the MOOC are clear and easy to understand.
PEOU4	The MOOC is easy to learn.
PEOU5	I consider it would be easy to learn about eating habits with these MOOCs.
PU1	I consider that these MOOCs would reduce the time and effort required to learn online courses.
PU2	In general, I consider the MOOC to be useful.
PU3	I consider MOOCs to be useful for learning about wellness and lifestyle.
PU4	I consider MOOCs to be expressive enough to learn about eating habits.
PU5	Using this MOOC would improve my learning about eating habits.
PU6	In general, I think that with this MOOC I can learn properly about wellness and lifestyle.
ITU1	Supposing that I would need to use a MOOC in the future, I will keep in mind these courses.
ITU2	If necessary, I would use this MOOC in the future.
ITU3	I would recommend the use of this MOOC.

V. EVALUATION OF THE MOOCs

The elderly people in Ecuador represent 6,5 % of the total population [23]. One of the important cities of Ecuador is

Cuenca. This city has some institutes and care centers that concentrate elderly people in order to provide them education, entertainment, health services, socialization, physical activities and more.

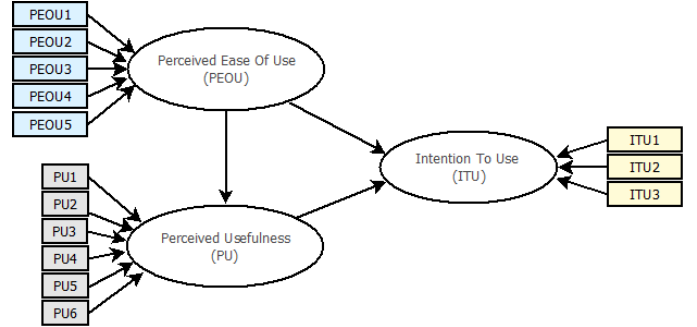


Figure 3. Constructors and Questions Associated

However, these institutes do not use specialized MOOCs or offer online education to elderly people in order to improve their education and the use of technology. In this context, these institutions have been visited in order to obtain the perceptions of a randomized population of 36 elders. These care centers are located in the urban zone of Cuenca. The random population consisted of 16 men and 20 women, aged between 65 and 85 years old. In order to perform the experiment, three tasks were defined:

Task 1: The MOOC was developed using MOOCEP method. It is accessible via internet through the following URL: <http://pam.cedia.org.ec/capacitaciones/>. Additionally, 18 tablets were available to be used for the elders. The tablets have the following characteristics: Inco model Aurora II, Android 5.1 Lollipop, 7-inch display.

Task 2: the subjects were divided onto 2 randomized groups of 18 subjects each one. The tablets were delivered to them and they proceeded to complete the MOOCs.

Task 3: Once task 2 was done, the tablet was collected and a survey was applied to each participant. The data was collected and tabulated.

The experiment tasks were completed by the participants and Figure 4 shows the values about perceived ease of use (PEOU), perceived usefulness (PU) and intention to use (ITU) of the MOOC, the variables are higher to the neutral variable (3) defined on the Likert scale (1-5); where 1 is the worst, and 5 is the best. However, certain outliers have been found, with the id (3, 13, 15, 22 y 23); these values were eliminated, considering that the participants had difficulties in understanding the questions or in handling the device.

TABLE III, shows the equivalent values of each of the variables of the TAM. Shapiro Wilk [24], stated that, there is not a normal distribution, and p-value shows a high significance in the three perception variables. Therefore, each hypothesis has been rejected. Also, the PEOU variable has a minimum value of 3.00, a maximum value of 5.00, and an average value of 4.37. These results show that the MOOC has been perceived by the participants as easy to use, therefore the hypothesis $H1_0$ is discarded.

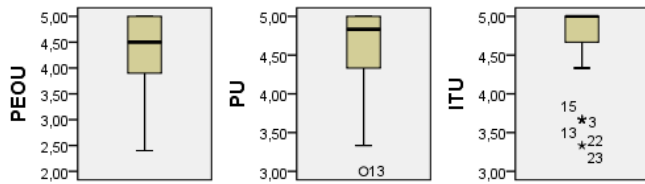


Figure 4. Box-plots for PEOU, PU and ITU variables.

Moreover, the PU variable has a minimum value of 3.33, a maximum value of 5.00 and an average value of 4.66; this shows that users perceived the MOOC as useful, therefore the hypothesis $H2_0$ is discarded. The ITU variable has a minimum value of 4.33 and a maximum value of 5.00 and an average value of 4.86; this shows that users intend to use the MOOC in the future, therefore the hypothesis $H3_0$ is discarded.

TABLE III. SHAPIRO-WILK TEST FOR THE PERCEPTION-BASED VARIABLES

	Min	Max	Mean	Std. Dev.	Std. E.	Shapiro Wilk	p-value
PEOU	3.00	5.00	4.37	0.64	0.1153	0.001	.000
PU	3.33	5.00	4.66	0.41	0.0735	0.000	.000
ITU	4.33	5.00	4.86	0.22	0.0402	0.000	.000

TABLE IV, shows that the causal relationships of perceived ease of use and perceived usefulness, has a significant value of 0.001 and R^2 shows that the variable PEOU explains 15.7% of the variance in PU.

TABLE IV. SIMPLE REGRESSION BETWEEN PEOU AND PU

Model	non-standardized coefficients B	Std. E	standardized coefficients Beta	T	Sig.	R	R^2
1 (Constant)	3.55	0.480		7.406	0.000		
PEOU	0.25	0.109	0.397	2.327	0.027	0.397	0.157

TABLE V Shows causal relationships of perceived usefulness and perceived intention to use, it shows a significant value of 0.297 and R^2 shows that the variable ITU explains 3.7% of the variance in PU.

TABLE V. SIMPLE REGRESSION BETWEEN PU AND ITU

Model	non-standardized coefficients B	Std. E	standardized coefficients Beta	t	Sig.	R	R^2
1 (Constant)	4.367	0.466		9.361	0.000		
PU	0.106	0.100	0.193	1.062	0.297	.193	.037

Finally, TABLE VI Shows causal relationships of perceived ease of use and intention to use, it shows a significant value of 0.070 and R^2 shows that the variable ITU explains 10.8% of the variance in PU.

TABLE VII. SIMPLE REGRESSION BETWEEN PEOU AND ITU

Model	non-standardized coefficients B	Std. E	standardized coefficients Beta	t	Sig.	R	R^2
1 (Constant)	4.358	0.270		16.127	0.000		
PEOU	0.115	0.061	0.329	1.878	0.070	0.329	0.108

As it has been shown, by means of the significance (i.e., 0.027) of PEOU and PU there is a causal relation between those variables, and therefore the hypothesis $H4_0$, is discarded; on the other hand, the significance between PEOU and ITU (i.e., 0.070) and PU and ITU (0.297) is not enough to establish a causal connection between those relations, therefore $H5_0$ and $H6_0$ hypotheses cannot be rejected. Therefore, there are causal connections between: the perceived ease of use and perceived usefulness; and not between: i) the perceived ease of use and intention to use in the future of the MOOCs build by using MOOCEP, and ii) the perceived usefulness and the intention to use in the future of these solutions.

VI. THREATS TO THE VALIDITY

This section discusses the possible threats that could affect the results obtained on this study.

CONCLUSION VALIDITY: In order to prevent variations on the results due to the individualities presented by each subject, an heterogeneous group was selected, with the only constraint being the age group, since the study was focused on elderly people (age 65 and older). Another factor that was determined while using the MOOC was the easiness with which the elderly people forgot how to use the MOOC. This is mainly due to the fact that they are not digital natives, so they were afraid and presented some levels of stress about using the tablets; to reduce this point there was an introductory talk where the use of the MOOC was explained, and the applicant group offered constant support through the session. Also there was permanent support from the psychologists and care givers of the care center.

CONSTRUCT VALIDITY: The main threat that could affect this point is the validity of the test that was applied to the elderly people, and whether the questions were clear and have a level of cohesion among them, therefore the reliability of the test comes into question. To evaluate this, an analysis of Cronbach's alpha reliability test was performed on all the questions with limited sample before the final experiment. The results obtained for PEOU was 0.758, PU 0.810 and ITU was 0.857, therefore they are reliable since its values are greater than 0.7 [25]

INTERNAL VALIDITY: The main threats to internal validity are related to the subject's experience and the authors' bias and understanding of the tool. To minimize the first one, the subject's experience with the use of the MOOC, an initial training was provided to the group of elders about the use of the tablet and of the MOOC; also the support group at the care center was trained in order to help the elders when using the device, since they felt more at ease and comfortable asking the

people that they were more used to interact with. To reduce the risk of author's bias and the use of the tool, a test run was performed with experts on the use of the tool and MOOCs, so the usability of the tools was guaranteed.

EXTERNAL VALIDITY: The external factors that are seen as main threats to the results of the study are the experience of the participants, the design of the MOOC along with the way it is applied and the complexity that it presents to the subjects. In order to minimize the risk that could present the limited, and sometimes lack of experience of the elders working with technology, an intensive training was applied right before the application of the study, so the elders get used to the tablets and the technological environment. Also, the application group was offering constant support and ready to help with inconveniences. For the desing of the MOOC and the complexity of it, since the MOOC was developed using the MOOCEP model, which takes into account all these restrains from the beginning. About the complexity of the tasks, they were designed according the age and concentracion span of the elderly people, so this risk will not affect the results.

VII. CONCLUSIONS

In this paper, it has been performed a set of evaluations oriented to measure the perceived ease of use, perceived usefulness, and intention to use in the future of MOOCs built by following the MOOCEP methodology. The results provide us insights about the perceptions of elderly people. The evaluation was based on the Technology Acceptance Model (TAM) and its constructs. Moreover, we followed the Wohlin's methodology, which provides rigorous steps towards a formal evaluation. The obtained results present that the use of the MOOCs built with the MOOCEP method are 1) effort free, 2) perceived as useful in allowing the increase of the participant's knowledge, and 3) elderly people are encourage to use this kind of tools in order to improve their knowledge in different areas. However, it is important to consider that there are elderly people with advanced age that are not able to use in the same way that another elderly group the technology solutions; therefore, it is necessary to divide and segment the groups before to built and try with those creations. Finally, as further work, it is necessary to establish evaluations from the MOOCs builders' perspective.

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