ΣΟΦΙΑ-SOPHIA

Design and preparation of a questionnaire according to delphi method to select virtual laboratories (vls) (4)*

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Abstract

Selecting informatics tools to virtually work with the practical component in university education is a complex decision involving many factors. The purpose of this article is to describe the design, adaptation and validation of a questionnaire to select Virtual Laboratories –VLs. Methodology-Delphi expert consultation was used to identify criterions to determine the relevancy of LVs in higher education. For this purpose two groups of cooperative work were organized, and started from a structured questionnaire which criterions or variables were added or modified according to opinions given by experts during three successive rounds. The answers were statistically analyzed. A maximum correlation coefficient of $r = 0.93$ was obtained, showing a high degree of validity. The method of internal consistency with Cronbach's alpha coefficient of $r = 0.814$ and a confidence level of 95% ($p \leq 0.05$) was used for reliability, while for the method of two halves, the coefficient of internal consistency in Cronbach's alpha is the first half of 0736, and the second half of 0718, the coefficients resulting from the test halves show a high reliability index. Heading for administration was composed of 10 criterions.

It was concluded that the questionnaire prepared and confirmed for evaluation of the VLs is composed of valid and reliable features.

Key words: Reliability, virtual laboratories, DELPHI Method, questionnaire validation.

ΣΟΦΙΑ – SOPHIA

Introduction

In the Project titled "European Space of Higher Education" –ESHE, Acosta & Paez (2007), state that the students should be provided with useful knowledge, techniques and skills to be used in their practice upon completing their career, in such a manner, that ensures them a major professionalization and competitiveness when facing this globalized world. Therefore, the practical component in higher education is essential to develop competences. (UNESCO, 2012). Many institutions use education software as a training aid in their teaching-learning process (Diaz, 2002; Sicardi, 2004; Lee & Lee, 2007). For these informatic means to confirm or ensure development of proposed competences for any academic course, a careful selection is required (Sicardi, 2004; Lee & Lee, 2007). For such process, several check-lists are needed. Other authors have used quantitative techniques with a certain degree of interpretation and difficulty for their application (Verma, Gupta & Singh, 2008; Cataldi, Chiarenza, Dominghini, Donnamaria & Lage, 2012), with no consensus among the various proposals. Likewise, they do not explain the procedure to select variables. The need for consensus on characteristics or concepts at evaluation standards according to regulations, continues to be in effect. (Jadhav & Sonar, 2009).

In order to solve this type of complex problems Linston & Turoff, (1975), Okoli & Pawlowski, (2004), and Hurtado & Mendez (s.f.), propose Delphi technique as an effective method to structure and agree about a group communication process, which purpose is to resolve a complex problem, aided by experts previously selected. The purpose of the research was to design, create and validate a tool to select VLs, through a method of expert consultation, such as Delphi method

Theoretic perspective

Delphi method is based on the principle of collective intelligence, and consists of successive application of questionnaires to a group of experts in several rounds (Bruner, 2005; Hsu & Sandford, 2007). Between each round, results are statistically analyzed, and the answers are compiled into new questionnaires, which in turn, are redistributed to experts (Okoli & Pawlowski, 2004 and Hurtado & Mendez). The group of experts discusses, on anonymous basis, in order to prevent leader effects, the importance and pertinence of selected criterions; and obtain consensus through a mathematic procedure of aggregation of individual

judgment, by using questionnaires. The process ends when consensus, or stability or results is achieved (Luna, Infante & Martinez (2006). See Figure 1.

However, it is important to ensure that the instrument is valid and reliable for the research where it is going to be applied. Therefore, experts recommend to calculate the reliability statistic, Crongach's Alpha, or index of internal consistence, to estimate the accuracy used by a group of questions to measure the behavioral aspect, at reflecting the relationship among their elements (Hernandez, Fernandez & Baptista, 2006). The degree of concurrent validity is quantified by using Spearman-Brown's correlation coefficient.

The research was given a qualitative approach when data was collected without numerical measurement, and attributes-characteristics and the most common evaluation scales were identified, to build and evaluate a virtual practice (Hernandez, Fernandez & Baptista, 2003). A quantitative approach, following theoretic postulates proposed by Delphi Method, calculated the reliability of a questionnaire to evaluate VLs (Brunner, 2005; Luna and cooperators, 2005; Cruz, 2006). The methodological sequence of Delphi method is composed of three fundamental phases. See Figure 1.

Preliminary phase

In this phase two groups were organized differentiated as coordinator group, and group of experts, in charge of validate the designed instrument. The coordination group was organized parting from members of UNAD social research group, in charge of developing the research s proposed by several authors (Hsu & Sandford, 2007; Romero, Salicetti, 2011). This group was formed by two doctors of education and one industrial engineer. In this group; a) the topic of study was delimited parting from the research problem stated by the project PG-14, b) the group of experts was selected; c) cooperation commitment by such experts to the study was achieved, d) partial and final results of the research were interpreted, e) proper progress of the research was supervised, including adjustments and corrections, and f) the questionnaire was confirmed and implemented. See Figure 1.

Figure 1. Development scheme of Delphi method.
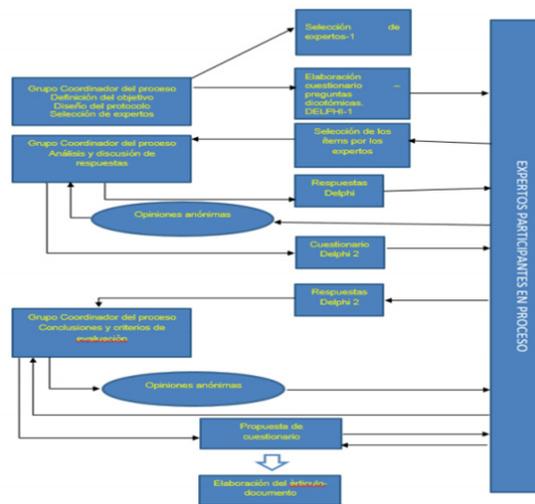
Sourse: Adapted by Pozo, Gutierrez, Perez & Rodriguez (2007).

All processes where carried out through e-mail in attached file, formed by a first page with a brief introduction to the topic of research, clear explanation of the research purpose, method to be used, the phase of the research process, directions to complement the questionnaire, followed by the corresponding instrument for validation (Luna, et al, 2005). In order to prevent slants and/or leadership effect on the study, it was realized on anonymous basis. (Cruz, 2006).

Selection of experts

Taking into account the importance of composition of the group for results to be achieved, in this study the evaluator experts were selected according to: occupation/profession, title, years of experience, teacher category, scientific degree, permanency in the job in certain group of the center, and current link to such activity (Cruz, 2006; Hsu & Sandford, 2007). In addition, the number of related researches was taken into account, as well as the number of publications developed on the topic. This group was composed of two doctors of education, two specialists, one industrial engineer, one psychologist, and one systems engineer, following the requirements for the coordination group proposed by Landeta (2002), setting a minimum of seven experts, but no more than 30. The members of this group, a) Know Delphi method, b) are academic researchers on the topic, and c) hold a great inter-communication ability to work jointly, as recommended by Brunner (2005), and Hsu & Sandford (2007). See tables 1 and 2.

Exploratory phase

During this part, the authors selected the critical aspects or attributes to be evaluated, common in headings confirmed recognized experts on the topic of study, such as Marques (2004), and Cataldi (2009). Afterwards, definitions of selected criterions were taken (Standard ISO/IEC 9126 s.f.). In an opinion survey, each participating expert was asked to state in a dichotomic scale (yes, no), which of the 18 criterions included in such survey would lead to proper selection of a VL. Using compiled and analyzed information, a first version, of the evaluation questionnaire was built, by consensus, and sent to a second round for validation by the group of selected experts, in order to perfect criterions, and establish the proper scale for the study. In order to facilitate the experts work, each criterion was accompanied by the statistical analysis, and Likert scale proposed by Hsu & Sandford (2007). See table 3. In addition to an open question, to collect qualitative evaluations by each expert on proposed criterions, or introduction of any new one. (Table 3).

The maximum term to answer the questionnaire was 10 days. Results from the second round of consultation for validation by the experts group, were tabulated and statistically analyzed, media, middle, typical deviation, maximum, minimum, variance, frequency, accumulated frequency, and closing points, and together with the definitive questionnaire, were sent to the group; unanimity of answers by 90 per cent of the experts involved in the process was achieved.

Final phase

During this last phase, results of the whole process of validation were synthetized, through interactive consultation to the experts with the definitive version of the questionnaire, for subsequent application in the research process. As questionnaire and definitive scales the ones shown in tables 4 and 5 were established.

In addition, the experts were asked to evaluate the relevance, pertinence and coherence of the characteristics system to foresee, design, and measure the impact on local performance of research projects.

Statistical analyzes were performed through the statistical program *Statistical Package for the Social Sciences* (SPSS, version 16.0). Reliability of the questionnaire was analyzed through Cronbach's alpha, for typified elements, and procedure of the halves with Spearman-Brown's correction.

Results

The coordinator group was organized as suggested by experts on Delphi method, and it was explained in the methodology (Cruz, 2006; Luna, 2006). Such coordinator group in turn, selected the expert group, according to values of competence coefficient (middle) to review, analyze, and provide valid and reliable criterions on the job to be performed (Gonzalez et.al,. 2001), Astigarraga, s.f. Cruz, 2006). See tables 1 and 2.

Table 1. Results of process to establish experts' competence coefficient.

Experts	Kc	Ka	K	Evaluation	Kc: Knowledge coefficient.
1	0.8	0.8	0.8		
2	0.8	0.8	0.75	Average of	**Ka:**
3	0.7	0.6	0.75	Experts'	Argumentation coefficient.
4	0.7	0.6	0.75	competence	
5	0.6	0.7	0.7	index	**Kc:**
6	0.6	0.5	0.6	**Kc** = middle	Experts' competence coefficient.
7	0.6	0.5	0.6		

Kcomp= ½ (kc + ka)-(Oñate, 1990)

Si 0.8 < K < 1.0 High competence coefficient.
Si 0.5 < K < 0.8 Middle competence coefficient coeficiente de competencia medio
Si K < 0.5 Low competence coefficient

Source: The autors

Table 2. Characterization of experts involved in the consultation

	Professional qualitication	Teaching category and/or title	Years of experience
1	Doctor	Assistant	20
2	Doctor	Assistant	10
3	Doctor	Auxiliary	11
4	Magister	Auxiliary	9
5	Specialist	Professor	18
6	Specialist	Professor	15
7	Engineer	Business, research and development sector	16

Source: Years of experience on VLs matters

Figure 2. Years of experience in the sector by experts panel

Years of experience on VLs matters

■ Less than 10 years   ■ Between 10 and 15 years   ■ Between 15 and 20 years.
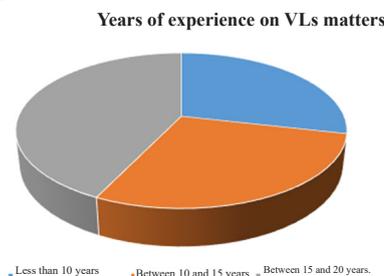
Source: the autors

Four of the experts come from three different academic institutions, directly related to education software and research. The three remaining are from UNAD. The competence index of the expert was mean. See Table 1. The exploratory phase was performed in three rounds of consultation for criterions validation as proposed by González, Guerrero, Maldonado (2001). In the first two rounds consensus of the group and the final version of the questionnaire were reached, which was finally formed by 10 criterions. See Table 3.

Quantitative results of evaluations performed din the second round were processed through a statistical analysis applying the methodology described in the section lf materials and methods. See Tables 4 and 4.1.

Table 3. Definition of criterions and definitive scale to evaluate VLs.

Dear cooperator
Carefully read each criterion proposed, and state in the column the evaluation, which in your opinion as an expert, corresponds to s criterion to evaluate virtual laboratories – VLs.

Group attributes or criterions to evaluate in a VL by AHP	Code	Criterion definition	C1= No suitable C2= Little suitable C3= Suitable C4= Fairly suitable C5= Very suitable
			C1 C2 C3 C4 C
Functionality	FUN	Ability of software product to provide functions that meet specific or implicit needs, when the software is used under certain conditions.	
Reliability	FIA	Ability of software product to keep a specified level of performance when used under specific conditions.	
Usabilidad	USAB	Ability of software product to be attractive, understood, learned and used by the user under specific conditions.	
Efficiency	EFI	Ability of software product to provide proper performance, related to the amount of resources used, under specific conditions.	
Maintainability	MAB	Ability of software product to be modified.	
Portability	POR	Ability of software product to be transferred from any environment to another.	
Technical aspects	ASPT	All features are designed to support education processes of an informatics resource. They include access to the program, installation, operation, presentation and navigation of the VL.	
Psychopedagogic aspects	ASPS	Include all VL features dirctly linked to aspects performed by education processes, such as the curriculum, the teacher, and the student, considered as main subjects of such process, teaching and learning strategies, and learning evaluation, among other.	
Communication aspects	ASPC	It is the way in which users interact among themselves and with the VL, sychronic and assynchronically to achieve purpose and objectives. Being the equipment platform interfaces, and programming language, and graphic environment combined with other resources, used and incorporated according to users' profile.	
Administrative aspects	ASPA	It refers to use, operation, and costs of the VL.	

Sourse: Taken and modified for academic purposes from: Marques, 2004; Miller, 2006; Jadhava & Sonar 2009; Verna Gupa & Singh 2008.

Table 4. Descriptive statistics of evaluation of the questionnaire to evaluate VLs.

		FUN	FIA	USAB	EFI	MAB	POR	ASPT	ASPS	ASPC	ASPA
N	Valid	7	7	7	7	7	7	7	7	7	7
	Lost	0	0	0	0	0	0	0	0	0	0
Mean		4,0	4,0	3,714	4,285	3,571	3,857	4,285	4,571	4,571	5,00
Typ. Deviat.		,0000	,00	,9511	,4879	,7868	,3779	,4879	,5345	,5345	,000
Minimal		38				Maximum		48			

Source: The autors

Since points marked in a questionnaire are not evidence of its validity, then it is necessary to determine Spearman-Brown's coefficients, and Cronchbach's alpha.

Table 5. Statistics of reliability of the questionnaire to evaluate VLs

	Part 1	Value	,736
		Nr. Of elements	5[a]
Cronbach's Alpha	Part 2	Value	,718
		Nr. Of elements	5[b]
	Total Nr. Of elements		10
Correlation among methods			,584
Spearman-Brown's	Longitud igual		,738
coefficient	Longitud desigual		,738
Two halves of Guttman			,714
Reliability coefficient or Cronbach' alpha			0,814
Infer-elements correlation			,923

a. The elements are: Fun, Fia, Usab, Efi, Mab.

b. The elements are: Pqr, Aspt, Asps, Aspc, Aspa.

N= Number of questionnaires

Source: The autors

Experts evaluation of importance, pertinence, and coherence of the indicators system resulted in 14 %, 57.1% and 28.6% respectively . See Table 5 and Figure 3.

Table 6. Experts' opinions frequency on the final questionnaire

	Frequency	Percentage	Accumulated percentage
Vey important	1	14,3	14,3
Very coherent	4	57,1	71,4
Very pertinent	2	28,6	100,0
Total	7	100,0	

Source: The autors

Figure 3. Frequency of experts' answers
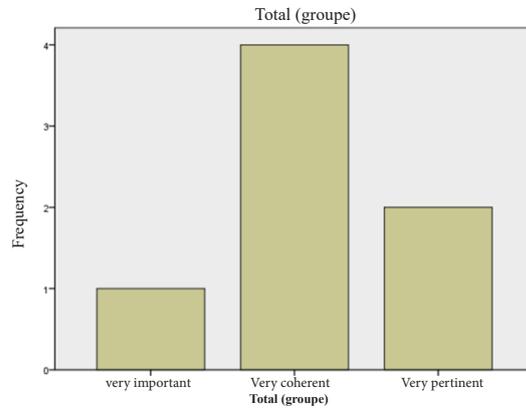
Table 7. Results from evaluation by experts to characteristics regarding items to select VLs.

Dear cooperator Carefully read each proposed item, and mark the option, which in your opinion as an expert, corresponds to such item, taking account the definitions of the features provided in table 3 and 4.	X1= very important. X2= very coherent X3= very pertinent		
Items	X1	X2	X3
On items content			
Information to be obtained from the items is relevant			
Important terms to be studied are defined			
Definition of each item is exhaustive			
On writing of the items			
In the phrases it is used a very technical language, or little clear, resulting in a difficult comprehension of the items			
The item properly expresses the alternative regarding the topic dealt with			
The items are inclined toward a particular type of answer			
The items have an equal meaning for all of them			
Too long questions are used which makes comprehension difficult			
On location of the items in the sequence			
The questions are naturally addressed			
The form of the questionnaire is suitable at the time of completing it			
Items need to be more concrete, specific, and closely linked to experience of the informant.			
On the answer			
The case of election of Likert's scale is sufficient with five possible options for evaluation (1) Very in agreement, 2) in agreement, 3) No agreement or disagreement, 4) in disagreement, 5) very in disagreement) to show de degree or agreement/disagreement of each item, to avoid central posture of the surveyed individual.			

Source:The autors

Discussion and conclusions

The experts were selected taking into consideration the characteristics proposed by Hsu & Sandford (2007); Romero, Salicetti (2011), which contribute to achieve reliable results.

Strategies for selection of experts (Kcomp's coefficient), lead to a founded grouping in a more objective procedure than the sole review of a curriculum.

Results achieved endorse the reliability and validity of the questionnaire to evaluate the VLs. Indicators, as they are structured, are sufficient for future research on the involved topic, therefore, a new round is not necessary, as stated by Landetta (2002); Cruz (2006), and Miller (2006).

The reliability statistic, Cronach's Alpha, or index of internal consistence is the estimator of the accuracy through which a group of questions measures a behavioral aspect, by reflecting the relationship among its elements (Hernandez, et. Al, 2006). And which, according to Hernandez et. al. (2006), of above 0,70 is acceptable, 0,814 being considered as notable level of acceptation, as reached in this work (table 3), showing a proper internal consistence for the various questions. Therefore, the analysis of the questionnaire shows some correlation coefficients which may be regarded as excellent.

Gratitudes

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