ARTIGO ORIGINAL

ASSESSMENT TOOLS FOR THE UTILITY PERCEPTION RELATED TO VIRTUAL LEARNING ENVIRONMENTS USED IN BLENDED LEARNING

FERRAMENTAS DE AVALIAÇÃO PARA A PERCEPÇÃO DE UTILIDADE RELACIONADA AOS AMBIENTES VIRTUAIS DE APRENDIZAGEM UTILIZADOS NO BLENDED LEARNING

Carlos Roberto Souza Carmo[1]

Renata de Oliveira Souza Carmo[2]

Fabio Caixeta Nunes[3]

Fernando de Lima Caneppele[4]

ABSTRACT

The objective of this research was to measure the internal reliability of one of the first data collection instruments for the assessment of factors related to the perception of self-declared utility by students and professors about virtual learning environments (VLE), and their information and communication technologies (ICT), used in the hybrid teaching modality, or blended learning, in the context of postgraduate stricto sensu in Brazil. Characterized as one of the most used reliability tests in the evaluation of data collection instruments based on questionnaires, scale, etc., Cronbach's alpha was applied to a sample composed of 26 respondents, evaluating the internal reliability of the questionnaire object of this study as a whole, and also, individual contribution of each of the 11 factors that make up the collection instrument, namely: ease of use of the VLE; the process of interaction between classroom and non-classroom moments; the perception of utility of activities for the teaching and learning process; the degree of self-declared motivation and interest in the studies developed on-line; the degree of utility and diversification of the activities developed on-line; interaction between professor and student; interaction between professor and VLE; interaction between the students themselves; levels of student participation and involvement in on-line activities;

[1] Mestre pelo Pontifícia Universidade Católica de São Paulo – PUC/SP (2008). Doutor pela Universidade Estadual Paulista – UNESP/BOTUCATU (2020). Professor dos cursos de graduação da Faculdade de Ciências Contábeis da Universidade Federal de Uberlândia – FACIC-UFU. ORCID: https://orcid.org/0000-0002-3806-9228. e-mail: carlosjj2004@hotmail.com.

[2] Mestre pela Universidade Federal de Uberlândia – PPGED-UFU (2018). Professora de língua portuguesa e língua inglesa, suas literaturas e suas metodologias de ensino na Universidade de Uberaba – UNIUBE. ORCID: https://orcid.org/0000-0002-0997-0754. e-mail: renatadeoliveira.carmo@gmail.com.

[3] Mestrado em Engenharia e Ciência de Materiais pela Faculdade de Zootecnia e Engenharia de Alimentos da Universidade de São Paulo – USP/FZEA, Pirassununga, SP, Brasil. ORCID: https://orcid.org/0000-0003-1309-7836. e-mail: fabiocaixeta@usp.br.

[4] Doutor em Agronomia - Energia na Agricultura pela Faculdade de Ciências Agronômicas – UNESP/FCA (2011) e pós-doutorado pela UNESP (2018). Atua como professor da graduação, pós-graduação e orientador de mestrado e doutorado junto aos Programas de Pós-graduação em Agronomia - Energia na Agricultura e Agronomia - Irrigação e Drenagem na Faculdade de Ciências Agronômicas UNESP/FCA e dos Programas de Pós-graduação em Engenharia e Ciência dos Materiais e Zootecnia na Faculdade de Zootecnia e Engenharia de Alimentos USP/FZEA. ORCID: https://orcid.org/0000-0003-4498-8682. e-mail: caneppele@usp.br.

interaction and complementarity between the content developed in person and on-line; the perception of general utility of ICT and VLE. At the end of this investigation, it was possible to observe the partial fulfillment of the existing knowledge gap until now.

Keywords: metrics; blended learning; quantitative methods applied

RESUMO
Esta pesquisa teve por objetivo mensurar a confiabilidade interna de um dos primeiros instrumentos de coleta de dados destinados à avaliação de fatores relacionados à percepção de utilidade autodeclarada por alunos e professores acerca dos ambientes virtuais de aprendizagem (AVA) e suas tecnologias de informação e comunicação (TIC), utilizados na modalidade de ensino híbrido, ou blended learning, no contexto da pós-graduação stricto sensu no Brasil. Caracterizado como um dos testes de confiabilidade mais empregados na avaliação de instrumentos de coleta de dados baseados em questionários, escala, etc., o alfa de Cronbach foi aplicado em uma amostra composta por 26 respondentes, avaliando-se a confiabilidade interna do questionário objeto deste estudo como um todo e, ainda, a contribuição individual de cada um dos 11 fatores integrantes do referido de instrumento de coleta, ou seja: facilidade de utilização do AVA; o processo de interação entre os momentos presenciais e não-presenciais; a percepção de utilidade das atividades para o processo de ensino e aprendizagem; o grau de motivação e interesse autodeclarados pelos estudos desenvolvidos on-line; o grau de utilidade e diversificação das atividades desenvolvidas on-line; interação entre professor e aluno; interação entre professor e AVA; interação entre os alunos em si; níveis de participação e envolvimento dos alunos nas atividades on-line; interação e complementariedade entre o conteúdo desenvolvido presencialmente e on-line; a percepção de utilidade geral das TIC e do AVA. Ao final desta investigação, foi possível observar o preenchimento de uma parte da lacuna do conhecimento existente até este momento.

Palavras-chave: métricas; ensino híbrido; métodos quantitativos aplicados.

1 Introduction

Innovation and technological advances have transformed the world in general, and especially education. The integration between off-line and on-line education has brought with it countless possibilities, among them blended learning.

Blended learning (BL) combines on-line (distance) and face-to-face learning modality providing students with greater flexibility in terms of time and space, among other benefits (BOELENS; VOET; De WEVER, 2018; SHU; GU, 2018; VANSLAMBROUCK *et al.*, 2019).

In addition to making the teaching and learning process more flexible, BL also promotes greater interactivity between students and professors using different technological approaches and tools, leading to independent learning and collaboration (SHU; GU, 2018).

Shifting the focus of the knowledge construction process from the professor to the student, BL enhances interaction among the students themselves and the professors. Thus, it may improve the quality of learning and contribute to student satisfaction and motivation. Furthermore, BL provides a better sense of autonomy and responsibility to the student (WESTERLAKEN *et al.*, 2019).

Despite the positive factors inherent in the implementation of BL, the increasing number of students has given rise to higher and more heterogeneous student populations, which also contributed significantly to BL adoption (BOELENS; VOET; De WEVER, 2018). Because in addition to providing greater flexibility to the teaching and learning process and enabling it to meet ever-increasing demand, BL provides more personalized teaching methods through its formatting geared to meet individual student needs (BOELENS; VOET; De WEVER, 2018).

However, due to the students' heterogeneity in skills, interests, motivation, and previous experiences, among other factors, understanding the perceived utility of these students about virtual learning environments (VLE). And, their information and communication technologies (ICT) becomes a key variable of BL (AL-FRAIHAT *et al.*, 2020; BOELENS; VOET; De WEVER, 2018), since the perspective under which students perceive the teaching and learning process is related to the outcomes achieved by them (HAN; ELLIS, 2019).

On the other hand, despite the need to understand how students of the BL modality evaluate the VLE and the ICT used in the combination of methods and practices of on-line and off-line teaching, little is known about the variables that make up this perception of utility (GAO; JIANG; TANG, 2020). This is because most of the studies conducted on BL are exploratory and qualitative, focusing mainly on the description of students' experiences and the process of implementing this methodology, and such studies can be considered recent from the empirical point of view (RAES *et al.*, 2020). Thus, these factors are a strong indication of the need for further studies on this issue.

In this context, this research aimed to measure the reliability of one of the first instruments (scale) designed to collect data for the evaluation of a series of factors related to

the perception of utility self-reported by students and professors about VLEs and their ICT, used in the BL modality, in the context of *stricto sensu* postgraduate studies in Brazil.

The collection instrument in question (questionnaire) was initially proposed by Caneppele, Carmo, and Carmo (2019) and later adjusted by Carmo *et al.* (2019). Whereas, its choice as the object of study of the present research is because it is characterized as a proposal of unprecedented evaluative scale in the context in which it has been applied until this moment. Thus, this study aimed to evaluate VLE and ICT used in the BL implemented in the Brazilian *stricto sensu* post-graduation. Additionally, we highlight the fact that this collection instrument proposes to analyze a set of factors related to 11 different items, namely: ease of use of the VLE; the interaction process between face-to-face and non-presence moments; the perception of the utility of the activities for the teaching and learning process; the degree of self-reported motivation and interest for the studies developed on-line; the degree of utility and diversification of the activities developed on-line; interaction between professor and student; interaction between professor and VLE; interaction between the students themselves; levels of student participation and involvement in on-line activities; interaction and complementarity between the content developed face-to-face and on-line; and, the perception of the utility of ICT and the VLE (CANEPPELE; CARMO; CARMO, 2019; CARMO *et al.*, 2019).

About studies on the implementation of BL in *stricto sensu* postgraduate studies, Carmo *et al.* (2019) note that research on this theme and context can be considered scarce compared to studies conducted at other educational levels, whereas, in the Brazilian context, this type of research is practically non-existent.

Additionally, the variety and relevance of the factors assessed by the scale proposed by Caneppele, Carmo, and Carmo (2019) and Carmo *et al.* (2019) stand out, namely: utility, motivation, and satisfaction (LÓPEZ-PÉREZ; PÉREZ-LÓPEZ; RODRÍGUEZ-ARIZA, 2011); interaction between on-line and off-line teaching and learning (SHU; GU, 2018; VANSLAMBROUCK *et al.*, 2019); motivation for learning and educational experiences (BOELENS; VOET; WEVER, 2018); faculty interaction (CHMIEL; SHAHAHA; SCHNEIDER, 2017); on-line interaction among students in BL mode (WESTERLAKEN *et al*., 2019), among the other factors.

Herein, the possibility of validating the reliability of a scale (questionnaire) aimed at collecting data and evaluating a set of factors related to a key variable of the teaching and learning process in BL modality. Thus, the overall assessment of VLEs and ICT used in this teaching modality (AL-FRAIHAT *et al.*, 2020; BOELENS; VOET; De WEVER, 2018) according to their users' self-reported perceived utility, which fills part of the knowledge gap pointed out by Carmo *et al.* (2019) and Raes *et al.* (2020).

2 Theorical Background

Evaluating the perception of the utility of students and professors from a post-graduation course of the Agronomic Sciences faculty of the Paulista State University (UNESP) regarding Google Classroom as a VLE in a discipline taught in BL modality, Caneppele, Carmo, and Carmo (2019) proposed a data collection instrument (questionnaire). This instrument was composed of 11 statements about factors related to the use of the VLE. Thus, the respondents (students) were asked to assign a score from 0 (zero) to 10 (ten) for each statement, according to their agreement with each one.

However, when evaluating the perception of the professor responsible for the subject, the authors used a collection instrument composed of only 9 statements. Although these statements assessed the 11 factors included in the questionnaire applied to the respective students, concentrating more than one of these factors in only one affirmation.

Subsequently, Carmo *et al.* (2019) replicated the research conducted by Caneppele, Carmo, and Carmo (2019) to assess the levels of self-reported perceived utility by students of a *stricto sensu* postgraduate course at another institution. Thus, students from the Faculty of Animal Science and Food Engineering at the University of São Paulo (USP) were evaluated about the Information Technology in Advanced Internet Development-Electronic Learning (TIDIA Ae) system. The TIDIA Ae is the VLE used in the teaching and learning process of a subject in BL modality.

In addition to revising the means of self-reported perceived utility about the VLE, Carmo, *et al.* (2019) also adjusted the collection instrument applied to the professor. Thus, professors must reflect on the same factors evaluated by the students. Therefore, by assigning scores for those 11 affirmatives instead of the 9 affirmatives initially proposed by Caneppele, Carmo, and Carmo (2019).

The data collection instrument allowed Caneppele, Carmo, and Carmo (2019) and Carmo *et al.* (2019) to assess the utility of students and professors, about 11 different factors inherent in the process of using two distinct VLEs, as described in Table 1.

Table 1 - Description of the instrument used for data collection

Item	Affirmative presented to the students	Affirmative presented to the professor	Factor Appraised
1	Navigation in the "VLE" and its use can be considered easy	As a professor, I realized that navigating the "VLE" and using it can be considered easy	Ease of use
2	The use of the “VLE” in the course helped me to keep up with my studies even when there was no face-to-face class; therefore, there was the interaction between the face-to-face classes and the “VLE” classes.	As a professor, I noticed that the use of the "VLE" in the course helped me to keep up with the students even when there was no face-to-face class. Therefore, there was an interaction between the face-to-face classes and the "VLE".	Interaction between face-to-face and on-line moments
3	The activities proposed and developed (readings, exercises, discussions, videos, etc.) via the "VLE" have contributed to my learning	As a professor, I noticed that the activities proposed and developed (readings, exercises, discussions, videos, etc.) via the "VLE" contributed to the students' learning	The utility of the activities for the teaching and learning process
4	The level of difficulty of the activities proposed/developed via the "VLE" allowed me to maintain my interest in the studies	As a professor, I noticed that the level of difficulty of the activities proposed/developed via the "VLE" allowed the students to maintain their interest in their studies	Motivation and interest in the studies developed on-line
5	The variety of activities proposed/developed via "VLE" (e-mail, forum, exercise list, sending feedback, etc.) was well explored throughout the studies	As a professor, I noticed that the variety of activities proposed/developed via "VLE" (e-mail, forum, exercise list, sending feedback, etc.) was well exploited by the students throughout the studies.	The utility and diversification of the activities developed on-line
6	Professor interaction and collaboration via the "VLE" was present throughout the studies proposed/performed in this learning environment	As a professor, I noticed that my interaction and collaboration with the students via the "VLE" was present throughout the studies proposed/performed in this learning environment	Interaction between professor and student
7	The professor's notes and interaction in the "VLE" contributed to my learning	As a professor, I realized that my notes and my interaction in the "VLE" contributed to the students' learning	Interaction between professor and “VLE”
8	The interaction and collaboration among students were present throughout the studies proposed/developed via the "VLE"	As a professor, I noticed that interaction and collaboration among students were present throughout the studies proposed/developed via the "VLE".	Interaction among students
9	I consider that I was "present" and, therefore, there was the interaction between me and the other students in the activities proposed/developed via the "VLE"	As a professor, I consider that I was "present" and, therefore, there was the interaction between me and the students in the execution of the activities proposed/developed via the "VLE"	Participation and involvement in on-line activities
10	There were consistency and correlation between the subjects/contents proposed in the "VLE" and those worked on in the classroom	As a professor, I consider that there were coherence and correlation between the subjects/contents proposed/developed in the "VLE" and those worked on in the classroom	Interaction between the content developed face-to-face and on-line

11	The "VLE" is a resource that can help maintain the rhythm of studies and learning when face-to-face meetings are not possible	As a professor, I consider that the VLE is a resource that can help maintain the rhythm of studies and learning when face-to-face meetings are not possible	The overall utility of ICTs and “VLE”

Source: prepared by the authors from Carmo *et al*. (2019).

Despite allowing to assess the perception of utility about those 11 different factors related to VLEs used in the implementation of postgraduate courses in BL modality, the reliability of the data collection instrument used by Caneppele, Carmo, and Carmo (2019) and Carmo *et al.* (2019) could not be proven. Due to the small number of respondents that comprised the respective research samples. That is, the research developed by Caneppele, Carmo, and Carmo (2019) relied on the responses provided by 11 students and one professor, and the study conducted by Carmo *et al.* (2019) relied on only 4 students and one professor.

Although the design and use of questionnaires, scales, or tests can be considered usual practices in socio-educational research, this type of data collection instrument requires that reliability be tested and evaluated. Thus, it will be possible to attribute higher quality to the instruments in question (RODRÍGUEZ-RODRÍGUEZ; REGUANT-ÁLVAREZ, 2020), by reducing the respective random errors (BARRIOS; COSCULLUELA, 2013; LÓPEZ-ROLDÁN; FACHELLI, 2015).

The reliability of a questionnaire or scale is assessed by its ability to measure a certain characteristic or attribute (RODRÍGUEZ-RODRÍGUEZ; REGUANT-ÁLVAREZ, 2020), or even, by its ability to allow to evaluate and estimate the characteristics of a determined phenomenon (LÓPEZ-ROLDÁN; FACHELLI, 2015).

According to Barrios and Cosculluela (2013), a measurement instrument that is considered reliable should present adequate internal consistency, in other words, each of its parts should be equivalent to the others.

Similarly, Souza, Alexandre, and Guirardello (2017) state that the internal consistency of a data collection instrument designed in the form of a questionnaire, scale, etc., should be assessed by the homogeneity with which its parts measure a given characteristic, compared to the overall measurement performed by the instrument as a whole.

In this sense, Cronbach's alpha coefficient (1951) is one of the most widely used tests in gauging the reliability levels of questionnaires used in research of the most varied natures (DeVELLIS, 2005; HORA, MONTEIRO, ARICA, 2010; SOUZA; ALEXANDRE; GUIRARDELLO, 2017; ZELLER, 2005).

Cronbach's alpha coefficient (1951) expresses the internal consistency of a test, scale, or questionnaire from the analysis of covariance between its questions and the collection instrument as a whole. In other words, it can be understood as the correlation between the variance of its internal components (questions) and the total variance of the respective instrument (BARRIOS; COSCULLUELA, 2013; COLLINS, 2007; DeVELLIS, 2005; FINK, 2010).

According to Equation 1, Cronbach's (1951) alpha coefficient assumes values between 0.00 (zero) and 1.00 (one), where 0.00 is for the total absence of reliability and 1.00 is for complete reliability (HAIR JUNIOR *et al.*, 2005; RODRÍGUEZ-RODRÍGUEZ; REGUANT-ÁLVAREZ, 2020).

$$a = \frac{n}{n-1}\left(1 - \frac{\sum_{i=1}^{k} v_i}{v_t}\right) \quad (1)$$

In Equation 1, prepared based on Cronbach (1951) and Hora, Monteiro, and Arica (2010), n is the number of questions in the questionnaire, v_i is the variance of the answers provided for each question i, with i= l, ..., k, and v_t corresponds to the total variance of the questionnaire. To interpret the values calculated for Cronbach's alpha coefficient (1951), the parameters proposed by Zeller (2005) and Rodríguez-Rodríguez and Reguant-Álvarez (2020), described in Table 2, may be used.

Table 2 – Parameters for evaluating Cronbach's alpha coefficient (1951)

Value	Evaluation
Higher than 0.90	Excellent
0.80 to 0.90	Adequate
0.70 to 0.80	Acceptable
0.60 to 0.70	Suspicious
Less than 0.60	Unacceptable

Source: elaborated by the authors, based on Zeller (2005) and Rodríguez-Rodríguez and Reguant-Álvarez (2020).

Although the values described in Table 2 offer excellent parameters for assessing the reliability of a data collection instrument, measured from Cronbach's alpha coefficient (1951), one must be considering that the measurement process in question goes beyond the analysis of a number. That is, although objective, those values, and parameters summarized in Ta 2 sblehould be adopted as indicators that demand a complementary analysis based on the

relationship between theoretical concepts and a given object of study (LÓPEZ-ROLDÁN; FACHELLI, 2015).

It is worth noting the lack of a single or widely accepted reliability assessment criterion across the scientific community about inferences about the reliability of data collection instruments based on questionnaires, scales, or tests (RODRÍGUEZ-RODRÍGUEZ; REGUANT-ÁLVAREZ, 2020).

Thus, the results of a given reliability assessment must be analyzed in an empirically contextualized manner and light of adjacent theory, making it possible to properly interpret the reliability measured with the aid of Cronbach's (1951) alpha coefficient (RODRÍGUEZ-RODRÍGUEZ; REGUANT-ÁLVAREZ, 2020).

3 Methodology

The use of Cronbach's alpha (1951) follows some assumptions related to three basics factors: the composition of the collection instrument; the significance and diversification of the group of respondents (sample); and, the prior validation of the scale being evaluated (HORA, MONTEIRO, ARICA, 2010).

Regarding the composition of the collection instrument, the evaluated questionnaire should be divided or grouped into dimensions in a manner that their questions or groups of questions address a given object of study in a correlated way (HORA, MONTEIRO, ARICA, 2010). In this sense, the instrument used in this research presents statements that assess 11 different factors, as described earlier in Table 1. However, despite the heterogeneity of the analyzed factors, they are all related to the same object of study, i.e., the VLE and the ICT used in the BL implementation in the *stricto sensu* post-graduation.

Concerning the significance and diversification of the respondent group, the questionnaire should be applied to an expressive and heterogeneous sample (HORA, MONTEIRO, ARICA, 2010). Herein, the sample analyzed presents heterogeneity regarding the characteristics of its participants both about the curricular components via BL and about the respective VLE. In other words, the 26 respondents in this research sample are students from *stricto sensu* postgraduate courses from two different higher education institutions (UNESP and USP). The participants evaluated two different VLEs (Google Classroom and TIDIA_Ae) used in the teaching and learning process in BL modality in 4 differents curricular

components: rural energization, pedagogical preparation in Engineering and Materials Science, and rational use of energy, and decision support systems in agribusiness.

Regarding the previous validation of the scale assessed by applying Cronbach's alpha coefficient (1951), the validity of a collection instrument is related to its ability to measure the respective object of study. This should not be confused with reliability (HORA, MONTEIRO, ARICA, 2010), which relates to the random errors generated from its use (BARRIOS; COSCULLUELA, 2013; LÓPEZ-ROLDÁN; FACHELLI, 2015). In this sense, although there is no objective quantitative criterion to assess the validity of a scale (HORA, MONTEIRO, ARICA, 2010), the questionnaire under analysis in this study has already been employed in 2 previous studies (CANEPPELE; CARMO; CARMO, 2019; CARMO *et al.*, 2019). Having carried out inferences (theoretical, empirical, and statistical) about the results based on the adjacent theory pertinent to the studied theme. Additionally, commonly, an expressive portion of researchers assess the validity of their scales from the respective levels of internal reliability (HORA, MONTEIRO, ARICA, 2010).

Cronbach's alpha (1951) is one of the most common tests to measure the reliability of data collection instruments based on questionnaires, for example. In addition to using it to assess the overall reliability of the questionnaire that is the object of this study, tests were performed to individually assess the 11 factors that make up the collection instrument. To this end, the variation rate in the overall Cronbach's alpha (1951) of the questionnaire was evaluated from the exclusion of each of the representative statements of the 11 individually evaluated factors. This procedure aims to assess the specific contribution of each factor to the overall reliability of the collection instrument (BARRIOS; COSCULLUELA, 2013; COLLINS, 2007; DeVELLIS, 2005; SOUZA; ALEXANDRE; GUIRARDELLO, 2017).

Thus, considering the object of this research, its nature, and the respective data analysis method, it can be classified as an empirical-analytical scientific investigation supported by applied quantitative methods.

4 Data Analysis and Results

Regarding the composition of the collection instrument, the questionnaire analyzed in this research sought to assess the perception of utility self-reported by 26 postgraduate

students about 11 different factors inherent to the VLEs used in the BL modality, according to the descriptive statistics summarized in Table 3.

Regarding the diversification of the group of respondents in this research sample, the information summarized in Tables 4 and 5 show the levels of diversification concerning the characteristics of these respondents, both with the curricular components taught using the BL methodology (Table 4) and about the VLEs used (Table 5).

Table 3 – Descriptive statistics of the respondents' evaluations for each factor analyzed

Factors	**Min.**	**Max.**	**Amplitude**	**Median**	**Avg,**	**Deviation**	**Coeff. of variation (%)**
Ease of use	5	10	5	9	8.77	1.50	17%
Interaction between face-to-face and on-line moments	2	10	8	10	8.77	2.01	23%
The utility of the activities for the teaching and learning process	5	10	5	10	9.15	1.29	14%
Motivation and interest in the studies developed on-line	4	10	6	9	8.54	1.79	21%
The utility and diversification of the activities developed on-line	5	10	5	10	8.81	1.70	19%
Interaction between professor and student	7	10	3	10	9.62	0.98	10%
Interaction between professor and “VLE”	5	10	5	10	9.15	1.32	14%
Interaction among students	3	10	7	9	8.00	2.35	29%
Participation and involvement in on-line activities	3	10	7	9	8.12	2.23	28%
Interaction between the content developed face-to-face and on-line	8	10	2	10	9.62	0.70	7%
The overall utility of ICTs and “VLE”	5	10	5	10	9.12	1.42	16%

Source: elaborated by the authors, based on survey data.

Regarding the significance of the sample used in this scientific investigation, it should be noted that the previously conducted researches that used the collection instrument under analysis had only 15 participants in total. That is 11 participants in the study of Caneppele, Carmo, and Carmo (2019) and another 4 participants in the research by Carmo *et al.* (2019), whereas this research had a sample made up of 26 respondents.

Table 4 – Descriptive statistics of the characteristics of the research participants, about the curricular components from the BL.

Curricular component	Number	Sex		Age			Previous experience with the VLE	
	(n)	Male	Female	Max.	Min.	Avg.	Yes	No

Rural Energization	7	6	1	54	26	41	2	5
Pedagogical preparation in Eng. and Materials Science	4	3	1	32	26	28	2	2
Rational energy use	11	8	3	57	23	37	3	8
Decision-making support system in agribusiness	4	3	1	40	24	30	2	2
Total	26	20	6	57	23	36	9	17

Source: elaborated by the authors, based on survey data.

Table 5 – Descriptive statistics of the characteristics of the research participants, about the VLEs used in the BL

VLE	Number	Sex		Age			Previous experience with the VLE	
	(n)	Male	Female	Max.	Min.	Avg.	Yes	No
Classroom	22	17	5	57	23	37	7	15
TIDIA_Ae	4	3	1	40	24	30	2	2
Total	26	20	6	57	23	36	9	17

Source: elaborated by the authors, based on survey data.

When starting the analysis of the data collection instrument, the application of Cronbach's alpha coefficient (1951) to the answers provided by the 26 students of *stricto sensu* post-graduation courses in the sample of this research indicated an internal reliability degree of 0.9297. This reliability level can be considered excellent according to the parameters proposed based on Zeller (2005) and Rodríguez-Rodríguez and Reguant-Álvarez (2020), as shown in the information summarized in Table 6.

Table 6 - Summary of the reliability test of the collection instrument

Cronbach's Alpha	Factors Appraised	Questionnaires		
		Validated	Excluded	Total
0.9297	11	26	0	26

Source: elaborated by the authors, based on survey data.

Therefore, it is possible to state that the overall reliability of the questionnaire that is the object of this study (CANEPPELE; CARMO; CARMO, 2019; CARMO *et al.*, 2019) could be proven from an objective evaluation criterion. Which is usually employed in studies with data collection via questionnaires, scales, and tests (RODRÍGUEZ-RODRÍGUEZ; REGUANT-ÁLVAREZ, 2020).

When evaluating the specific contribution of each factor appraised by the collection instrument proposed by Caneppele, Carmo, and Carmo (2019) and Carmo *et al.* (2019), it should be noted that the rate of change of Cronbach's alpha (1951), generated from the exclusion of each of those factors, could be considered low, as presented in Table 7.

Table 7 shows that the exclusion of a particular factor integral to the collection instrument proposed by Caneppele, Carmo, and Carmo (2019) and Carmo *et al.* (2019) will imply a maximum variation of -1.45%. Such is the case of the factor that evaluates the level of perceived utility about the interaction between face-to-face and non-presence moments.

Additionally, it should be noted that except for the factors related to the utility and diversification of the activities developed on-line (variation = 0.88%) and the interaction and complementarity between the content developed in-person and on-line (variation = 0.05%), the exclusion of any other factor would imply a drop in the internal reliability assessed by Cronbach's alpha (1951).

Table 7 - Summary of the reliability test of the collection instrument according to the factor appraised.

Factor	Cronbach's alpha if factor is excluded	Absolute variation in Cronbach's Alpha	Relative variation in Cronbach's Alpha
Ease of use	0.9250	-0.005	-0.50%
Interaction between face-to-face and on-line moments	0.9162	-0.013	-1.45%
The utility of the activities for the teaching and learning process	0.9217	-0.008	-0.86%
Motivation and interest in the studies developed on-line	0.9163	-0.013	-1.44%
The utility and diversification of the activities developed on-line	0.9378	0.008	0.88%
Interaction between professor and student	0.9264	-0.003	-0.35%
Interaction between professor and “VLE”	0.9171	-0.013	-1.36%
Interaction among students	0.9166	-0.013	-1.41%
Participation and involvement in on-line activities	0.9207	-0.009	-0.97%
Interaction between the content developed face-to-face and on-line	0.9302	0.000	0.05%
The overall utility of ICTs and “VLE”	0.9228	-0.007	-0.74%

Source: elaborated by the authors, based on survey data.

In this sense, this trend of low variation per excluded factor denotes that the factors evaluated by the collection instrument present a certain uniformity about their contribution to the internal reliability of the collection instrument as a whole.

It is worth mentioning that, according to the parameters proposed for the evaluation of Cronbach's alpha (1951) - see the description presented earlier in Table 4 - from 0.70 the Cronbach's alpha coefficient (1951) can already be considered acceptable. And, from this point on, this evaluation tends to vary from "acceptable" to "excellent," passing through the

concept of "adequate," through variations of 0.10 points/concept. Therefore, every 10% of range on a scale ranging from 0.00 (zero) to 1.00 (one).

However, as shown in Table 7, for any factor excluded from the collection instrument proposed by Caneppele, Carmo, and Carmo (2019) and Carmo *et al.* (2019), the respective Cronbach's alpha coefficient (1951) would never be less than 0.90. Therefore, in all cases, it will be classified as holding internal reliability considered "excellent" (>0.90), according to the criteria established for this research based on Zeller (2005) and Rodríguez-Rodríguez and Reguant-Álvarez (2020).

Thus, both from the perspective of the collection instrument as a whole, and about its internal components, the questionnaire allows evaluating the perception of utility self-reported by postgraduate students about the VLE, and its ICT, used in the teaching and learning process in the BL modality.

However, although the evaluative objectivity provided by an analytical-quantitative reliability metric (such as Cronbach's alpha coefficient (1951)), the results of studies based on scales, questionnaires, tests, etc. must be analyzed in a contextualized manner and light of the theory. Thus, inferences can be made to produce knowledge in a robust form and with the proper empirical and theoretical depth.

5 Conclusions

Given the BL evolution, there is a need to understand how students in this modality evaluate the VLE and the ICT used in this teaching and learning method that combines on-line and off-line practices.

In this context, the data collection instrument (questionnaire) initially proposed by Caneppele, Carmo, and Carmo (2019) and later adjusted by Carmo *et al.* (2019) proved to be an alternative to meet that demand.

However, despite having already been successfully employed in studies involving professors and *stricto sensu* postgraduate students, the internal reliability of the collection instrument had not yet been objectively evaluated.

Using Cronbach's alpha coefficient (1951) is possible to measure the internal reliability of one of the first instruments (scale) designed to collect data about students' and professors' self-reported perception of utility about VLEs and their ICT, used in the BL

modality. Thus, the present research filled part of the knowledge gap existing up to this point, as pointed out by Carmo *et al.* (2019) and Raes *et al.* (2020). Therefore, it is expected that this study can be added to previous studies, contributing to the expansion of knowledge related to the evaluation of ELVs and ICT used in BL.

Acknowledgements

We thank the reviewers and editors for their comments and suggestions. The last author is grateful for the financial support of CAPES.

Authors' contributions

On behalf of all authors, the corresponding author states that all the authors have contributed equally to this study. All authors read and approved the final version of the manuscript.

References

AL-FRAIHAT, Dimah; JOY, Mike; MASA'DEH, Ra'ed; SINCLAIR, Jane. Evaluating E-learning systems success: an empirical study. **Computers in Human Behavior**, [*s. l.*], v. 102, p. 67-86, Jan. 2020. Available at: https://doi.org/10.1016/j.chb.2019.08.004. Accessed on: Out. 27, 2020.

BARRIOS, Maite; COSCULLUELA, Antoni. Fiabilidad. *In*; MENESES, Julio (coord.). **Psicometría**. Barcelona (Espanha): Editorial UOC, 2013. p. 75-140.

BOELENS, Ruth; VOET, Michiel; De WEVER, Bram. The design of blended learning in response to student diversity in higher education: Instructors' views and use of differentiated instruction in blended learning. **Computers & Education**, [*s. l.*], v. 120, p. 197-212, May 2018. Available at: https://doi.org/10.1016/j.compedu.2018.02.009. Accessed on: Out. 26, 2020.

CANEPPELE, Fernando de Lima; CARMO, Renata de Oliveira Souza; CARMO, Carlos Roberto Souza. Ensino híbrido na pós-graduação *stricto sensu*: a percepção discente e docente acerca da utilização de tecnologias digitais da informação e comunicação. **Cadernos da FUCAMP**, [*s. l.*], v. 18, n. 35, p. 47-64, 2019. Available at: http://www.fucamp.edu.br/editora/index.php/cadernos/article/view/1863. Accessed on: Out. 29, 2020.

CARMO, Carlos Roberto Souza; CANEPPELE, Fernando de Lima Caneppele; ZUIN, Luis Fernando Soares; CARMO, Renata de Oliveira Souza. *Blended learning* no Brasil: as contribuições do TIDIA na pós-graduação *stricto sensu* da Universidade de São Paulo. **Cadernos da Fucamp**, [*s. l.*], v.18, n.36, p.80-93, 2019. Available at: https://www.fucamp.edu.br/editora/index.php/cadernos/article/view/2044/1278. Accessed on: Out. 26, 2020.

CHMIEL, Aviva S.; SHAHA, Maya; SCHNEIDER, Daniel K.. Introduction of blended learning in a master program: developing an integrative mixed method evaluation framework. **Nurse Education Today**, [*s. l.*], v. 48, p 172-179, Jan. 2017. Available at: https://doi.org/10.1016/j.nedt.2016.10.008. Accessed on: Out. 24, 2020.

COLLINS, Linda M.. Research resign and methods. *In*: BIRREN, James E. (Editor-in-chief). **Encyclopedia of gerontology**. 2. ed. [*S. l.*]: Elsevier, 2007. p. 433-442. Available at: https://doi.org/10.1016/B0-12-370870-2/00162-1. Accessed on: Out. 22, 2020.

CRONBACH, Lee J.. Coefficient alpha and the internal structure of tests. **Psychometrika**, [*s. l.*], v. 16, n. 3, p. 297–334, Sep. 1951. Available at: https://link.springer.com/article/10.1007/BF02310555. Accessed on: Out. 06, 2020.

De VELLIS, Robert F.. Inter-rater reliability. *In*: KEMPF-LEONARD , Kimberly (Editor-in-chief). **Encyclopedia of social measurement**. [*S. l.*]: Elsevier, 2005. p. 317-322. Available at: https://doi.org/10.1016/B0-12-369398-5/00095-5. Accessed on: Out. 20, 2020.

FINK, Arlene. Survey research methods. *In*: PETERSON, Penelope; BAKER, Eva; McGAW, Barry (Editors-in-chief). **International encyclopedia of education**. 3. ed. [*S. l.*]: Elsevier, 2010. p 152-160. Available at: https://doi.org/10.1016/B978-0-08-044894-7.00296-7. Accessed on: Out. 08, 2020.

GAO, Bo Wendy; JIANG, Juan; TANG, Ying. The effect of blended learning platform and engagement on students' satisfaction: the case from the tourism management teaching. **Journal of Hospitality, Leisure, Sport & Tourism Education**, *[s. l.*], v. 27, article number: 100272, Nov. 2020. Available at: https://doi.org/10.1016/j.jhlste.2020.100272. Accessed on: Out. 28, 2020.

HAIR JUNIOR, Joseph F.; ANDERSON, Rolph E.; TATHAM, Ronald L.; BLACK, William C. **Análise multivariada de dados**. Porto Alegre: Bookman, 2005.

HAN, Feifei; ELLIS, Robert A.. Identifying consistent patterns of quality learning discussions in blended learning. **The Internet and Higher Education**, [*s. l.*], v. 40, p. 12-19, Jan. 2019. Available at: https://doi.org/10.1016/j.iheduc.2018.09.002. Accessed on: Out. 27, 2020.

HORA, Henrique Rego M. da; MONTEIRO, Gina Torres Rego; ARICA, José. Confiabilidade em questionários para qualidade: um estudo com o coeficiente alfa de Cronbach. **Produto & Produção**, Porto Alegre, v.11, n.2, p.85-103, 2010. Available at: https://doi.org/10.22456/1983-8026.9321. Accessed on: Out. 08, 2020.

LÓPEZ-PÉREZ, M. Victoria; PÉREZ-LÓPEZ, M. Carmen; RODRÍGUEZ-ARIZA, Lázaro. Blended learning in higher education: Students' perceptions and their relation to outcomes. **Computers & Education**, [*s. l.*], v. 56, issue 3, p 818-826, Apr. 2011. Available at: https://doi.org/10.1016/j.compedu.2010.10.023. Accessed on: Out. 17, 2020.

LÓPEZ-ROLDÁN, Pedro; FACHELLI, Sandra. **Metodología de la investigación social cuantitativa**. Barcelona (Espanha): Universitat Autònoma de Barcelona, 2015. Available at: https://ddd.uab.cat/pub/llibres/2015/129382/metinvsoccuan_presentacioa2015.pdf. Accessed on: Jul. 1th, 2020.

RAES, Annelies; VANNESTE, Pieter; PIETERS, Marieke; WINDEY, Ine; NOORTGATE, Wim Van Den; DEPAEPE, Fien. Learning and instruction in the hybrid virtual classroom: an investigation of students' engagement and the effect of quizzes. **Computers & Education**, [*s. l.*], v. 143, article number: 103682, Jan. 2020. Available at: https://doi.org/10.1016/j.compedu.2019.103682. Accessed on: Out. 19, 2020.

RODRÍGUEZ-RODRÍGUEZ, Julio; REGUANT-ÁLVAREZ, Mercedes. Calcular la fiabilidad de un cuestionario o escala mediante el SPSS: el coeficiente alfa de Cronbach. **REIRE Revista d'Innovació i Recerca en Educació**, [*s. l.*], v. 13, n. 2, p. 1–13, 2020. Available at: https://revistes.ub.edu/index.php/REIRE/article/view/reire2020.13.230048/31484. Accessed on Out. 09, 2020.

SHU, Hang; GU, Xiaoqing. Determining the differences between online and face-to-face student–group interactions in a blended learning course. **The Internet and Higher Education**, [*s. l.*], v. 39, p. 13-21, Oct. 2018. Available at: https://doi.org/10.1016/j.iheduc.2018.05.003. Accessed on: Out. 27, 2020.

SOUZA, Ana Cláudia de; ALEXANDRE, Neusa Maria Costa; GUIRARDELLO, Edinêis de Brito. Propriedades psicométricas na avaliação de instrumentos: avaliação da confiabilidade e da validade. **Epidemiologia e Serviços de Saúde**, Brasília, v.26 n. 3, p. 649-659, jul./set. 2017. Available at: http://scielo.iec.gov.br/scielo.php?script=sci_arttext&pid=S1679-49742017000300649&lng=pt&nrm=iso. Accessed on: Out. 08, 2020.

VANSLAMBROUCK, Silke; ZHU, Chang; PYNOO, Bram; LOMBAERTS, Koen; TONDEUR, Jo; SCHERER, Ronny. A latent profile analysis of adult students' online self-regulation in blended learning environments. **Computers in Human Behavior**, [*s. l.*], v. 99, p. 126-136, Oct. 2019. Available at: https://doi.org/10.1016/j.chb.2019.05.021. Accessed on: Out. 20, 2020.

WESTERLAKEN, Mirjam; CHRISTIAANS-DINGELHOFF, Ingrid; FILIUS, Renée M.; VRIES, Bas de; BRUIJNE, Martine de; VAN DAM, Marjel. Blended learning for postgraduates: an interactive experience. **BMC Medical Education**, [*s. l.*], v. 19, article number: 289, 2019. Available at: https://doi.org/10.1186/s12909-019-1717-5. Accessed on: Out. 23, 2020.

ZELLER, Richard A.. Measurement error, issues and solutions. *In*: KEMPF-LEONARD, Kimberly (Editor-in-chief). **Encyclopedia of social measurement**. [*s. l.*]: Elsevier, 2005. p. 665-676. Available at: https://doi.org/10.1016/B0-12-369398-5/00109-2. Accessed on: Out. 11, 2020.