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Scale Development on University Students' Digital and Online Competencies

Desarrollo de una escala de competencias digitales y en línea para estudiantes universitarios

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ABSTRACT

This study aims to develop a self-assessment tool to help university students independently evaluate their digital and online competencies (DOCs). A quantitative methodology was employed, focusing on instrument validation and its ability to measure DOCs effectively. The development process was conducted in four structured phases, combining theoretical foundations with empirical testing. Data were collected from 945 students in the initial survey to test the instrument's reliability and validity, followed by a larger sample of 2954 students for confirmatory analysis using Structural Equation Modelling–Partial Least Squares (SEM-PLS). The results confirmed that the tool provides a robust, scientific scale capable of measuring DOCs accurately. Additionally, this tool allows students to assess their readiness and improve their competencies in alignment with the increasing demands of digital learning environments in higher education. The research highlights the importance of developing scalable, adaptable self-assessment instruments to support lifelong learning and digital literacy among students. This validated scale offers significant potential for broader implementation and research in educational technology contexts.

RESUMEN

Este estudio tiene como objetivo desarrollar una herramienta de autoevaluación en línea que permita a los estudiantes universitarios evaluar de forma independiente sus competencias digitales y en línea (DOC). Se empleó una metodología cuantitativa enfocada en la validación del instrumento y su capacidad para medir las DOC de manera efectiva. El proceso de desarrollo se llevó a cabo en cuatro fases estructuradas, combinando fundamentos teóricos y pruebas empíricas. Los datos se recolectaron de una muestra inicial de 945 estudiantes para evaluar la confiabilidad y validez del instrumento, seguida de una muestra ampliada de 2.954 estudiantes para un análisis confirmatorio utilizando Modelos de Ecuaciones Estructurales (SEM-PLS). Los resultados confirmaron que la herramienta proporciona una escala científica robusta capaz de medir las DOC con precisión. Además, este instrumento permite a los estudiantes evaluar su preparación y mejorar sus competencias en consonancia con las crecientes demandas de los entornos de aprendizaje digital en la educación superior. La investigación subraya la importancia de desarrollar instrumentos de autoevaluación escalables y adaptables que apoyen el aprendizaje continuo y la alfabetización digital. Esta escala validada ofrece un potencial significativo para su implementación y para investigaciones futuras en tecnología educativa.

KEYWORDS - *PALABRAS CLAVE*

Digital and online competence (DOC), distance education, students' DOCs, online learning, DOC instrument

Competencia digital y en línea, educación a distancia, estudiantes, aprendizaje en línea, instrumento

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1. INTRODUCTION

Due to the long coronavirus disease 2019 (COVID-19) pandemic, education continues to rethink learning strategies and evaluations that can be supported by technologies (Hashim et al., 2021; Kusmawan, 2018a, 2022; Novella-García & Cloquell-Lozano, 2021; Pettersson, 2018). In higher education environments, research and discussions have recently focused more and more on digital literacy and competencies to support student learning, which has made it necessary to build digital transformation to study the impact of digital shock (Hashim et al., 2021). Various perspectives and definitions of digital and online competence (DOC) continue to expand beyond the existing developments in the media and technology fields concerning creating a digital literacy mindset. However, few colleges or schools focus their research and development on developing tools for students to evaluate whether they have sufficient and appropriate digital and online skills.

In recent years, more and more online learning models have been developed to implement education, such as open and distance learning models (Anderson & Dron, 2011), blended learning (Blayone et al., 2018; Cleveland-Innes & Garrison, 2012; Palalas et al., 2015), mobile learning (Alhassan, 2016; Blayone et al., 2017, 2018), and digital collaboration (Islam et al., 2017). These are improving the learning function of digital learning models (Blayone et al., 2018; Siemens et al., 2015), which is supported by a combination of learning activities, digital devices, and global networks that aim to achieve educational goals (Beetham & Sharpe, 2013). In addition, recent studies have emphasized the role of digital literacy in online learning readiness and satisfaction. Wijaya & Ediyono (2022) and Ikaningrum & Sarwanti (2021) highlight the importance of digital literacy in enhancing students' ability to access, evaluate, and use digital resources effectively. Gumelar et al. (2022) further stress that higher digital literacy leads to improved perceptions and satisfaction with online learning environments.

Online learning practices are also increasingly diverse, combining various technologies, pedagogies, and cultural values in an integrated manner (Beetham & Sharpe, 2013; Blayone et al., 2018; Bui et al., 2003). Another model of online learning known as massive open online courses emphasizes the presentation of content regarding specific skills and is open access; it can be accessed by the wider learning community globally (Blayone et al., 2017; Bocconi et al., 2016; Kusmawan et al., 2006; Yuan, 2015). Additionally, online learning models that seek to implement an interactive learning management system that maximizes individual flexibility in supporting various forms of learning are known as cooperative learning (Beetham & Sharpe, 2013; Dalsgaard & Paulsen, 2009; Paulsen, 2008) and collaborative learning models (Anderson & Dron, 2011; Garrison & Archer, 2000). However, challenges such as network connectivity and accessibility to digital resources still pose barriers. Subban et al. (2022) identified that while students may be digitally ready, issues like internet coverage remain critical obstacles to effective online learning. Furthermore, Lusianai et al. (2022) suggest that targeted training programs in digital tools like Mendeley can improve students' digital competencies and access to academic resources.

As mentioned above, the development of various learning models indicates that learning media facilities are increasingly open with various services based on various technologies and are continuously and rapidly developing. Encouragement and facilities are needed for our student's

capacity to be reliable online learners. We must also prepare a learning environment that allows students to develop DOCs (López-Meneses et al., 2020). Given that most conventional universities have started implementing open and distance education systems, structured training or training facilities should be provided for students to improve their DOCs. However, training activities usually entail a long journey. Hence, to facilitate the development of these competencies both independently and sustainably, other alternatives are required. This research proposes the need for a flexible tool to permit a self-evaluation process that is sustainably used by all students to measure their online learning competencies independently and continuously. Such a tool can be provided in various ways. For this reason, this research argues that DOCs measurement tools flexibly help students measure their competencies independently (Kusmawan, 2018b). Consequently, this paper focuses on a research problem of how the DOC scale instrument was constructed and how the quality of the scale instrument is measured statistically through its validity and reliability.

2. STUDENT LEARNING READINESS

2.1 Digital Skills and Learning Competencies

The International Telecommunication Union (ITU) has categorized digital skills into three groups based on individual digital competencies: basic, standard, and advanced (Berita Satu Research, 2021). Furthermore, the ITU explains that basic digital skills comprise the ability to copy or move files or folders, copy, and paste tools to replicate or move material within documents, send emails with attached files, and transfer files between computers and other devices. Additionally, standard digital skills include creating content by using personal devices such as smartphones or computers, using spreadsheet formulas in one's work or study, and creating presentations that contain text, images, videos, or charts by using presentation software. A person is considered to have standard skills if they can find, download, install, and configure software and transfer files between computers and other devices. Third, advanced digital skills depend on the ability to create computer programs by using specialized programming languages. Implementing a digitalization strategy that will cultivate a broad range of 21st-century skills will enable students to use technology in flexible, adaptive, and innovative ways (Berita Satu Research, 2021; Bond et al., 2018).

Several international studies report an increasing trend in online course attendance (Ramos et al., 2011). Several meta-analytic studies have proven that online learners exhibit learning strategies and skills that are relatively suitable for students engaging in face-to-face learning (Blayone, 2018; López-Meneses et al., 2020; Reyna et al., 2019). Additionally, in other studies, it was found that the proportion of students who abandon online colleges was very high (Al-Araibi et al., 2016; Dalsgaard & Paulsen, 2009; Kusmawan, 2017b; Nora & Snyder, 2009). To prevent high dropout rates, most community colleges in the United States use online readiness surveys to select prospective students interested in enrolling in online courses (Cooper & Allen, 1971). These survey results are used to predict the readiness of prospective students who will take online lectures. In a more recent study, Tan et al. (2024) identified cognitive processing and technology use as crucial for adapting to digital learning environments in vocational education, highlighting the importance of these competencies for future career demands. Similarly, Chaw & Tang (2023) emphasize that digital competence in higher education is linked

to improved learning performance, particularly in areas such as data literacy and problem-solving. However, no research has been done to evaluate how well the results of online learning readiness surveys can predict student performance during online courses. Thus, there has not been a clear report on whether college survey results can predict student performance or influence the decisions of prospective students to continue taking online courses.

Based on the above-mentioned literature, there are two intersecting issues: online versus face-to-face (F2F) learning and high dropout rates of online learners. However, amid the COVID-19 pandemic, where traditional F2F higher education has also entailed online education modes, the demands of both learning strategies are similar. Namely, they both require an evaluation of students' readiness to become online learners. Their evaluation strategies should also be similar. Both must measure the competence of digital and online learners as a prerequisite for adequately attending online lectures. Recent findings by Wicaksono & Prasetiyo (2023) suggest that integrating digital skills into learning processes is crucial, especially in the context of digital native students who require engagement through tailored strategies. Furthermore, Zakharevych & Hryhorenko (2024) argue that beyond technical abilities, digital competence must include critical thinking and information literacy to ensure students can navigate complex digital landscapes effectively. The following section will discuss the concept of online learning readiness.

2.2 A Tool to Measure Student Online Learning Readiness

Measuring a student's online learning readiness reveals various success factors in the multiple conditions that support it, including learning readiness models (Alaaraj & Ibrahim, 2014; Nora & Snyder, 2009) and learning readiness tools (Hung et al., 2010). Researchers on this topic generally adopt a macrolevel perspective (Blayone et al., 2018), focusing on organizational, regional, and national readiness. However, several studies use a microlevel perspective (Blayone, 2018) by focusing specifically on students or teachers (Gay, 2016). At the micro level, digital competence is defined as the knowledge, skills, and attitudes supported through technology readiness (Ala-Mutka, 2011; Kusmawan, 2017a; Kusmawan et al., 2006; Lin et al., 2016). This understanding entails online learning readiness tools (Blayone, 2018).

For online learning providers, to evaluate the online learning readiness of students, several measuring tools have been developed. One of these instruments has been published online by Pennsylvania State University at:

https://pennstatelearning.psu.edu/istudy_tutorials/learningonline/ORQ/ORQ.htm.

The instrument uses five aspects that are considered factors in online learning readiness, namely, self-direction, learning preferences, learning habits, learning technological skills, and computer equipment capabilities. Several other aspects of measurement have emerged, including computing skills, digital technology, and information retrieval skills. The above-mentioned aspects of competence can be used as benchmarks for this research while constructing the DOCs, which were considered to be the minimum standard for students' ability to learn independently.

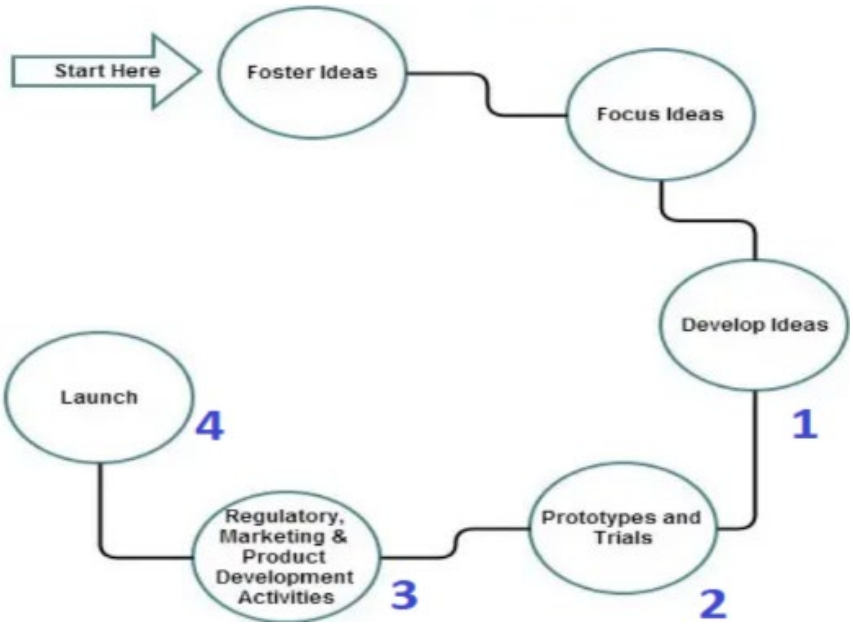
In conclusion, four main competency areas in online and digital learning generally constitute topics of worldwide research: (a) access to technology, (b) belief in using technology for

learning, (c) readiness to become an independent learner, and (d) learning styles and habits. These areas have the potential to reveal the online learner competencies that institutions can foster to facilitate distance learning or independent online learning of students. In an integrated manner, these four competency areas are named DOCs.

Additionally, Fig. 1 shows phases to be considered as the procedure of researching and developing a product, starting from fostering ideas to launching the product open to the public (Luenendonk, 2019). Based on Fig. 1, there are at least four phases that constitute the minimum procedure for developing an instrument, namely, developing ideas, prototyping a blueprint and trialing the first product of the instrument, gaining the first result of the instrument through a field study (survey), and applying (piloting) the instrument to actual students.

Figure 1

Phases of an instrument



Source: Luenendonk (2019)

2. METHODS

3.1 Research Design

The quantitative research and analyses were aimed to acquire a measurement scale of students' DOCs. There are, generally, seven steps considered in scale development, that is, (1) determination of measuring construction, (2) preparation of item indicators, (3) content validity testing, (4) trials, (5) field tests, (6) item selection, and (7) preparation of the final scale (Ghomi & Redecker, 2019; Larasati & Widyastuti, 2020; Risnita, 2012). Considering field activities conducted while developing the scales, this research recognized the developing

model of Borg and Gall (1983), comprising a four-step development process, reorganized the seven steps into four, containing measurable cycle steps to ensure that the designed product has a feasibility standard: 1) reviewing the results of previous research, 2) developing products, 3) testing the designed product, and 4) reviewing and correcting the product based on the test results. Table 1 presents the research steps and programs and research development output targets.

Table 1

Steps, programs, and research development targets

No.	Field Research	Scale Development and Analyses Procedure	Target
1	Review the results of previous research to develop ideas	1. Determine measuring construction; past research and information collecting; include literature reviews and preparations for a research framework. 2. Prepare item indicators; planning includes the formulation of students' digital and online competencies (DOCs).	✓ Literature review and analyses ✓ Components of DOC
2	Prototyping a product and trialing the first product of an instrument	3. Content validity testing. ▪ Develop a blueprint product design of DOC instrument and application ▪ Initial testing, conducting initial field trials on a limited scale.	✓ DOC instrument design ✓ Workflow design
3	Test the designed product to gain the first result of the instrument through a survey	4. Trials: the primary test involving broader students. Operational product revision, namely, making improvements to broader testing scale results so that the product developed is already an operational model design ready to be validated. 5. Field testing: Operational field testing is a validation step on the operational model produced. 6. Item selection: making final improvements to the developed model to produce a final product.	✓ First field-tested DOC instrument
4	Review and correct the product based on a pilot survey of the instrument to actual students	7. Preparation of the final scale; dissemination and implementation are steps to disseminate the developed product/model and apply it in the field. 8. Do a pilot study.	✓ Field-retested DOC instrument ✓ Field-retested DOC self-evaluative app workflow design

3.2 Research Instruments

The instrument designed in this research is called a DOC instrument. It is designed in a Likert scale format. A scale can be used as a research data collection tool (Geng et al., 2019). Furthermore, a scale can be used to measure a person's values, attitudes, interests, and comfort levels and can be represented in the form of a survey statement that is based on

collected survey data, where a range of values is calculated based on the frequency interval formula (Alem et al., 2016; Hung, 2016; Lin et al., 2016; Risnita, 2012; Sudjana, 2006). This research has produced a four-competency-area instrument based on several previous studies and expertise inputs suggested by experts engaged in this study. Table 2 shows the structure of this DOC instrument.

Table 2

*Competencies and measurement**

No.	Competence Areas	Measurement Goal
1	Access to information and technology	Exposing students' access to communication technology media
2	Use of technology for learning	Discovering students' potential for online learning
3	Readiness to learn independently	Determining students' readiness for an independent (self-directed) learning
4	Learning habits and styles	Discovering students' learning habits and styles

* Detail question statements are enclosed in this paper

The DOC instrument is designed in a Likert scale format with a four-point option and a total of 30 questions. It is slightly different from other Likert scales, which usually ask for responses regarding the attitudes of respondents; here, the four options for each DOC survey item are intended to elicit the ideas or activities of respondents that they use every day and are related to the use of learning technology for learning (Sappaile, 2007). This follows the research objective of obtaining an instrument to reveal students' DOCs (Sudjana, 2006). The DOC instrument survey can be seen at https://forms.office.com/r/tLTxaCTx9x. The answer categories range from 1 to 4, indicating the “most minimum” to “standard” statements relating to the competencies mentioned in Table 2.

3.3 Research Participants

Research participants were divided into two groups: student respondents, as users of research products, and expert groups, as sources of information related to instrument quality and application design. In the second phase of research in 2021, however, activities involving experts are no longer being applied because they were carried out in phase 1 research in 2020, and the results have been published (Kusmawan, 2020). Participants in this study are students at the Faculty of Teacher Training and Education, Universitas Terbuka, Indonesia (population). The sample of respondents was randomly selected from the relevant population group. Student respondents consisted of two groups. The first group, composed of 945 students, and the second group, composed of 2,954 students, both took part in the DOC instrument survey.

3.4 Research Analyses

To obtain information on the reliability of the DOC instrument, quantitative data analysis was conducted. Data processing was initially conducted using SPSS to obtain Cronbach’s alpha values in the reliability tests of the DOCs of both groups. Following analyses aimed to scrutinize

the strength of the items in terms of their support for each of the four competency groups, the study conducted a multivariate analysis using the structural equation modeling–partial least square (SEM-PLS). The use of this statistical analysis is primarily driven by conditions in which the sample size of this study is large enough. In the meantime, literature concerning DOC instrumentation has been limited in practical examples of how the construct of these competencies must be structured.

Through the analyses, this study found loading factor/outer loading to be one of the measures to reveal whether a question is valid or not. The loading factor is the number that shows the correlation between the score of a question item and the score of the indicator that measures the contract. In this study, the loading factor was used in testing the validity of question items.

Decision-making is based on the value of the loading factor; if the loading factor value is greater than 0.5, then the question item is valid (Ghozali, 2008; Truong & McColl, 2011).

3. RESULTS AND DISCUSSION

4.1 DOC Instrument's Validity and Reliability

As previously mentioned (see Table 1), the research product is the DOC instrument. The instrument was constructed as a four-point Likert scale that stretches the respondent's choice of opinion ranging from a score of 1, indicating unacceptable opinion to a score of 4, indicating the one that corresponds to the respondent's opinion.

The number of items of the instrument was initially 34 items. All these items are categorized into four groups: access to technology for learning, the use of technology for learning, readiness to learn independently, and learning habits and styles, as shown in Table 2. Grouping the items was based on the judgment of the researcher's expertise assuming that based on the results of the literature reviews, four factors contributed to students' DOCs.

Considering the data as results of the field surveys, statistical analysis was then carried out on the 34 items and analyzed to determine the validity and reliability of the instrument, as well as validate the group factors that are the grouped items. As mentioned in Table 1, the survey was conducted twice. Therefore, based on the second survey, further confirmatory statistical analyses were applied to get items that are confirmed to be valid and reliable in its group.

The first survey was responded to by 945 respondents. Having the quality of the DOC instrument validity and reliability determined, as well as their grouping factor, Table 3 shows that the first trial of the survey has resulted from a principal component analysis with the rotation method of Varimax with Kaiser normalization indicating a significantly high Cronbach's alpha value of 0.825 (N=34). The value suggests a high validity of the DOC instrument. In addition to Cronbach's alpha, the reliability of the instrument was further evaluated using Zumbo's ordinal alpha, which is recognized as more suitable for Likert-type scales. The results indicated a high ordinal alpha value, thereby enhancing the reliability estimation of the DOC instrument in this context. Further analysis with factor analyses has resulted in a four-grouping factor (bold-shaded in Table 4) corresponding to the assumed factors developed in this study.

However, some items do not belong to certain factors leaving 28 valid and reliable item instruments.

Table 3

Reliability statistics of DOC instrument: Trials field testing

Case Processing Summary			
		N	%
Case	Valid	945	100.0
	Excluded[a]	0	0.0
	Total	945	100.0

Note. a. Listwise deletion based on all variables in the procedure.

Table 4

Item–total statistics correlations (validity analyses)

Rotated Component Matrix[a]							
Item	Component						
	1	2	3	4	5	6	7
Q1	−.016	.990	−.011	−.017	−.007	−.019	.012
Q2	−.005	.986	−.011	−.018	.014	−.026	.013
Q3	−.011	.987	−.008	−.015	−.004	−.024	.006
Q4	−.016	.991	−.007	−.020	.013	−.014	.009
Q5	−.019	.991	−.013	−.017	−.001	−.020	.012
Q6	−.051	−.035	−.191	.033	−.002	.804	.015
Q7	−.237	−.134	−.078	−.101	.102	−.052	.625
Q8	.011	−.010	.989	.016	.045	−.034	−.032
Q9	.028	−.017	.978	.013	.050	.003	−.016
Q10	011	−.016	.969	.016	.038	−.055	−.022
Q11	.012	−.015	.992	.013	.038	−.024	−.023
Q12	.008	−.011	.990	.017	.027	−.037	−.029
Q13	−.015	.461	−.018	.019	−.060	.005	−.338
Q14	−.025	−.037	.068	.000	.055	.840	.033
Q15	−.001	−.019	.029	**.616**	.014	−.107	−.029
Q16	.128	.011	−.006	**.620**	.032	.084	−.069
Q17	.079	−.011	−.007	**.541**	.054	.023	−.240
Q18	.045	.029	.089	**.688**	.078	−.022	.129
Q19	.087	.032	.002	**.666**	.031	−.012	.167
Q20	.093	−.089	−.042	**.610**	−.016	.081	−.099
Q21	.170	.070	−.028	−.005	−.087	.093	.627
Q22	.988	−.021	−.011	.073	.049	−.018	.003
Q23	.975	−.026	−.008	.069	.042	−.005	.015
Q24	.988	−.022	−.009	.074	.033	−.014	.003
Q25	.981	−.028	.005	.081	.057	−.023	.004

Rotated Component Matrix[a]							
Item	Component						
	1	2	3	4	5	6	7
Q26	.985	−.028	.007	.069	.066	−.010	.009
Q27	.987	−.022	.005	.073	.048	−.008	.005
Q28	.991	−.023	.005	.076	.064	−.019	−.003
Q29	.991	−.023	.005	.076	.064	−.019	−.003
Q30	.018	−.025	.006	.094	.679	−.086	.156
Q31	.063	−.006	.105	−.008	.812	−.036	−.135
Q32	.006	.007	.029	.010	.824	.023	−.046
Q33	.202	−.001	.023	.094	.663	.192	.031
Q34	-.599	-.290	-.309	-.284	.036	-.057	.198

Note. Extraction Method: principal component analysis. Rotation method: Varimax with Kaiser normalization; a. Rotation converged in five iterations.

Having the results based on the first survey, this research conducted the second one. The second survey was conducted on the Faculty of Teacher Training and Education (FTE) students. The survey was administered online using Microsoft Forms. The respondent was selected randomly. The survey received 2,954 responses from the FTE students, at Universitas Terbuka, Indonesia. The survey results were analyzed by SPSS using the statistical reliability of the instrument, with the quality standpoint referring to Cronbach's alpha value.

As shown in Table 5, the analysis results show that the reliability score of the 28 DOC instrument items is 0.938 (Cronbach's alpha) and 0.915 (Cronbach's alpha based on standardized items). These statistical results indicate a very high level of reliability of the survey instrument (Sappaile, 2007; Sudjana, 2006; Suryabrata, 2000). In addition to Cronbach's alpha, the inclusion of Zumbo's ordinal alpha for reliability estimation yielded a high ordinal alpha value, further confirming the reliability of the DOC instrument. This additional reliability measure reinforces the robustness of the instrument for evaluating students' digital and online competencies.

Table 5

Reliability statistics of DOC instrument

Case Processing Summary			
		N	%
Case	Valid	2954	100.0
	Excluded[a]	0	0.0
	Total	2954	100.0

Note. a. Listwise deletion based on all variables in the procedure

Table 6 shows the item–total statistical analysis results. It shows "Corrected item–total correlation" and "Cronbach's alpha if item deleted" for all items have values higher than the r-table value of 0.3491 (df = 28, t = .05) (Hidayat, 2012). It indicates that all individual survey

items have a strong correlation with the total score of the survey instrument. It means that all DOC survey instrument items are statistically valid and reliable (Sudjana, 2006).

Table 6

Item–total correlations (validity analyses)

	Item–total statistics			
Item	Scale Means if an Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if the Item Deleted
Q1	87.68	173.003	.466	.917
Q2	87.73	173.100	.417	.917
Q3	87.71	173.085	.389	.917
Q4	87.73	173.154	.307	.917
Q5	87.68	173.021	.419	.917
Q8	86.61	174.994	.391	.916
Q9	86.60	174.888	.381	.916
Q10	86.61	174.938	.379	.916
Q11	86.61	174.890	.411	.916
Q12	86.60	174.899	.456	.916
Q15	86.89	171.502	.458	.918
Q16	87.13	172.121	.387	.916
Q17	87.39	170.066	.502	.919
Q18	87.03	170.673	.512	.917
Q19	86.95	173.012	.487	.916
Q20	87.24	172.717	.519	.917
Q22	87.02	157.323	.870	.906
Q23	87.02	157.459	.864	.906
Q24	87.02	157.328	.871	.906
Q25	87.02	157.389	.869	.906
Q26	87.02	157.350	.868	.906
Q27	87.02	157.326	.871	.906
Q28	87.02	157.539	.861	.906
Q29	87.02	157.369	.867	.906
Q30	87.02	157.326	.870	.906
Q31	87.02	157.451	.865	.906
Q32	87.02	157.363	.867	.906
Q33	87.02	157.332	.870	.906

4.2 Confirmatory Analyses with SEM-PLS

Having those 28 items is statistically valid and reliable against the factors that contribute to students' DOCs. A further analysis using SEM was applied. SEM is one of the areas of statistical study that can test a series of relationships that are usually difficult to measure simultaneously

(Hair et al., 2021). SEM is a multivariate analysis technique that combines factor analysis and regression analysis (correlation), with the aim of testing the relationship between variables in a model, both between indicators and their constructs and relationships between constructs.

PLS is a component or variance-based SEM structural equation model. PLS is an alternative approach that shifts from a covariance-based to a variance-based SEM approach. SEMs based on covariance generally test causality or theory, whereas PLS is more toward predictive models given to big data analysis (Monecke & Leisch, 2012). Monecke and Leisch (2012) went on to explain that in PLS. There is a loading factor/outer loading, which is one of the measures to determine whether a question is valid or not. A loading factor is a number that shows the correlation between the score of a question item and the score of the indicator that measures the contract. In this study, the loading factor was used in testing the validity of question items. Decision-making is based on the value of the loading factor; if the value of the loading factor is greater than 0.5, then the item in question is valid (Ghozali, 2008; Truong & McColl, 2011). From the results of the loading factor of the second survey with data from 2,945 respondents, it can be found that all question items are valid due to the loading factor values of all variables being greater than 0.7.

4. CONCLUSION

Overall, as evidenced by the statistical analysis results, this study has produced a DOC instrument with a high level of validity and reliability. The instrument was constructed based on the result of literature reviews on how a DOC is developed. As reported before, the items are developed about several preceding research alike and are then grouped into four factors assuming that these factors are the main aspects that contribute to the students' DOCs.

Through two phases of field surveys, this study found that the field results corresponded with the factors assumed and formulated at the beginning of the study. The results of this study show its success in confirming the Likert scale developed and promoted initially as a DOC instrument with a high level of statistical validity and reliability tests. Confirmation analysis through SEM-PLS has further proven that the four-scale instruments can be firmly constructed as DOC Instruments.

5.1 Limitations and Recommendations of the Study

This research has the advantage of providing alternative measurements of DOCs and has been studied with the scope of respondents from several regions in Indonesia. However, the targeted respondents of this study were not only students in college but also students in high schools; thus, the proportion of respondents is still considered to be less symmetrical to the regional representativeness. Nevertheless, with some follow-up research that could be designed as replicative to this study in the future, the researcher is confident that this study would be more polished in terms of the extent that this instrument can be advanced.

This study recommends that further research be conducted on a broader range of respondents to get a more thorough level of trust from potential users when using the DOC instrument. To develop an online media or application to deliver this DOC instrument, further research is necessary. This media/application may accommodate students' self-evaluation of their DOCs.

Such an application could be designed to maintain the sustainability of the self-evaluation process for students. Focus research analyses on this area should be statistical analyses related to the usability and user-friendliness of the application.

5. AUTHORS' CONTRIBUTIONS

D.S.; formal analysis, U.K. and D.S.; funding acquisition, U.K. and D.S.; investigation, U.K. and D.S.; methodology, U.K. and D.S.; project administration, U.K. and D.S.; resources, U.K. and D.S.; software, U.K. and D.S.; supervision, U.K. and D.S.; validation, U.K. and D.S.; visualization, U.K.; writing—original draft preparation, U.K. and D.S.; writing—review and editing, U.K. and D.S.

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