Content Validation of Digital Instrument for Measurement of Pedagogic Competence for Social Science Teacher Candidates in the Industrial Revolution 4.0 Era in Indonesia

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***Abstract*—The primary objective of this study is to determine the content validity of digital instruments used to assess social studies teacher candidates in Indonesia during the Fourth Industrial Revolution. The development of instruments was used as a research strategy. Two experts were used as content validity test subjects. Multiple-choice questions were used to elicit information on the pedagogical abilities of prospective social studies teachers. In this study, the instrument's content validity was determined using an expert test based on the Gregory formula. According to the findings of this investigation, the instrument's content validity is very high.**

***Index Terms*—Content validity, digital instruments, pedagogic competence, social studies teacher candidates, Industrial Revolution 4.0.**

I. Introduction

The Indonesian government is attempting to overcome the big challenges related to the learning process in the Industrial Revolution 4.0, especially in the field of primary and secondary education by increasing the competence of teacher candidates from the start. The competence of teacher candidates can be known well through the process of measuring their competence. Competency measurement can be done using a valid instrument.

The reality on the ground is that many competency measurement processes are still inefficient. This is because the instrument used to take the measurements is not yet valid. Additionally, the measurement process is still conducted in the traditional manner, with questionnaires distributed face to face to respondents [1]-[3]. As a result, innovations must be made to provide measuring tools that respondents can complete online rather than in person. One of the innovations that could be implemented is the provision of digital instrument. Even though the instrument is digital, its content must be validated. As a result, content validity testing of the digital instrument used in this study is necessary.

This research builds on the findings of several previous studies that examined instrument development. Rejeki *et al*. demonstrates the development of a digital instrument based on a Decision Support System (DSS) for the purpose of identifying mentally disabled children [4]. The research has not yet detailed the procedure for determining the instrument's content validity. Megananda *et al*. demonstrate the development of a digital distance measuring instrument based on an Arduino Uno for use in a physics practicum [5]. The difficulty encountered in Megananda research is that the procedure for calculating the content validation of the measuring instrument has not been demonstrated. Dewi *et al*. demonstrated the formula for determining the content validity of the instrument used to measure resilience [6]. The obstacles encountered in Dewi research's do not yet illustrate the content validity formula's calculation process.

Dubrova *et al*. demonstrate how to quantify and analyze the experience of using digital tools in educational settings [7]. The difficulty encountered in Dubrova *et al*.'s research is that the procedure for calculating the content validation of the measuring instrument has not been demonstrated. Dewi *et al*. demonstrated the formula for determining the content validity of an instrument used to assess resilience [6]. The obstacles encountered in Dewi *et al*.'s research do not yet illustrate the content validity formula's calculation process. Waltner *et al*.'s research demonstrates the development of instruments to assess students' sustainability competencies and the validation process [8]. Waltner *et al*.'s research did not demonstrate an exhaustive calculation process for determining the validity of the instrument used to assess students' sustainability competence.

Based on the problems in the field, the innovations offered, and some previous research that underlies this research, the primary purpose of this research is to determine the content validity of the digital instrument used to measure the pedagogic competence of social studies teacher candidates in the Industrial Revolution Era 4.0, especially in Indonesia. The question of this research is how to calculate the content

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validity of digital instrument to measure the pedagogic competence of social studies teacher candidates in the Industrial Revolution 4.0 Era in Indonesia?

II. Research Method

A. Approach and Focus of Research

This research approach is instrument development. The steps are taken to develop digital instrument to measure the pedagogic competence of social studies teacher candidates in the Industrial Revolution 4.0 Era in Indonesia can be seen in Fig. 1.

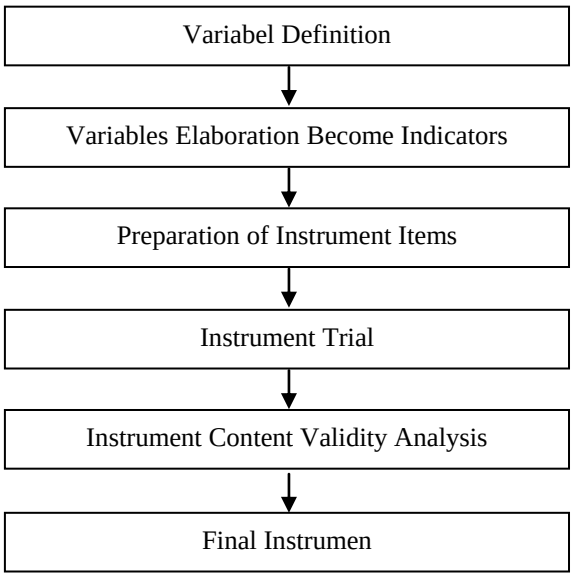

Fig. 1. Development stages of digital instrument to measure pedagogic competence of prospective social sciences teachers in the Industrial Revolution 4.0 Era in Indonesia.

The focus of this research was only on developing digital instruments to measure the pedagogic competence of social studies teacher candidates. This is conducted based on the special assignment given by the Directorate General of Research and Development, Ministry of Education, Culture, Research and Technology of the Republic of Indonesia to the research teams to develop digital instruments focused only on social studies teacher candidates.

The variable definition stage is used to ascertain the educational/learning aspects of social studies that social studies teacher candidates must be familiar with. The stage of elaborating variables to indicators is used to establish question indicators that are relevant to the educational/social studies component of learning. The stages of instrument item compilation were completed in order to obtain instrument items that were used to assess the pedagogic competence of social studies teacher candidates in Indonesia during the Industrial Revolution 4.0 era. The instrument testing phase was designed to evaluate the content validity of the instrument developed with the assistance of experts and the instrument's reliability, which had been developed with the assistance of several social studies teachers. The stages of instrument content validity analysis were used to analyze data from the content validity test results for each instrument item conducted by two experts, in order to determine which instrument items were invalid and should be discarded, and which instruments should be used.

B. Research Subject

The research subjects for the content validity test of the digital instrument are social studies teacher candidates in Indonesia during the Industrial Revolution 4.0 era. Two experts in the field of social studies education and two experts in the field of information technology education evaluation are on board. The final digital instrument will be distributed to prospective social studies teachers from several universities in Indonesia that offer social studies education study programs. A purposive sampling technique is used to determine which social studies teacher candidates will complete the digital instrument.

C. Research Object

The object being targeted in this research is a digital instrument used to measure the pedagogic competence of social studies teacher candidates in the Industrial Revolution 4.0 era in Indonesia.

D. Research Location

The final digital instrument will be filled in by several social studies teacher candidates from *Universitas Pendidikan Ganesha* and *Universitas Negeri Yogyakarta*. This selection is based on the purposive sampling technique used to select respondents, specifically at the two universities, because both universities already have prospective teachers who have completed a study program in social studies education.

E. Data Collection Instrument

The instrument used to obtain data related to the pedagogic competence of social studies teacher candidates is in the form of multiple-choice questions that are already valid. Besides being valid, the questions are also packaged in digital format.

F. Data Analysis Technique

Testing the validity of the instrument's content in this study was carried out through expert testing using the Gregory formula. The Gregory formula in question is as follows [9]-[11].

$$\text{Content Validity} = \frac{D}{A + B + C + D} \tag{1}$$

Notes:

A = cell that showed disagreement between the two assessors

B and C = cells that showed differences in views between assessors

D = cells that showed valid agreement between the two assessors

Categorization of content validity results refers to the classification of validity proposed by Guilford, with the following details [12]-[16]:

$0{,}80 < r_{xy} < 1{,}00$: very high validity
$0{,}60 < r_{xy} < 0{,}80$: high validity
$0{,}40 < r_{xy} < 0{,}60$: intermediate validity
$0{,}20 < r_{xy} < 0{,}40$: low validity

$0{,}00 < r_{xy} < 0{,}20$: very low validity
$r_{xy} < 0{,}00$: invalid

III. Result and Discussion

Based on the steps for developing digital instrument described previously in the methodology, several results can be shown following these development steps. The results in question can be explained in full as follows.

A. Results of Variable Definition

There are several variables in the digital instrument to measure the pedagogic competence of social studies teacher candidates in the Industrial Revolution 4.0 Era in Indonesia. Those variables can be defined based on the results of direct observations in the field regarding the obstacles in the implementation of measuring the pedagogic competence of social studies teacher candidates. Those variables intended, included:

A1. Have a comprehensive ability to master the characteristics of students from the physical, moral, spiritual, social, cultural, emotional, and intellectual aspects.

A2. Have a comprehensive ability to master learning theory and educational learning principles.

A3. Have competence in developing curriculum related to social studies subjects.

A4. Utilizing information and communication technology for learning purposes.

A5. Have comprehensive competence in the use of social studies learning resources.

A6. Have comprehensive competence in planning social studies learning at school

A7. Have comprehensive competence in implementing social studies learning in schools that are active, innovative, creative, effective, and fun.

A8. Have comprehensive competence in evaluating social studies learning in schools.

B. Results of Variable Elaboration Become Indicators

Based on the variables that have been obtained previously, the indicators can then be determined. As for several indicators in digital instrument to measure the pedagogic competence of social studies teacher candidates in the Industrial Revolution 4.0 Era in Indonesia, the details can be seen in Table I.

TABLE I: Indicators in Digital Instrument to Measure the Pedagogic Competence of Prospective IPS Teachers in the Era of the Industrial Revolution 4.0 in Indon

Variabel	Indicators	
A1	I1	Identifying the emotional intelligence needed to master the characteristics of students as an initial teaching provision in social studies subjects
	I2	Mention the possible difficulties of students in learning certain social studies topics
A2	I3	Apply learning theory by maximizing digital technology with educational learning principles in social studies subjects
	I4	Determine the steps in social studies learning for specific basic competencies
A3	I5	Formulating learning objectives for specific basic competencies in social studies subjects
	I6	Presenting the suitable social studies material, following the basic competencies/specific learning objectives
	I7	Organizing learning materials according to the chosen approach by considering the characteristics of students
	I8	Lowering indicators/instruments for achieving specific basic competencies in learning
A4	I9	Teachers can design creative learning by utilizing information and communication technology in learning lessons
A5	I10	Provided material and learning outcomes for prospective teachers can determine the relevant learning media
	I11	Determine the source of the material to be used in learning
A6	I12	Provided the context of the material for certain students/classes, prospective teachers can determine the formulation of relevant learning achievement indicators
	I13	Determine the sequence of steps in learning
	I14	Some parts of the RPP are provided in full, and prospective teachers can assess the parts of the RPP that are not appropriate
	I15	Provided certain social studies learning materials and achievements, prospective teachers can determine the relevant assessment instruments
A7	I16	Provided certain social studies learning materials and achievements, prospective teachers can determine the relevant learning model
	I17	Provided learning steps in specific learning models that some of the steps are not right, prospective teachers can determine the inappropriate steps
	I18	Provided learning steps based on KD and certain learning materials presented randomly and not coherently, prospective teachers can determine the proper learning steps according to KD and specific materials
	I19	Provided some principles related to social studies learning, prospective teachers can determine the principles that are following social studies learning
A8	I20	Determine authentic assessment instruments
	I21	Determining the critical attitude assessment instrument based on learning materials
	I22	Determining the knowledge assessment instrument based on learning materials
	I23	Determine the exact benefits of the assessment results

C. Results of Preparation of Instrument Items

Based on several indicators shown in Table I, a digital instrument was developed to measure the pedagogic competence of social studies teacher candidates in the Industrial Revolution 4.0 Era in Indonesia. The details regarding these points can be seen in Table II.

TABLE II: Items of Digital Instrument to Measure the Pedagogic Competency of Prospective IPS Teachers in the Era of the Industrial Revolution 4.0 in Indonesia

Indicators	Instrument Items
I1	There are 6 questions/instruments for indicator I1, namely BI-1, BI-2, BI-3, BI-4, BI-5, BI-6
I2	There are 4 questions/instruments for I2 indicators, namely BI-7, BI-8, BI-9, BI-10
I3	There are 4 questions/instruments for the I3 indicator, namely BI-11, BI-12, BI-13, BI-14
I4	There are 3 questions/instruments for the I4 indicator, namely BI-15, BI-16, BI-17
I5	There is 1 question/instrument item for indicator I5, namely BI-18
I6	There is 1 question/instrument item for indicator I6, namely BI-19
17	There are 4 questions/instruments for indicator I7, namely BI-20, BI-21, BI-22, BI-23

Indicators	Instrument Items
I8	There are 6 questions/instruments for indicator I8, namely BI-24, BI-25, BI-26, BI-27, BI-28, BI-29
I9	There are 4 questions/instruments for indicator I9, namely BI-30, BI-31, BI-32, BI-33
I10	There are 3 questions/instruments for indicator I10, namely BI-34, BI-35, BI-36
I11	There is 1 question/instrument item for indicator I11, namely BI-37
I12	There is 1 question/instrument item for indicator I12, namely BI-38
I13	There are 2 questions/instruments for indicator I13, namely BI-39, BI-40
I14	There are 4 questions/instruments for indicator I14, namely BI-41, BI-42, BI-43, BI-44
I15	There are 3 questions/instruments for indicator I15, namely BI-45, BI-46, BI-47
I16	There are 3 questions/instruments for indicator I16, namely BI-48, BI-49, BI-50
I17	There are 3 questions/instruments for indicator I17, namely BI-51, BI-52, BI-53
I18	There are 2 questions/instruments for indicator I18, namely BI-54, BI-55
I19	There are 3 questions/instruments for indicator I19, namely BI-56, BI-57, BI-58
I20	There is 1 question/instrument item for the I20 indicator, namely BI-59
I21	There are 5 questions/instruments for the I21 indicator, namely BI-60, BI-61, BI-62, BI-63, BI-64
I22	There is 1 question/instrument item for the I22 indicator, namely BI-65
I23	There are 2 questions/instruments for the I23 indicator, namely BI-66, BI-67

TABLE III: CONTENT VALIDITY TEST RESULTS ON DIGITAL INSTRUMENT TO MEASURE THE PEDAGOGIC COMPETENCE OF PROSPECTIVE IPS TEACHERS IN THE ERA OF THE INDUSTRIAL REVOLUTION 4.0 IN INDONESIA

Instrument Items	Experts							
	Experts 1 (Social Studies Education)				Experts 2 (IT Education Evaluation)			
	Irrelevant		Relevant		Irrelevant		Relevant	
	1	2	3	4	1	2	3	4
BI-1				√			√	
BI-2				√				√
BI-3			√				√	
BI-4			√				√	
BI-5			√					√
BI-6			√				√	
BI-7			√				√	
BI-8				√				√
BI-9				√				√
BI-10				√				√
BI-11				√				√
BI-12				√			√	
BI-13				√			√	
BI-14				√			√	
BI-15				√			√	
BI-16				√			√	
BI-17				√			√	
BI-18				√				√
BI-19				√				√
BI-20				√				√
BI-21				√				√
BI-22				√				√
BI-23				√				√
BI-24				√				√
BI-25				√				√
BI-26				√				√
BI-27				√				√
BI-28				√				√
BI-29			√					√
BI-30			√					√
BI-31			√					√
BI-32			√					√
BI-33			√					√
BI-34			√				√	
BI-35			√				√	
BI-36			√				√	
BI-37	√					√		
BI-38		√			√			
BI-39				√				√
BI-40				√				√
BI-41				√				√
BI-42				√				√
BI-43				√				√
BI-44				√				√
BI-45				√			√	
BI-46				√			√	
BI-47				√			√	
BI-48				√			√	
BI-49				√			√	
BI-50				√			√	
BI-51				√				√
BI-52				√			√	
BI-53				√			√	
BI-54			√					√
BI-55			√					√
BI-56			√					√
BI-57			√				√	
BI-58				√			√	
BI-59				√			√	
BI-60			√					√
BI-61				√			√	
BI-62			√				√	
BI-63			√				√	
BI-64			√					√
BI-65			√					√
BI-66				√			√	
BI-67				√			√	

D. *Results of Instrument Trial*

Based on several instrument items shown in Table II, the content validity test was carried out by two experts on digital instrument to measure the pedagogic competence of social studies teacher candidates in the Industrial Revolution 4.0 Era in Indonesia. The results of the instrument content validity test by the two experts can be seen in Table III.

E. *Results of Instrument Content Validity Analysis*

Based on the test results in Table III, these results can be analyzed using the Gregory formula with the following calculation process.

1) *Compilation of test results from both experts*

TABLE IV: COMPILATION OF THE RESULTS OF THE EXPERT'S TRIAL ON DIGITAL INSTRUMENTS TO MEASURE THE PEDAGOGIC COMPETENCY OF PROSPECTIVE IPS TEACHERS IN THE ERA OF THE INDUSTRIAL REVOLUTION 4.0 IN INDONESIA

Experts 1 (Social Studies Education)		Experts 2 (IT Education Evaluation)	
Less Relevant (Score 1-2)	Very Relevant (Score 3-4)	Less Relevant (Score 1-2)	Very Relevant (Score 3-4)
BI-37, BI-38	BI-1, BI-2, BI-3, BI-4, BI-5, BI-6, BI-7, BI-8, BI-9, BI-10, BI-11, BI-12, BI-13, BI-14, BI-15,	BI-37, BI-38	BI-1, BI-2, BI-3, BI-4, BI-5, BI-6, BI-7, BI-8, BI-9, BI-10, BI-11, BI-12, BI-13, BI-14, BI-15,

Experts 1 (Social Studies Education)		Experts 2 (IT Education Evaluation)	
Less Relevant (Score 1-2)	**Very Relevant (Score 3-4)**	**Less Relevant (Score 1-2)**	**Very Relevant (Score 3-4)**
	BI-16, BI-17, BI-18, BI-19, BI-20, BI-21, BI-22, BI-23, BI-24, BI-25, BI-26, BI-27, BI-28, BI-29, BI-30, BI-31, BI-32, BI-33, BI-34, BI-35, BI-36, BI-39, BI-40, BI-41, BI-42, BI-43, BI-44, BI-45, BI-46, BI-47, BI-48, BI-49, BI-50, BI-51, BI-52, BI-53, BI-54, BI-55, BI-56, BI-57, BI-58, BI-59, BI-60, BI-61, BI-62, BI-63, BI-64, BI-65, BI-66, BI-67		BI-16, BI-17, BI-18, BI-19, BI-20, BI-21, BI-22, BI-23, BI-24, BI-25, BI-26, BI-27, BI-28, BI-29, BI-30, BI-31, BI-32, BI-33, BI-34, BI-35, BI-36, BI-39, BI-40, BI-41, BI-42, BI-43, BI-44, BI-45, BI-46, BI-47, BI-48, BI-49, BI-50, BI-51, BI-52, BI-53, BI-54, BI-55, BI-56, BI-57, BI-58, BI-59, BI-60, BI-61, BI-62, BI-63, BI-64, BI-65, BI-66, BI-67

2) Cross tabulation of test results from the two experts

TABLE V: CROSS-TABULATION OF THE RESULTS OF THE TEST OF THE TWO EXPERT ON DIGITAL INSTRUMENT TO MEASURE THE PEDAGOGIC COMPETENCY OF PROSPECTIVE IPS TEACHERS IN THE ERA OF THE INDUSTRIAL REVOLUTION 4.0 IN INDONESIA

		Experts 2 (IT Education Evaluation)	
		Less Relevant (Score 1-2)	**Very Relevant (Score 3-4)**
Experts 1 (Social Studies Education)	**Less Relevant (Skor 1 - 2)**	BI-37,BI-38 (2)	- (0)
	Very Relevant (Skor 3 – 4)	- (0)	BI-1, BI-2, BI-3, BI-4, BI-5, BI-6, BI-7, BI-8, BI-9, BI-10, BI-11, BI-12, BI-13, BI-14, BI-15, BI-16, BI-17, BI-18, BI-19, BI-20, BI-21, BI-22, BI-23, BI-24, BI-25, BI-26, BI-27, BI-28, BI-29, BI-30, BI-31, BI-32, BI-33, BI-34, BI-35, BI-36, BI-39, BI-40, BI-41, BI-42, BI-43, BI-44, BI-45, BI-46, BI-47, BI-48, BI-49, BI-50, BI-51, BI-52, BI-53, BI-54, BI-55, BI-56, BI-57, BI-58, BI-59, BI-60, BI-61, BI-62, BI-63, BI-64, BI-65, BI-66, BI-67 (65)

3) Calculating content validity using the gregory formula

$$\text{Content Validity} = \frac{D}{A + B + C + D}$$

$$\text{Content Validity} = \frac{65}{2 + 0 + 0 + 65} = \frac{65}{67} = 0.97$$

F. Results of Final Instrument

The final results of the digital instrument to measure the pedagogic competence of social studies teacher candidates in the Industrial Revolution 4.0 Era in Indonesia can be seen in Fig. 2.

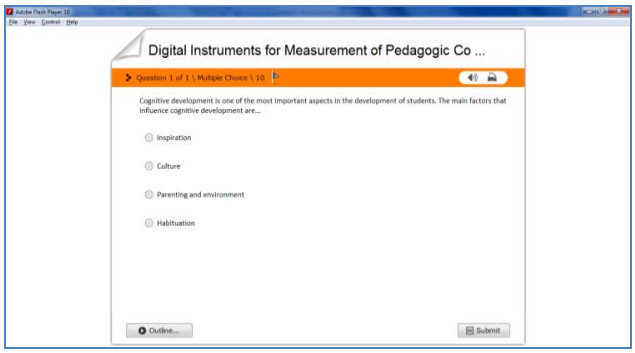

Fig. 2. Display of one part of digital instrument for measurement of pedagogic competence for social science teacher candidates in the industrial revolution 4.0 era in Indonesia.

When viewed from the results of the analysis of the content validity of the instrument, which was matched with the categorization of the validity of the instrument, which refers to the classification of validity by Guilford, then the results of content validity ($r_{xy} = 0.97$) are included in the very high validity category because they are in the range $0.80 < r_{xy} \leq 1.00$.

The findings of this study were corroborated by several previous studies conducted by other researchers, including Prasojo *et al.*'s research [17], which shares similar instrument validity characteristics with this study. However, Prasojo *et al.*focus on instrument validity in terms of motivation, ability, and use of digital technology. The findings of Yahfizham *et al.* bolster this study's position on instrument validity but placed a greater emphasis on the instrument's construct validity [18]. By contrast, this study emphasizes the instrument's content validity. The findings of Dewi *et al.* bolster this study's position as a solution to overcome the limitations of previous studies by demonstrating the existence of a calculation process for determining the validity of digital instrument contents [19]. The findings of Luque-Vara *et al.* also, bolster this research's position by demonstrating the process of validating the instrument's content for assessing teacher knowledge [20]. The findings of Chhetri & Sinha's research also bolster this study's position because they demonstrate similarity in terms of determining the validity of digital instrument [21].However, Chhetri & Sinha are more likely to test the validity of attitude and ICT competence instruments, whereas this study is more likely to test the validity of an instrument for assessing the pedagogic competence of social studies teacher candidates. Rodrigues *et al.* findings also bolster this study's instrument validity position [22]. Similarly, the research of Connell *et al.* [23] bolsters the research's position and contribution to overcoming the limitations of previous studies that were unable to demonstrate the existence of a process of content validity for digital instrument.

Inessence, this study has succeeded in resolving the limitations of previous studies [4]-[8], which were unable to demonstrate in detail the process of calculating the instrument's content validity. The process of calculating the instrument's content validity can be seen in the calculation of content validity using the Gregory formula that has been shown previously. Besides that advantage, the results of this

research show that there is added value in the form of digital instruments that can be accessed and answered directly from anywhere social studies teacher candidates, so they do not require a special location to answer the test. However, this research also has limitations. It has not shown the results of the detailed reliability test calculations.

IV. Conclusion

In summary, this research demonstrated the results of calculating the content validity of digital instrument used to assess the pedagogic competence of social studies teacher candidates in Indonesia during the Industrial Revolution 4.0 Era. This finding is supported by instrument content validity test results that demonstrate extremely high validity. Additionally, the results of this study demonstrated the final form of a digital instrument, indicating that it is valid and ready for use. The results of this research also show added value regarding the ease with which social studies teacher candidates can do test questions from wherever they are located because the test is digitally formatted and can be accessed via the internet. Future work could include conducting reliability tests on the formed digital instrument to overcome the limitations of this research.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

IGAW developed the idea of research, designed the research instrument and drafted and critically revised the manuscript. BK, AJ, SYH, and SH designed the programme mapping, course, activities and resources. ES, DS, and LARL prepared the theoretical base of research. PIC, and DGHD statistically analysed the data.

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