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The Development of an Authentic Assessment Instrument Based on Google Sites to Measure the Learning Outcomes of the IPAS Project

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Keywords

Authentic assessment instruments, Google Sites, IPAS Project

Abstract

This research aims to explain the form of an authentic assessment instrument based on Google Sites to measure the learning outcomes of the IPAS Project on the Earth and Space aspects, as well as test its validity, reliability and practicality. The test subjects were 110 students. The data analysis technique uses Aiken's V for content validity, CFA for construct validity, ICC for interrater reliability, CR and VE for construct reliability, Cronbach's Alpha for internal reliability of the instrument, and percentage for practicality. The research results obtained three forms of authentic assessment instruments based on Google Sites that measure the learning outcomes of the IPAS Project, namely independent assignment assessment sheets, group project assignment assessment sheets, and objective tests. The instrument is valid in terms of both content validity and construct validity, except for items B2 and B4 so they must be removed from the model. The instrument is reliable in terms of interrater reliability, instrument reliability and construct reliability, except for dimension C which has a VE value below the criteria. A very practical instrument to use in measuring the learning outcomes of the IPAS Project.

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INTRODUCTION

The 21st century is a difficult to predict century because changes in various aspects of life occur very rapidly and are full of competition (Larasati et al., 2021; Sudarmin et al., 2019). This can be seen from the variety of easily accessible information (Petsangsri & Pislae-Ngam, 2020), the increasing use of computing or robots (Suryanti & Wijayanti, 2018), automation, and communication that has become limitless (Astutik & Hariyati, 2021). To be able to face rapid changes and intense competition, 21st century skills are required.

21st century skills have become competencies that everyone must possess. The 21st century skills, referred to as the 4Cs (Khoiri et al., 2021; Redhana, 2019), have now evolved into the 6Cs with the addition of character and citizenship skills (Anggraeni et al., 2023; Kemendikbudristek, 2022). 21st century skills are not innate but are acquired through training, learning, or experience (Redhana, 2019). The role of society and teachers is crucial in developing these skills (Jayadi et al., 2020). In this study, a learning model that can develop 21st century skills is used, namely project-based learning (Jacobson-Lundeberg, 2016). The implementation of project-based learning can be integrated with digital technology.

The 21st century's rapidly evolving technology demands that teachers adapt to new ways of learning. Currently, digital transformation in education is being promoted (Cruz et al., 2023), requiring teachers to innovate their teaching methods to enhance the quality of learning (Djuniadi et al., 2022). The quality of education can be a key trigger for educational change (Kim et al., 2019). Additionally, teachers' perceptions, quality, and competencies influence student learning outcomes (Burroughs et al., 2019; Sang et al., 2018; Sirait, 2016). Educational changes and learning outcomes leading to improved 21st century skills are greatly needed in schools, especially in vocational high schools.

Vocational high schools play a crucial role as educational institutions that produce job ready graduates and are important for implementing 21st century learning. The productive population in 2030 is predicted to reach 64% of Indonesia's total population, making it necessary to ensure that this large number of human resources becomes a strength, not a threat (Astutik & Hariyati, 2021). However, the PISA results show that Indonesia's ranking in international scientific literacy is still very low (Novita et al., 2021). In 2015, Indonesia ranked 62nd out of 70 countries with a score of 403 (OECD, 2016). In 2018, Indonesia ranked 70th out of 79 countries with a score of 396 (OECD, 2019). These results indicate that Indonesia's student scientific literacy is declining and remains low (Astutik & Hariyati, 2021). In 2022, Indonesia ranked 66th out of 80 countries with a score of 383 (OECD, 2023). Although Indonesia's student scientific literacy ranking improved from 2018 to 2022, the scores obtained are low, even declining, with no significant change from year to year (Hafizha & Rakhmania, 2024). Data from the Badan Pusat Statistik (BPS) in August 2021 shows that the largest contributor to unemployment in Indonesia comes from vocational high schools graduates, at 11.13% (Kusnandar, 2021). This reflects the need for improvement in vocational high schools education.

The government has included 21st century skills content at all levels of education up to vocational high school level through the Merdeka Curriculum. As a result, a new subject has emerged at the vocational high schools level, namely Projek Ilmu Pengetahuan dan Sosial, known as Projek IPAS (BSKAP, 2022). The learning outcomes of Projek IPAS consist of three elements that refer to scientific literacy competencies. Scientific literacy is the ability to use scientific knowledge not only to understand concepts but also to apply them in everyday life, such as solving problems or producing scientific products (Astuti et al., 2021; Novili et al., 2017). These three elements are incorporated into one project theme that can cover one or several aspects of Projek IPAS.

Interview results at SMK 1 Cluwak found that Projek IPAS teachers still have difficulty in determining project themes and developing assessment instruments. This fact is supported by the questionnaire responses from 15 Projek IPAS teachers in Pati. All teachers developed assessment instruments, but only one had consulted their instrument with experts. All teachers who filled out the questionnaire agreed that having a valid and reliable Projek IPAS assessment instrument would be beneficial.

Assessment in Projek IPAS in project-based learning can use authentic assessment. Puteri et al. (2023) stated that the assessment applied in the classroom to address the challenges of 21st-century education is formative authentic assessment. Yakob et al. (2023) stated that authentic assessment is suitable for improving students' scientific performance in virtual chemistry laboratory learning. Project-based learning is effective in fostering the scientific process skills of high school students (Sejati et al., 2021). These studies serve as a foundation for developing authentic Projek IPAS assessment instruments using a project-based learning model.

Innovation involving the use of technology is needed in education, including for the development of assessment instruments. After the Covid-19 pandemic, digital transformation has been increasingly seen by researchers as a necessary condition for renewal in education (Volkov & Chikarova, 2021). The digital transformation movement also enhances the creation of more flexible school management systems, as well as the introduction of new practices, methods, and resources to support the learning process (Bakhmat et al., 2020). There are now many applications specifically created to support learning and can be used by education practitioners (Sudarmin et al., 2022). With the support of digital transformation in the learning process and the need for valid and reliable assessment instruments for teachers, there is a need to develop authentic assessment instruments based on digital technology, one of which is Google Sites. Google Sites is quite familiar among teachers.

The development of assessment instruments focuses on the theme of earthquake disaster mitigation, which is a contextual theme because Indonesia frequently experiences earthquakes (Aroyandini et al., 2022). Additionally, the level of disaster literacy in formal education and society is still minimal (Juhadi et al., 2021), yet disaster education for children and adolescents is important to enhance their resilience to disasters (Yeon et al., 2020). This theme is an effort to instill conservation awareness in students, as one of the goals of conservation is to care for and preserve valuable places from destruction (Rizkiana, 2022). Disaster mitigation theme is part of the Earth and Space aspect in Projek IPAS (BSKAP, 2022). Given the importance of disaster mitigation knowledge, instilling conservation awareness, and the need for valid and reliable assessment instrument references for Projek IPAS, this study aims to describe the form of the instrument, test its validity, estimate its reliability, and test the practicality of an authentic assessment instrument based on Google Sites to measure the learning outcomes of Projek IPAS on the theme of earthquake disaster mitigation.

METHOD

The type of research is Research and Development (R&D). The research design is a modified 3D design from the 4D model (Thiagarajan et al., 1976), with the stages being Define, Design, Develop (3D). The Define stage includes needs analysis, school curriculum, and project themes. The Design stage includes 1) developing the instrument grid, 2) determining the instrument format, 3) writing instrument items, 4) determining the instrument scale and scoring, 5) designing the Google Sites layout for assessment. The Develop stage includes expert appraisal by testing the content and readability of the instrument with experts, and developmental testing to obtain direct feedback in the form of responses or comments from teachers as instrument users. The student subjects consisted of 110 individuals from SMK 1 Cluwak, SMK 2 Pati, and SMK PGRI 1 Tayu. Data analysis techniques included Aiken's V for content validity, CFA for construct validity, ICC for interrater reliability, CR and VE for construct reliability, Cronbach's Alpha for internal instrument reliability, and percentage for practicality.

RESULTS AND DISCUSSION

Instrument Form

The instruments were developed in three forms: independent task assessment sheets, group project task assessment sheets, and objective tests themed on earthquake disaster mitigation in the Earth and Space aspect, encompassing all elements of the CP Projek IPAS. The instrument application was designed based on Google Sites. There is no specificity regarding the type of device used because Google Sites does not need to be installed (Nugroho & Hendrastomo, 2021). Google Sites can integrate material links and question links, as well as be connected to other Google products (Arief, 2017; Saputra et al., 2022). The initial appearance of the instrument is shown in Figure 1. After pressing one of the logos, for example, SMKN 1 CLUWAK (A), a display like Figure 2 appears. The workflow diagram of the application is presented in Figure 3.

Figure 1 Initial appearance of the assessment instrument product

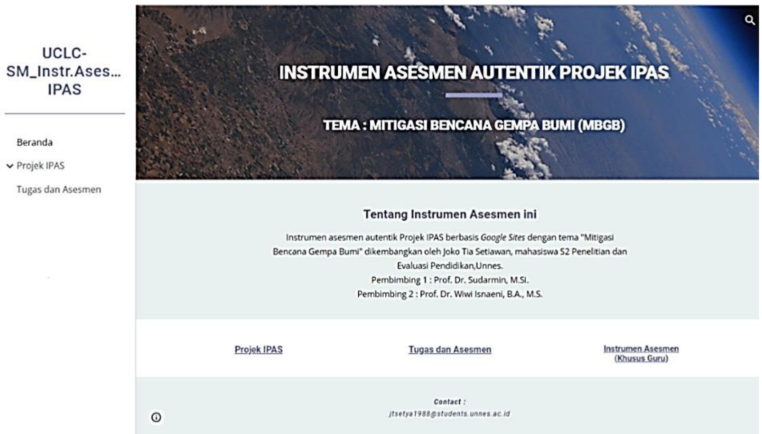


Figure 2 Home page of the Google Sites-based assessment application

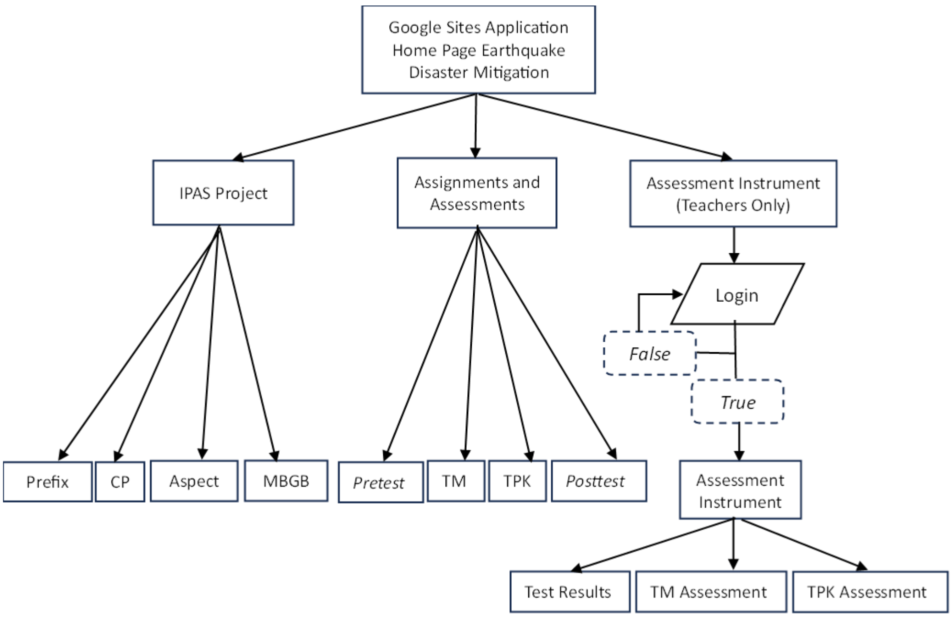


Figure 3 Google Sites application workflow chart

The assessment instrument (Teachers Only) can only be accessed by teachers through the login box. If the login input is correct, the assessment instrument page can be opened. There are three menus on the assessment instrument page: 1) Test Results, 2) TM Assessment, and 3) TPK Assessment. The Test Results menu contains a recap of pretest and posttest scores of students. The TM Assessment menu contains a recap of task completion results, assessment forms, and a recap of independent task assessment results for students. The TPK assessment menu contains assessment forms and a recap of group project task assessment results.

The individual assignment sheet is prepared together with assignment items and assessment guidelines. The individual task involves assigning students to estimate the resilience of a house building observed against earthquakes and the mitigation steps that will be taken according to the students' areas of expertise. The individual assignment is associated with students' concentrations or areas of expertise in vocational high schools to align with the characteristics of IPAS Project subjects (BSKAP, 2022; Mulyadi, 2023). This assignment falls under authentic assessment because it involves activities that engage students in solving real-life situations by applying skills and knowledge they have mastered (Ellis et al., 2020; Yildirim & Şenel, 2023). The instrument includes tasks that students must perform along with their assessment rubric (Shikwaya & Amadhila, 2023). Individual tasks encourage independence, thus demanding student activity before and after the learning process (Egok, 2016). Furthermore, individual tasks are in line with students' daily lives because they utilize digital technology such as gadgets that seem to be inseparable from teenagers' daily lives (Ati et al., 2022).

The group project assessment sheet is prepared together with the project tasks and assessment guidelines. The project task involves creating a digital poster on earthquake disaster mitigation. The selection of this project task is not only because it is aligned with the students' expertise areas but also due to the demands of technological developments based on the digital revolution (Kaliongga et al., 2023). In this regard, the test subjects come from vocational high school students who have knowledge of design editing through applications. The group project assessment sheet covers all indicators found in the third CP element. Each indicator can be aligned with the performance of the students. Project performance instructions are packaged in the form of worksheets or LKPD (Trimawati et al., 2020). This group activity also assesses attitude domains. The assessment items include being calm and responsible, and showing cohesive teamwork. Responsibility and teamwork are part of the attitude domain (Martaningsih et al., 2015).

The objective test in this assessment instrument development takes the form of multiple-choice tests. The objective test is prepared along with the answer key and assessment guidelines. Although authentic assessment arises from dissatisfaction with written tests, including multiple-choice tests used in previous eras, written assessment of learning outcomes is still commonly practiced (Martaningsih et al., 2015). Therefore, multiple-choice tests are still developed in this research. The question answering is done directly through Google Form available on the Google Sites page with a specific token as a password to open the questions. After completing the test, students can immediately see their scores, allowing them to project the abilities they have absorbed during the learning process. The objective test instrument measures students' higher-order thinking. This is because the questions are structured at the analysis cognitive level (C4) according to Bloom's taxonomy (Anggraena et al., 2022). Higher-order thinking skills are needed in this era.

All three forms of these instruments are authentic because they are used for meaningful measurement of student learning outcomes for attitude, knowledge, and skills domains (Kusumawati et al., 2021; Martaningsih et al., 2015). The independent task assessment sheet and the objective test measure the knowledge domain. The group project assessment sheet measures the attitude and skills domains.

Instrument Validity

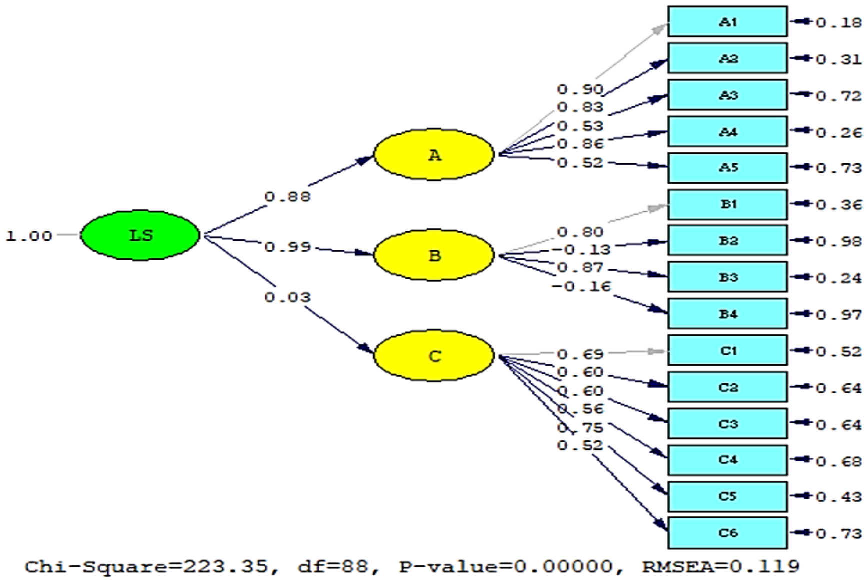
Validity includes content and construct validity. Content validation is obtained from five expert validators. The V_{table} value for five validators, on a scale of 1 to 5, with a 5% error rate, is 0.80 (Aiken, 1985). The valid criteria are if the value of $V_{count} \geq V_{table}$. The calculated validation result is 0.90, indicating that the instrument is valid.

Construct validation uses Second (2^{nd}) Order Confirmatory Factor Analysis (CFA) assisted by the LISREL 8.80 application. Second (2^{nd}) Order CFA is a confirmatory factor analysis model where the latent variables at the first level explain the latent variables at the second level (Haryono, 2016). The latent variables at the second level in this analysis are Scientific Literacy, coded as LS. The coding of the first-level latent variables and manifest variables is presented in Table 1.

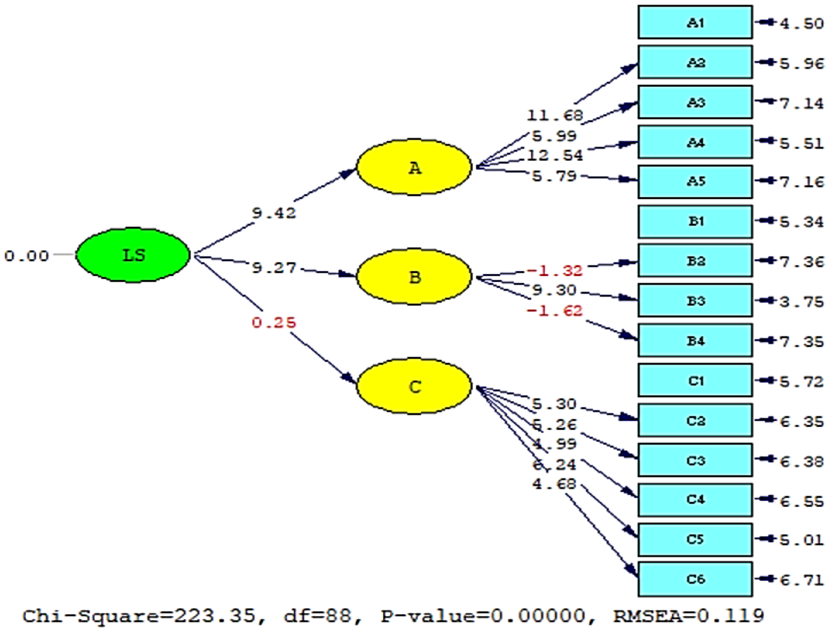
Table 1 Coding of IPAS Project CP Variables, Dimensions, and Indicators

No	Latent Variable (Dimension)	Code	Manifest Variable (Indicators)	Code
1	Explain the phenomenon scientifically	A	Understand scientific knowledge about earthquakes.	A1
			Apply scientific knowledge about earthquakes.	A2
			Make simple predictions about the resistance of buildings to earthquakes with proof.	A3
			Explain phenomena related to earthquakes from the perspective of earth and space.	A4
			Link earthquake disaster mitigation with technical skills in their field of expertise.	A5
2	Design and evaluate scientific investigations	B	Determine procedures for conducting scientific investigations into earthquake disaster mitigation.	B1
			Follows proper procedures for conducting scientific investigations.	B2
			Explain the appropriate method of investigation for a scientific question about earthquakes.	B3
			Identify flaws or errors in the design of scientific experiments.	B4
3	Translating data and evidence scientifically	C	Translate data and evidence from various sources to build an argument.	C1
			Defend arguments with scientific explanations.	C2
			Identify correct conclusions drawn from tables, graphs, or other data sources.	C3
			Plan action as a follow-up.	C4
			Communicate the learning process and results.	C5
			Carry out self-reflection on the stages of activities carried out.	C6

The analysis results for the loading factor values and t-values are presented in Figure 4.



(a)



(b)

Figure 4 Shows the (a) loading factor values and (b) t-values from the analysis of the IPAS Project assessment instrument using 2nd Order CFA.

The first level analysis is conducted from latent construct dimensions to their indicators. An item is considered valid if the loading factor value is ≥ 0.50, and the t-value is ≥ 1.96 (Haryono, 2016). The loading factor values for each indicator item are > 0.50, except for indicator items B2 and B4 as shown in Figure 4(a). The t-values for each indicator item are > 1.96, except for indicator items B2 and B4 as shown in Figure 4(b). The analysis results show that out of 15 indicator items, 13 items are valid, and 2 items are invalid, namely items B2 and B4. The decision is to remove these two items from the model. The summary of the analysis results can be seen in Table 2.

Table 2 CFA Construct Validity Test Results

No	Item	*Loading Factor*	*t-value*	Achievement Level
1	A1	0.90		Valid
2	A2	0.83	11.68	Valid
3	A3	0.53	5.99	Valid
4	A4	0.86	12.54	Valid
5	A5	0.52	5.79	Valid
6	B1	0.80		Valid
7	B2	0.13	-1.32	Invalid
8	B3	0.87	9.30	Valid
9	B4	-0.16	-1.62	Invalid
10	C1	0.69		Valid
11	C2	0.60	5.30	Valid
12	C3	0.60	5.26	Valid
13	C4	0.56	4.99	Valid
14	C5	0.75	6.24	Valid
15	C6	0.52	4.68	Valid

Source: Analysis results using LISREL 8.80

After items B2 and B4 were removed from the model, the analysis was carried out again. Results analysis showed that 13 items were valid. The summary is presented in Table 3.

Table 3 CFA Construct Validity Test Results without items B2 and B4

No	Item	*Loading Factor*	*t-value*	Achievement Level
1	A1	0.90		Valid
2	A2	0.83	11.66	Valid
3	A3	0.53	5.98	Valid
4	A4	0.86	12.54	Valid
5	A5	0.52	5.79	Valid
6	B1	0.81		Valid
7	B3	0.88	9.38	Valid
8	C1	0.69		Valid
9	C2	0.60	5.31	Valid
10	C3	0.60	5.26	Valid
11	C4	0.56	4.99	Valid
12	C5	0.75	6.24	Valid
13	C6	0.52	4.68	Valid

Source: Analysis results using LISREL 8.80

The second level analysis was carried out from the latent construct of scientific literacy to the latent construct of its dimensions. The loading factor and t-value values for each dimension are presented in Table 4.

Table 4 Construct Validity Test Results for Each Dimension

No	Dimension	Before Item B2 and B4 Issued			After Item B2 and B4 Issued		
		Loading Factor	*t-Value*	Achievement Level	*Loading Factor*	*t-Value*	Achievement Level
1	A	0.88	9.42	Valid	0.87	9.28	Valid
2	B	0.99	9.27	Valid	0.99	9.38	Valid

3	C	0.03	0.25	Invalid	0.02	0.20	Invalid

Source: Analysis results using LISREL 8.80

In Table 4, dimensions A and B have values above the criteria, while dimension C has values below the criteria. Even though the loading factor and t-value values for each dimension changed both before and after items B2 and B4 were removed, the test results remained the same. The results of testing the scientific literacy construct for dimensions A and B constructs were valid, while those for dimension C constructs were invalid. The decision taken based on the results of this test was that indicators B2 and B4 were removed from the model, while dimension C and its indicators were retained in the model. The considerations are 1) invalid indicators must be removed from the model because they cannot explain the dimensional construct being measured (Haryono, 2016), 2) IPAS Project CP are these three elements even though scientific literacy is a reference and has been defined by the OECD (BSKAP, 2022; Wasis et al., 2020), 3) the C dimension indicators provide valid results for the C dimension itself so that the C dimension is maintained in the model. The invalidity of dimension C regarding Scientific Literacy can be caused by 1) the indicators for dimension C may not be able to describe the construct of scientific literacy even though they are able to describe dimension C itself, 2) there is the possibility of inaccuracy in the way these indicators are measured.

Instrument Reliability

The reliability of this assessment instrument includes interrater reliability, construct reliability and internal reliability. The results of the interrater reliability analysis for 5 indicators according to 5 experts have an Intraclass Correlation Coefficients (ICC) value on Average Measures of 0.81. This shows that the reliability of the ICC is in the good category. The reliability coefficient criteria refer to research by Perinetti (2018) that reliability is in the range of 0.75 to 0.90 has a good category.

A construct is said to be reliable if the Composite Reliability (CR) value is ≥ 0.70, and Variance Extracted (VE) ≥ 0.50 (Cheung et al., 2023; Haryono, 2016). To determine the CR and VE values, data from the construct validity test results are used, namely the Standardized Loading Factor (SLF) value and the standard errors (e) value. The data is then calculated to determine the CR value and VE value. The calculation results are presented in Table 5.

Table 5 Construct Reliability Estimation Results

Dimension	*CR*	*VE*
A	0,86	0,56
B	0,83	0,71
C	0,79	0,39

Source: Analysis results using Ms. Excel

Internal reliability estimation using Cronbach's Alpha with the help of the SPSS application. If a variable shows a Cronbach Alpha value > 0.60, it can be concluded that the variable is reliable or consistent in measuring (Taherdoost, 2018). The results of the analysis of each form of instrument are presented in Table 6.

Table 6 Reliability of Instrument Forms

Instrument's Shape	Amount Items	*Cronbach's Alpha*	Achievement Level
Independent Assignment Assessment Sheet	4	0.709	Reliable
Group Project Assigment Assesment Sheet	12	0.807	Reliable
Objective Test	25	0.912	Reliable

Source: Analysis results using SPSS 26.0

Table 5 presents CR and VE values. Dimensions A and B have CR and VE values above the criteria. Dimension C has a CR value above the criteria, but a VE value below the criteria. Table 6 presents the Cronbach's Alpha value for each form of instrument. The Cronbach's Alpha value for the three forms of instrument is greater than 0.60 so that the three forms of instrument are reliable.

Composite Reliability (CR) and Variance Extracted (VE) are important metrics that provide information about the reliability of a dimension or construct. However, they both provide different information. CR measures the internal reliability of a dimension by taking into account the relationship between the items in the measurement instrument. A high CR value indicates a good level of reliability (Haryono, 2016). VE measures the extent to which variability in a construct is explained by its items. A high VE value indicates that the items truly reflect the construct.

Dimension C has a CR value above the criteria, but a VE value below the criteria. This shows that although dimension C has high internal reliability, most of the variability in dimension C is not well explained by its items (Cheung et al., 2023; Haryono, 2016). The interpretation is that the dimensions may be more homogeneous. The items may have high similarity and may not cover all the variability of the construct. Therefore, it is worth considering updating or developing item indicators on dimension C that better reflect the measured construct. All dimension C indicator items are indicators in the group project assignment assessment sheet instrument. The results of the reliability analysis were good for the CR value in the construct reliability analysis, and the Cronbach's Alpha value in the internal reliability analysis of the instrument was above the criteria. These results indicate that the group project assignment assessment sheet instrument is reliable, but needs further development.

Instrument Practicality

An assessment instrument is said to be practical if the instrument is simple, easy to use and administer (Rohmah et al., 2023). The teacher response questionnaire was given to 4 raters consisting of 2 raters from the same school, and 2 raters from different schools. The results of the practicality test show a mean of 92%, which means that the assessment instrument developed is in the very practical category (Nesri & Kristanto, 2020). The Google Sites-based assessment application can be easily accessed via laptop and smartphone. The application display can adjust to the device screen used. Access to enter Google Sites is also easy because you just press the application link. There are many benefits from using Google Sites in learning (Rosiyana, 2021), and it is easy to operate (Saputra et al., 2022). The instruments developed are very practical for use in learning assessments for the IPAS Project on the Earth and Space aspect of the earthquake disaster mitigation theme.

CONCLUSION

The instrument developed consists of three forms, namely independent assignment assessment sheets, group project assignment assessment sheets, and objective tests. The independent assignment assessment sheet measures the results of students' work in estimating the resistance of the observed house building to earthquakes and the mitigation steps that will be taken according to the student's area of expertise. The group project assignment assessment sheet measures the results of students' work in groups in making digital posters for earthquake disaster mitigation. Objective tests measure knowledge students gain during earthquake disaster mitigation learning. The instruments are valid in terms of both content validity and construct validity, except for the indicator coded B2, namely following appropriate procedures for conducting scientific investigations and the indicator coded B4, namely identifying deficiencies or errors in the design of scientific experiments, so these two indicators must be removed from the model. The instrument is reliable in terms of interrater reliability, internal reliability for each form of the instrument, and construct reliability, except for the third learning achievement element which has a Variance Extracted (VE) value below the criteria. A very practical instrument to use in measuring learning outcomes for the IPAS Project on the Earth and Space aspect of the Earthquake Disaster Mitigation theme. This assessment instrument can be developed further so that all indicators and dimensions can construct into the scientific literacy variable which is a reference for the three elements of the IPAS Project learning outcomes. This assessment instrument can be adopted for developing assessment instruments for other aspects of the IPAS Project.

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