Measuring Inclusivity in Mathematics Learning Evaluation: Instrument Development Using a Design for Change Approach

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Abstract

This research is motivated by the need for a more inclusive and adaptive mathematics learning evaluation system in inclusive schools at the vocational education level. So far, conventional evaluations have not fully been able to capture the diversity of learning experiences as well in terms of how teachers and students perceive it, thus requiring instruments that align with the principles of Design for Change. The purpose of this study is to develop and test an instrument to measure students' and teachers' perceptions of mathematics evaluation on the basis of Design for Change in inclusive schools at the vocational education level in Bali Province. Through research involving 1,254 respondents consisting of 114 teachers and 1,140 students, the instrument was tested in terms of usability, flexibility, challenges, feedback, engagement, relevance, and critical thinking using exploratory factor analysis and confirmatory factor analysis. The data were analyzed using SPSS 26.0 to support the statistical procedures involved in the validation process. The content validity index value was above 0.8, while the Kaiser–Meyer–Olkin index showed results of 0.922 for teachers and 0.936 for students, indicating sample adequacy. The analysis identified four factors that demonstrated validity and reliability for both teachers and students, with a high level of construct validity and model fit. This finding confirms that Design for Change is capable of supporting inclusive education by accommodating diverse learning needs and providing meaningful feedback, despite challenges such as the complexity of assessment design, the need for training, and time limitations. This validated instrument can serve as a reference for educators and policymakers in strengthening a fair and inclusive evaluation system.

Keywords: design for change, inclusive school, mathematics learning evaluation, student's perception, teacher's perception

1. Introduction

Evaluation of mathematics learning in inclusive vocational schools requires an adaptive and transformative approach to meet the diverse learning needs of students, while also equipping them with 21st-century competencies and vocational skills to prepare them for the workforce (Daga, 2025; Kurniawan, 2025; Moray, 2024; Sutikno, 2013). In the context of vocational schools, evaluation not only focuses on mastery of academic concepts but also on the development of practical abilities and work skills, such as critical thinking, creativity, collaboration, communication, and real-world problem-solving. This is important because vocational education aims to produce graduates who are job-ready and competitive, while inclusive education emphasizes equal access and participation for all students (Wahyudi et al., 2023). The integration of these two perspectives presents both challenges and opportunities in designing meaningful learning evaluations (Rebia et al., 2023). Conventional evaluation models are often not sufficiently responsive to the diverse characteristics of students, especially in the context of inclusive education, which emphasizes equal access and participation for all learners (Jana et al., 2021; Phytanza et al., 2022; Putri et al., 2025; Thahir et al., 2024). One innovative approach that has begun to be used to address this challenge is learning evaluation based on Design Thinking. The concept of Design Thinking is then simplified in the educational context as the Design for Change approach (Suryawan et al., 2023; Lin, 2021; Putra et al., 2022). Philosophically, Design

Thinking through the DfC approach plays a role in supporting teachers to foster student leadership in the learning process that aligns with their needs (Delli & Gkiolnta, 2021; Iman et al., 2021). This approach is implemented through the stages of Feel, Imagine, Do, and Share in the learning process, emphasizing the meaning of content and process, not just the final outcome (Nasir et al., 2023; Putra et al., 2022).

The DfC approach serves as a project-based learning method that encourages students to feel, imagine, act, and share solutions to real-world problems around them (Design for Change, 2024; Lin, 2021; Nailasariy, 2024). Several studies have shown that the DfC approach is effective in enhancing students' active engagement, social empathy, critical thinking skills, and collaboration (Lin, 2021; Suwardika et al., 2024; Nailasariy, 2024; Suryawan et al., 2025). However, most research on DfC still focuses on general learning contexts without specifically examining its application in mathematics subjects or within inclusive school environments. The study by Lin (2021) examined a case study on integrating the DfC approach as a form of educational innovation. However, this research focused on education and learning in general and did not integrate it into mathematics instruction. Other studies have revealed that DfC serves as a unique approach to help teachers implement meaningful learning and to encourage students to explore life in accordance with their potential (Glanville et al., 2020; Suryawan et al., 2025). In its implementation, DfC is simpler compared to PBL, PjBL, or discovery learning (Mahayukti & Dewi, 2022; Pujawan et al., 2022; Suryawan et al., 2023; Suryawan & Sariyasa, 2018). Meanwhile, studies conducted by Lin (2021) and Nailasariy (2024) have primarily explored the application of DfC in character education or student empowerment, without addressing its integration into the evaluation of mathematics learning, which is inherently logical and structured. This creates a contextual gap, considering that mathematics learning is often perceived as rigid and lacking space for creativity and emotional expression - both of which are key aspects of the DfC approach.

The success of implementing learning evaluation using the DfC approach in mathematics education greatly depends on the perceptions of both students and teachers (Mustika, 2022). In this study, students' perceptions refer to the ways students recognize, interpret, and respond to their experiences in DfC-based mathematics learning in inclusive schools. These perceptions include their understanding of the relevance, engagement, fairness, and inclusivity in the evaluation process, as well as the feelings and judgments formed through interactions with learning activities (Mahande & Abdal, 2025). According to Mustika (2024), an inclusive mathematics learning environment designed through a design approach can strengthen students' understanding and responses toward more meaningful evaluations. Meanwhile, teachers' perceptions are the comprehensive views formed by teachers regarding the implementation of DfC principles in inclusive mathematics learning evaluation. These perceptions include teachers' beliefs, attitudes, and considerations about the effectiveness, relevance, and adoption of evaluation methods designed to accommodate the diversity of students (Mustika et al., 2024; Shasabilla, 2024).

Based on findings from the study by Dewi et al. (2025), teachers tend to view the DfC approach as an effective solution to enhance creativity and inclusivity in evaluation, although they face challenges in applying it consistently. In the educational context, perception has been shown to play an important role in influencing motivation, learning strategies, and student learning outcomes (Lailiyah et al., 2021; Kamalia & El-Yunusi, 2024; Mosimege & Egara, 2023). Nevertheless, studies on both students' and teachers' perceptions of DfC-based learning evaluation-particularly in mathematics learning within inclusive vocational education are still very limited. This limitation has resulted in the absence of instruments specifically designed to measure students' and teachers' perceptions in the context of DfC-based learning evaluation.

The instruments available to measure educational perceptions generally still focus on project-based learning approaches or student-centered learning in general (Ambarwati et al., 2021; Dina, 2025; Sulisworo et al., 2020). One related study on instrument development is the research by Sumandya et al. (2025), which developed an instrument to measure students' and teachers' perceptions of mathematics learning evaluation based on Understanding by Design (UbD). However, the study was only conducted in general high schools and has not been able to accommodate schools at the vocational level with specific skill focuses. This research was also carried out using the Understanding by Design approach, which technically does not specifically accommodate the distinctive dimensions of DfC such as social empathy, ownership of solutions, and participatory reflection. In the instruments that have been studied and developed, the contextual aspects of inclusive schools are often overlooked. The indicators in existing instruments tend to be general and do not take into account the differences in cognitive, social, and emotional abilities of students in an inclusive environment (Nurfadhillah, 2021). Thus, there is a research gap regarding the absence of instruments that can comprehensively and contextually measure the perceptions of students and teachers toward mathematics learning using the DfC approach in inclusive schools at the vocational education level. This gap involves both the lack of alignment with DfC's unique dimensions and the failure to adequately address learners' varied needs in inclusive and heterogeneous classrooms.

Existing evaluation instruments based on frameworks such as UbD and Problem-Based Learning (PBL) primarily focus on instructional alignment, inquiry processes, and problem-solving outcomes. UbD-based instruments emphasize coherence between learning objectives, assessments, and instructional strategies through backward design, while PBL-oriented evaluations highlight students' cognitive engagement, collaboration, autonomy, and problem-solving in authentic contexts (Sumandya et al., 2023). In contrast, Design for Change (DfC)-based evaluation instruments adopt a more holistic perspective by integrating cognitive, socio-emotional, and reflective dimensions (Maclean, 2022). Through the stages of Feel, Imagine, Do, and Share, DfC captures empathy, creative ideation, agency, and reflective action-competencies that are less emphasized in UbD and PBL frameworks. This distinction underscores DfC's unique contribution in evaluating not only instructional effectiveness or problem-solving performance, but also learners' socio-emotional growth, empowerment, and participatory engagement, which are particularly critical in inclusive educational settings. Consequently, specialized evaluation instruments are required to adequately measure constructs embedded within the DfC framework beyond the scope of UbD- or PBL-based assessments.

From a methodological perspective, most existing instruments measuring teachers' and students' perceptions have not undergone rigorous validation processes, both theoretically and empirically (Santosa, 2025; Sari et al., 2017). The validity applied is still limited to classical approaches and rarely involves modern psychometric techniques such as Confirmatory Factor Analysis (CFA) or cross-group validation (Sari et al., 2021; Mulyono, 2022). As a result, important aspects of DfC-based learning evaluation are not explicitly reflected in the indicators of the developed instruments. Considering these needs, this study aims to develop a valid and reliable instrument to measure students' and teachers' perceptions of DfC-based mathematics learning evaluation in inclusive schools at the vocational education level. This instrument is expected to contribute to the development of learner-centered and socially valued learning evaluations, as well as serve as a practical tool for teachers to design more inclusive, meaningful, and empowering learning assessments.

2. Method

2.1 Research Design

This research uses a mixed methods approach, combining quantitative and qualitative methods within a single study as well as across several related studies, by applying an explanatory design (Creswell, 2014; Dawadi et al., 2021). The main objective of this study is to develop an instrument that examines teachers' and students' perceptions of design-for-change-based evaluation in inclusive vocational education schools. The quantitative part of this research employs Structural Equation Modeling (SEM) analysis to gain a deeper understanding of the relationships between perception variables. SEM is conducted through two main stages: Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). Meanwhile, the qualitative part of this study is carried out through observations and interviews with teachers and students at inclusive vocational schools.

2.2 Sample and Data Collection

The sample of this study consisted of 114 teacher respondents and 1,140 student respondents drawn from inclusive vocational schools designated as Centers of Excellence in Bali Province. Participant selection was carried out using a convenience sampling technique, a non-probabilistic approach that is particularly suitable for studies focusing on specific institutional contexts and well-defined populations. In this research, the target population was limited to inclusive vocational schools officially recognized as Centers of Excellence, which possess distinct organizational structures, curricular implementations, and inclusive education practices. Consequently, probability-based random sampling was neither methodologically appropriate nor feasible, as the study did not aim to generalize findings to all vocational schools but rather to obtain an in-depth understanding of perceptions within this specific educational setting. Convenience sampling enabled the inclusion of respondents who met the predefined inclusion criteria and were directly involved in the implementation of inclusive practices, thereby enhancing the contextual relevance and ecological validity of the findings. Data were collected through structured questionnaires that had been previously developed and validated. The questionnaires measured perception indicators related to the Design for Change evaluation framework as experienced by teachers and students in inclusive vocational education environments. Responses were recorded using a five-point Likert scale: 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree (Joshi et al., 2015; Budiaji, 2013).

2.3 Procedure and Data Analysis

In this study, the qualitative approach was conducted through descriptive analysis by presenting interview results with mathematics teachers as well as student interview responses that were considered representative and able to illustrate the characteristics of the research subjects. Meanwhile, in the quantitative design, the initial sample data from respondents was managed using Microsoft Excel to ensure data consistency and completeness. The next stage involved data cleaning to eliminate incomplete or inconsistent responses, as well as coding using SPSS 26.0 so that the quantitative Likert scale data could be processed statistically. Next, the data from 114 teachers and 1,140 students that had been validated were analyzed using Structural Equation Modeling (SEM). This analysis is a multivariate statistical technique used to estimate relationships among variables simultaneously, with the aim of prediction, exploration, or structural model development (Hair et al., 2019). In the SEM-PLS approach, the model evaluation process includes three main stages: measurement model evaluation, structural model evaluation, and assessment of model fit and adequacy (Ghasemy et al., 2021). The analysis is conducted through two main approaches: Exploratory Factor Analysis (EFA) to identify the underlying factor structure of the instrument items, and Confirmatory Factor Analysis (CFA) to test and verify the model's fit with empirical data. This procedure provides a strong foundation for construct validity and the reliability of the research findings.

2.4 Instrument Development Process

The instrument consisted of 42 items divided into 21 statements for teachers and 21 for students, using a 5-point Likert scale from "strongly disagree" to "strongly agree." Table 1 outlines grid used to measure teachers' and students' perceptions of DfC implementation in mathematics learning at inclusive vocational schools in Bali Province.

Table 1. Instrument Grid for Teachers and Students

Indicator	*Question*
Usefulness	I consider the DfC approach advantageous for improving students' conceptual grasp of mathematical content
	DfC serves as an effective strategy for creating assessments that align with the diverse abilities of students in inclusive educational settings
	I perceive that the DfC approach enhances the realization of deeper and longer-lasting educational outcomes
	I assert that applying DfC principles in assessment fosters equitable opportunities for every student, including those requiring special educational support
	DfC-oriented assessments enable students to show more comprehensive understanding rather than merely recalling facts or performing computations
	I think the DfC approach acknowledges and accommodates variations in students' learning styles and skill levels.
Challenges	The DfC approach promotes active student participation in the assessment process, such as comprehending the goals of the evaluation and the criteria used to assess it.
	DfC supports students in becoming more engaged in learning and in reflecting on the outcomes they have attained
	I observe that the DfC approach can enhance students' learning motivation and foster the development of critical thinking abilities.
	I believe the DfC approach offers flexibility in constructing assessments that can be adapted to the diverse needs and capabilities of learners in inclusive environments
	In my view, DfC enables the creation of adaptive assessments that can be adjusted in line with students' academic progress
	I believe that DfC creates opportunities to explore various assessment techniques, leading to more innovative evaluation practices
	I note that feedback derived from DfC-oriented assessments is generally more useful and constructive for students.

Table 1. Instrument Grid for Teachers and Students(continued)

Indicator	*Question*
Flexibility	I observe that feedback contributes to enhancing students' comprehension and the development of essential skills.
	I believe feedback derived from DfC offers explicit direction for refining students' future learning processes
	I recognize certain obstacles in applying DfC, including the necessity to accommodate varied student needs and the limited time available to design thorough assessments.
	I think that successful implementation of DfC demands additional training and support to address the complexities involved in constructing and administering assessments.
	I believe that, although challenges exist, the long-term advantages of adopting DfC outweigh the difficulties.
Feedback	I am convinced that adopting the DfC approach yields positive effects on students' academic outcomes, particularly in cultivating a more profound grasp of mathematical concepts.
	I observe that DfC-driven assessments promote noticeable enhancements in students' problem-solving abilities.
	I note that DfC approach supports learners in maximizing their potential, including students with special educational needs.

To guarantee linguistic accuracy, the questionnaire was made available in two versions, English and Indonesian (Behr, 2017). Each statement was also tested for face validity and content validity to ensure clarity and consistency (Connell et al., 2018; Ridwansyah et al., 2024; Habibi, 2024). The translation process was carried out by experts to align with cultural context and local language. The validation steps were conducted gradually to make the instrument clearer and more valid. Five individuals representing the initial respondents were asked to assess the clarity of the statements. Next, two focus group discussions were involved to evaluate the suitability of visual media, and the researcher also interviewed an academic expert along with two students to strengthen the instrument's validity.

2.5 Results of the Instrument Validation

Based on the recommendations of Davis (1992) and Polit & Beck (2006), content validity is assessed using the Content Validity Index (CVI). An instrument is considered valid if it has a CVI value of $\geqslant 0.8$. In this study, the measurement was conducted using I-CVI and S-CVI. The I-CVI value is obtained from the proportion of experts who give a high rating to an item compared to the total number of experts evaluating it. Meanwhile, the S-CVI is calculated from the average of all I-CVI values. The overall index of content validity is represented by the Scale Content Validity Index, Average (S-CVI/Ave), derived from the calculation of the I-CVI for teachers as shown in Table 2 below.

Table 2. CVI for Teacher

No	Code	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Total	I-CVI	UA	Result
1	XI.1	1	1	1	1	1	5	1	1	Relevant
2	XI.2	1	1	1	1	1	5	1	1	Relevant
3	XI.3	1	1	1	1	1	5	1	1	Relevant
4	XI.4	1	1	1	1	1	5	1	1	Relevant
5	XI.5	1	1	1	1	1	5	1	1	Relevant
6	XI.6	1	1	1	1	1	5	1	1	Relevant
7	XI.7	1	1	1	1	1	5	1	1	Relevant
8	XI.8	1	1	1	1	1	5	1	1	Relevant
9	XI.9	1	1	1	1	1	5	1	1	Relevant
10	XI.10	0	1	1	1	1	4	0.8	0	Relevant
11	XI.11	1	1	0	1	1	4	0.8	0	Relevant

Table 2. CVI for Teacher(continued)

No	Code	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Total	I-CVI	UA	Result
12	XI.12	1	1	1	1	1	5	1	1	Relevant
13	XI.13	1	1	1	1	1	5	1	1	Relevant
14	XI.14	1	1	1	1	1	5	1	1	Relevant
15	XI.15	1	1	1	1	1	5	1	1	Relevant
16	XI.16	1	1	1	1	1	5	1	1	Relevant
17	XI.16	1	1	1	1	1	5	1	1	Relevant
18	XI.16	1	1	1	1	1	5	1	1	Relevant
19	XI.16	1	1	1	1	1	5	1	1	Relevant
20	XI.16	1	1	1	1	1	5	1	1	Relevant
21	XI.16	1	1	1	1	1	5	1	1	Relevant
Average								0.98	0.90	Relevant

Table 3 below shows the overall content validity index represented by the Scale Content Validity Index, Average (S-CVI/Ave), derived from the calculation of the I-CVI for students.

Table 3. CVI for Students

No	Code	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Total	I-CVI	UA	Result
1	XI.1	1	1	1	1	1	5	1	1	Relevant
2	XI.2	1	1	1	1	1	5	1	1	Relevant
3	XI.3	1	1	1	1	1	5	1	1	Relevant
4	XI.4	1	1	1	1	1	5	1	1	Relevant
5	XI.5	1	1	1	1	1	5	1	1	Relevant
6	XI.6	1	1	1	1	1	5	1	1	Relevant
7	XI.7	1	1	1	1	1	5	1	1	Relevant
8	XI.8	1	1	1	1	1	5	1	1	Relevant
9	XI.9	1	1	1	1	1	5	1	1	Relevant
10	XI.10	0	1	1	1	1	4	0.8	0	Relevant
11	XI.11	1	1	0	1	1	4	0.8	0	Relevant
12	XI.12	1	1	1	1	1	5	1	1	Relevant
13	XI.13	1	1	1	1	1	5	1	1	Relevant
14	XI.14	1	1	1	1	1	5	1	1	Relevant
15	XI.15	1	1	1	1	1	5	1	1	Relevant
16	XI.16	1	1	1	1	1	5	1	1	Relevant
17	XI.16	1	1	1	1	1	5	1	1	Relevant
18	XI.16	1	1	1	1	1	5	1	1	Relevant
19	XI.16	1	1	1	1	1	5	1	1	Relevant
20	XI.16	1	1	1	1	1	5	1	1	Relevant
21	XI.16	1	1	1	1	1	5	1	1	Relevant
Average								0.98	0.90	Relevant

The analysis results show that all statements in the questionnaire are considered valid because their values have exceeded the minimum threshold of 0.8 (Polit & Beck, 2014). In this assessment, expert opinions are very important to consider, so input from five experts was used as a reference in accordance with the recommendations of Polit and Beck.

3. Results

3.1 Quantitative Result

Exploratory Factor Analysis (EFA) was employed to verify the underlying factor structure of the variables. In this study, the indicators were adapted from prior research and used as the main source of data. Data normality was assessed through the application of the Kolmogorov–Smirnov test, in which the residuals are considered normally distributed when the significance value exceeds 0.05. Normality was also confirmed through skewness and kurtosis tests, with criteria of two-tailed significance > 0.05, and absolute values of 0.046 < 1.96 and 0.995 < 1.96, indicating a normal data distribution. The suitability of the data for factor analysis was then examined through EFA. Linearity tests showed that the data were consistently distributed, while multicollinearity was tested using the Variance Inflation Factor (VIF). The analysis results indicated that multicollinearity was not an issue, as all VIF values were < 10 (Hair et al., 1995). Therefore, factor analysis is considered capable of providing relevant information (Hair et al., 2019). The analysis steps undertaken included: KMO and Bartlett's test, Anti-Image test, Communalities test, as well as component extraction and factor loading. The results of the KMO and Bartlett's test, Anti-Image test, Communalities test, component extraction, and factor loading for teachers are presented in Table 4.

Table 4. KMO and Bartlett's Test (Teachers)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.922
Bartlett's Test of Sphericity	Approx. Chi-Square	1608
	Df	210
	Sig.	.000

Meanwhile, the results of the KMO and Bartlett's test, Anti-Image test, Communalities test, as well as component extraction and factor loading for students are presented in Table 5.

Table 5. KMO and Bartlett's Test (Students)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.936
Bartlett's Test of Sphericity	Approx. Chi-Square	11152
	Df	210
	Sig.	.000

Construct and convergent validity were assessed through Exploratory Factor Analysis (EFA) employing the Varimax rotation method. Based on the table above, for teachers, the KMO value is 0.922 and $\chi^2 = 1608$; df = 210; Sig. < 0.000, while for students, the KMO value is 0.936 and $\chi^2 = 11152$; df = 210; Sig. < 0.000. The results indicate compliance with the statistical assumptions for factor analysis and establish the instrument's validity in measuring teachers' perceptions regarding DfC-based assessments in inclusive schools. The exploratory factor analysis results for the teacher group are shown in Table 6.

Next, Table 7 below shows the results of the exploratory factor analysis of students' perceptions of the DfC approach in mathematics learning for inclusive schools at the vocational education level.

Table 6. EFA for Teacher

Variables	Factor	Code Item	MSA	Extraction	Initial Eigenvalues	Variance	Component Matrix			
							1	2	3	4
Teacher perception	Factor 1	XI.3	0.916	0.774	9.618	44.801	0.83			
		XI.6	0.939	0.725			0.772			
		XI.5	0.886	0.634			0.761			
		XI.2	0.958	0.628			0.741			
		XI.1	0.922	0.807			0.741			
		XI.4	0.929	0.69			0.705			
	Factor 2	XI.21	0.907	0.788	2.127	10.128		0.794		
		XI.19	0.904	0.785				0.789		
		XI.17	0.922	0.677				0.777		
		XI.18	0.923	0.646				0.699		
		XI.20	0.954	0.759				0.697		
		XI.16	0.939	0.587				0.644		
	Factor 3	XI.11	0.913	0.695	1.827	8.699			0.786	
		XI.8	0.918	0.718					0.778	
		XI.10	0.906	0.628					0.773	
		XI7	0.922	0.698					0.704	
		XI.9	0.910	0.682					0.697	
	Factor 4	XI.13	0.874	0.702	1.340	6.382				0.832
		XI.12	0.908	0.776						0.807
		XI.14	0.922	0.761						0.742
		XI.15	0.929	0.752						0.74

Table 7. EFA for Student

Variables	Factor	Code Item	MSA	Extraction	Initial Eigenvalues	Variance	Component Matrix			
							1	2	3	4
Student perception	Factor 1	XI.1	0.941	0.75	7.584	36.116	0.809			
		XI.3	0.944	0.726			0.8			
		XI.6	0.964	0.583			0.727			
		XI.8	0.956	0.566			0.738			
		XI.10	0.947	0.733			0.801			
		XI.20	0.945	0.735			0.8			
	Factor 2	XI.2	0.921	0.686	2.162	10.298		0.783		
		XI.4	0.938	0.61				0.735		
		XI.7	0.930	0.602				0.751		
		XI.9	0.927	0.639				0.746		
		XI.16	0.932	0.625				0.754		
	Factor 3	XI.12	0.940	0.601	1.945	9.263			0.72	
		XI.14	0.938	0.571					0.723	
		XI.15	0.908	0.73					0.81	
		XI.18	0.921	0.644					0.769	
		XI.19	0.938	0.587					0.692	
	Factor 4	XI.5	0.922	0.588	1.723	8.026				0.744
		XI.11	0.930	0.643						0.74
		XI.13	0.926	0.606						0.73
		XI.17	0.921	0.58						0.742
		XI.21	0.937	0.611						0.716

Based on the analysis results in Table 6 and Table 7, a clearer depiction of the exploratory factor analysis results for teachers will be shown through the Scree plot presented in Figure 1. Meanwhile, a clearer depiction of the exploratory factor analysis results for students will be shown through the Scree plot presented in Figure 2.

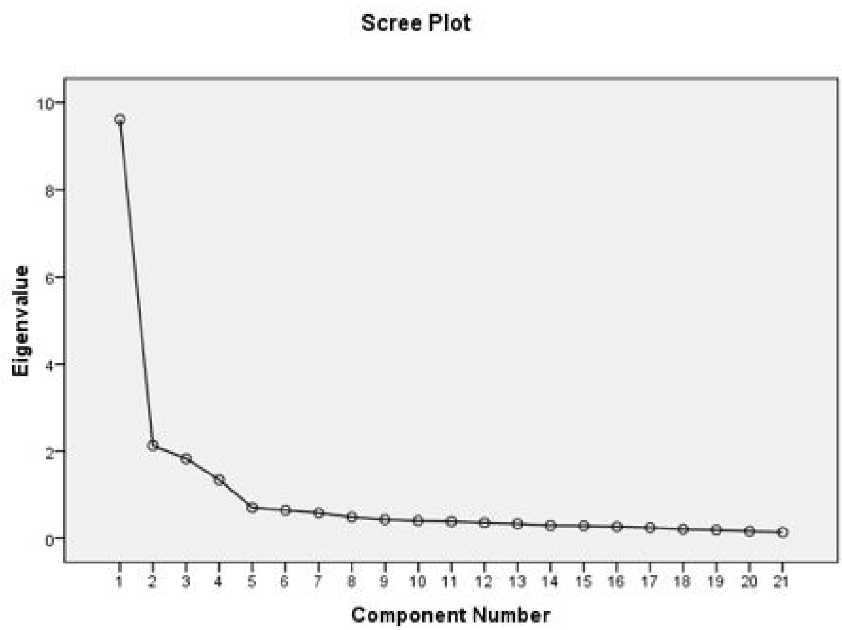

Figure 1. Scree Plot for Teacher

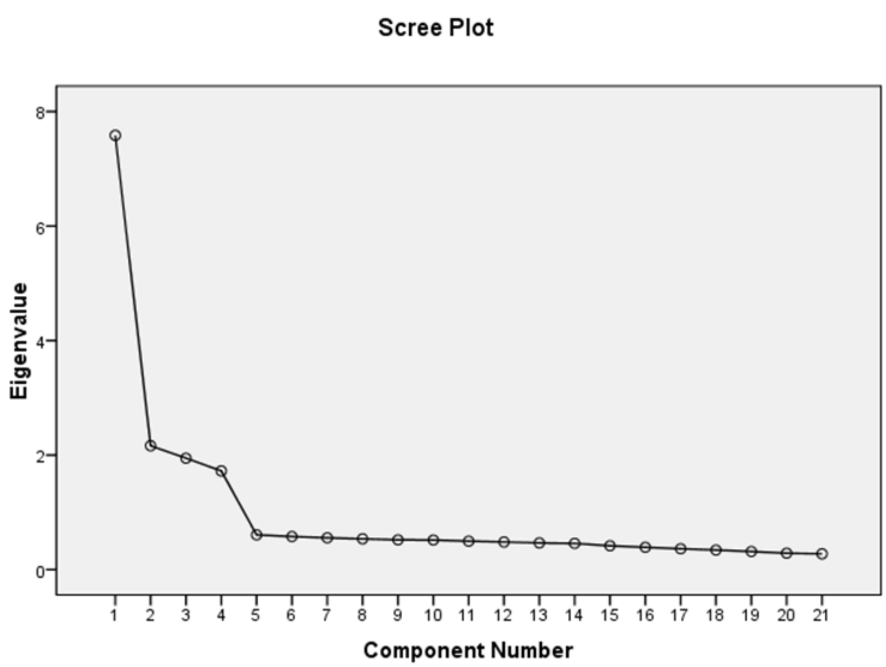

Figure 2. Scree Plot for Student

The statistical analysis results show that the data used have met the criteria for conducting Exploratory Factor Analysis (EFA). This is indicated by several indicators, including Bartlett's Test of Sphericity with a significance value ($p < 0.500$), factor loadings above 0.500, and a KMO value of 0.922 for teachers and 0.936 for students, indicating adequate samples for further analysis. Additionally, communalities (extraction) values higher than 0.300 and eigenvalues exceeding 1.00 further support the feasibility of applying EFA (Harerimana & Mtshali, 2020; Luo et al., 2019). The anti-image correlation results also support data validity by showing Measure of Sampling Adequacy (MSA) values greater than 0.5 for all items (Coakes & Steed, 2003; Hair et al., 2010). The Varimax rotation was used in the analysis process to obtain a clearer factor structure (Corner, 2009). The analysis revealed that all components complied with the set criteria, resulting in the retention of all items and factors due to sufficient extraction values. Thus, the EFA confirmed the underlying factor structure and validated the instrument for capturing teachers' and students' perceptions of DfC-based learning evaluations within inclusive educational environments. Based on Table 6, it can be concluded that four factors were formed, which is also confirmed by the scree plot results showing the same (four elbow points). Therefore, based on the scree plot, the data are best reduced to four factors. These four factors explain the majority of the data variation, while the subsequent factors are considered "noise" or minor contributions of lesser importance. Table 8 below shows the variables, factors, items, number of items, and alpha values for the analysis results of teachers' and students' perceptions regarding the DfC approach in mathematics learning evaluation at inclusive vocational education schools in Bali Province.

Table 8. Variabel, Factor, Item, Number of the Item, and Alpha

Variable	Factor	Item	Number	Alpha
Teacher perception	Factor 1 Usefulness	Item, 1,2,3,4,5,6	6 Item	0,895
	Factor 2 Challenges	Item, 16,17,18,19.20,21	6 Item	0,820
	Factor 3 Flexibility	Item, 7,8,9,10,11.	5 Item	0,997
	Factor 4 Feedback	Item, 12,13,14,15	4 Item	0,923
Student perception	Factor 1 Feedback	Item, 1,3,6,8, 10, 20	6 Item	0,895
	Factor 2 Critical	Item, 2, 4, 7, 9, 16	5 Item	0,820
	Factor 3 Relevance	Item, 12, 14, 15, 18, 19	5 Item	0,997
	Factor 4 Engagement	Item, 5, 11, 13, 17, 21	5 Item	0,923

Exploratory Factor Analysis (EFA) was used to explore the underlying factor structure and to test the validity of the instrument in measuring teachers' and students' perceptions of the implementation of the DfC approach in the context of inclusive education. Principal component analysis with Varimax rotation performed on the teacher dataset extracted four components: (1) Usefulness, capturing the contribution of DfC to conceptual understanding and differentiated abilities; (2) Challenges, representing practical constraints such as training needs; (3) Flexibility, reflecting the adaptation of assessments to students' developmental stages; (4) Feedback, denoting the value of constructive responses in directing learning.

The results of the exploratory factor analysis (EFA) indicate four main dimensions representing students' learning experiences. First, the feedback dimension, which emphasizes its role in facilitating students to identify mistakes and develop skills continuously. Second, the critical thinking dimension, reflecting Design for Change's contribution to fostering problem-solving skills and deepening conceptual understanding. Third, the relevance dimension, which measures the extent to which mathematical concepts in DfC can be applied to real-life contexts. Fourth, the engagement dimension, highlighting active participation and student motivation during the assessment process.

Sample adequacy for both instruments was confirmed as high with KMO values of 0.922 for teachers and 0.936 for students, while Bartlett's Test of Sphericity showed significant results ($p < 0.000$), affirming the data's suitability for additional analysis. Communalities for all items were above 0.300, and factor eigenvalues exceeded 1.00, confirming the appropriateness of retaining the factors (Harerimana & Mtshali, 2020; Luo et al., 2019). Thus, the analysis results show that the instrument has a valid and reliable factor structure, consistent with DfC principles and can serve as a basis for further validation through CFA. Figure 3 below shows the CFA analysis results for teachers.

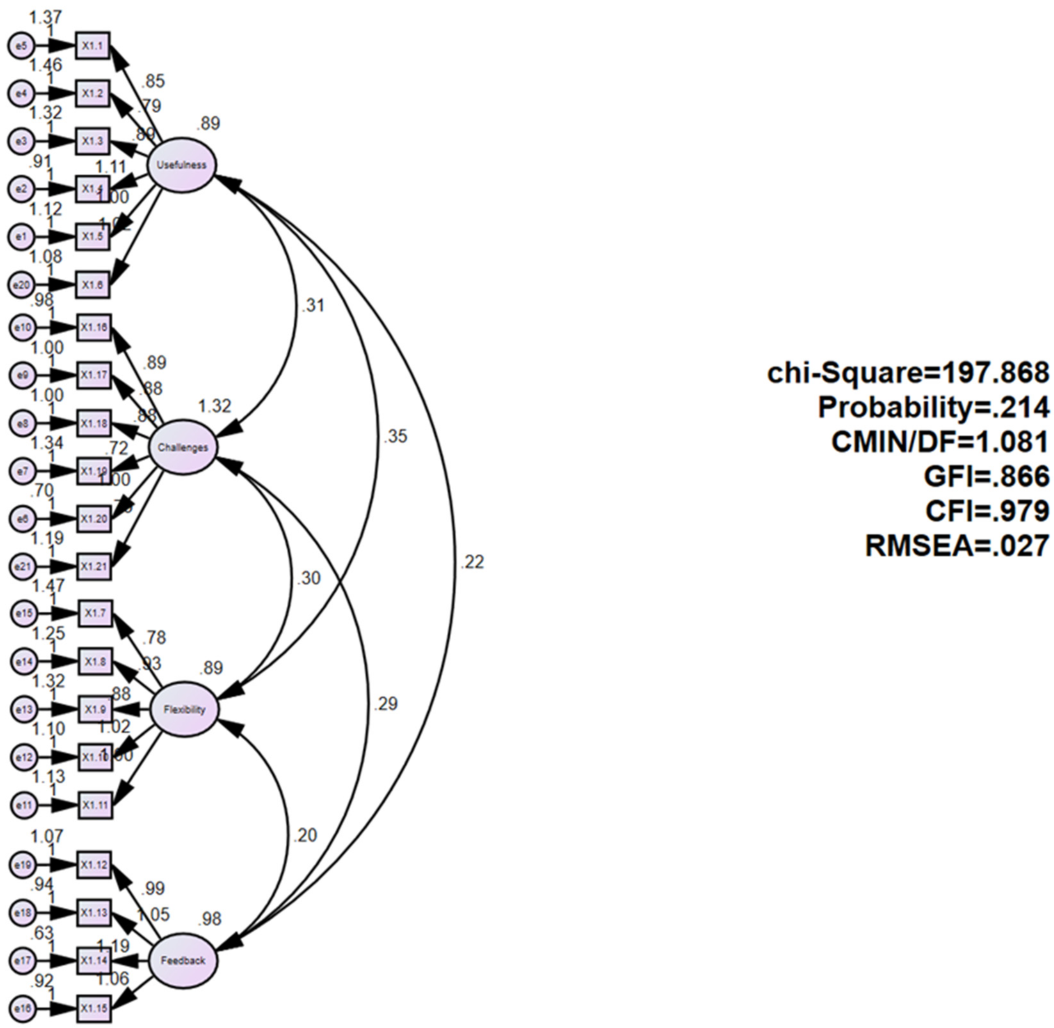

Figure 3. CFA Analysis Results for Teacher

Figure 4 below shows the results of the CFA analysis for students.

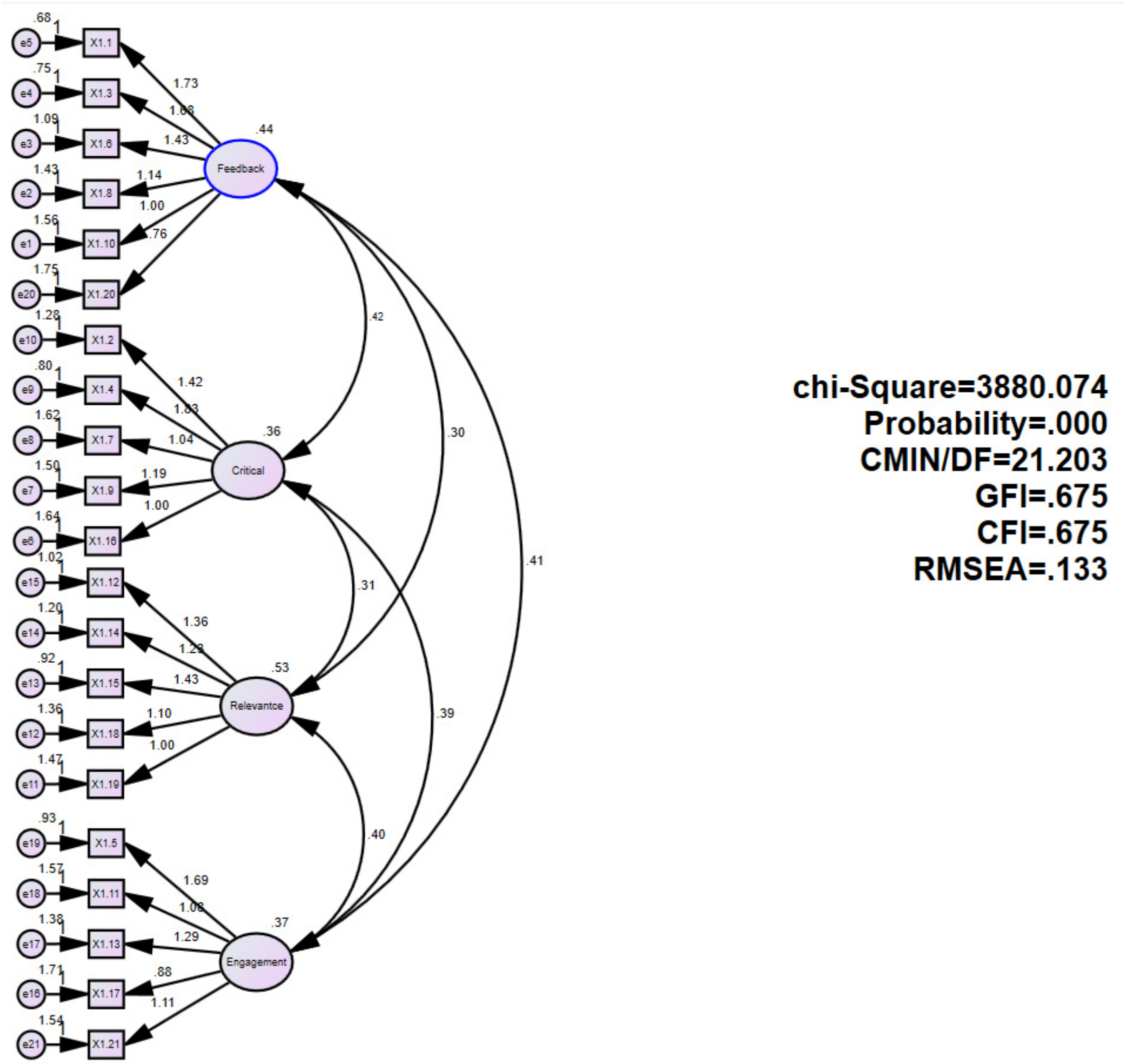

Figure 4. Results of the CFA Conducted on Student

To assess the goodness-of-fit of the model used in this study, the model fit measures will be presented in Table 9 below.

Table 9. Model FIT Statistic

Suitability Measure	Threshold Value	Actual Value For Teacher	Actual Value For student	Interpretation
p-value for Chi-square test	> 0.05	0.214	0.263	Very good fit
CMIN/DF	< 2 (very good), 2 - 3 (good)	1,081	1.064	Model fit level Very good
TLI	0.90 - 1.00	0.976	0.998	Very good fit
CFI	0.90 - 1.00	0.979	0.999	Very good fit
GFI	0.90 - 1.00	0,866	0.984	Good fit
AGFI	0.90 - 1.00	0.831	0.990	Good fit
RMSEA	< 0.05 (very good), 0.05 - 0.08 (fair)	0.027	0.008	Very good.

The results of the CFA analysis indicate that the formulated model aligns with the data on learning based on Design for Change (DfC), meaning the constructs tested are able to accurately represent the implementation of DfC in inclusive schools. Each variable demonstrated a good fit with the proposed theoretical model, as shown by the model fit indicators which fall within the good category. This confirms the relevance of DfC principles, such as flexibility, feedback provision, and material relevance, within the context of inclusive learning. Therefore, the DfC approach is proven effective in facilitating deep conceptual understanding for all students, including those facing certain learning challenges. The results of the CFA instrument development process analysis for teachers are shown in Table 10.

Table 10. Teacher Instrument CFA Procedure

Variables	Factor	Code Item	Loading	CR	AVE
Teacher perception	Factor 1	US1	0.665	0.790	0.528
	Usefulness	US2	0.739		
		US3	0.590		
		US4	0.526		
		US5	0.567		
		US6	0.682		
	Factor 2	CLag1	0.809	0.878	0.595
	Challenges	CLag2	0.581		
		CLag3	0.711		
		CLag4	0.712		
		CLag5	0.717		
		CLag6	0.642		
	Factor 3	FLeXI	0.665	0.802	0.513
	Flexibility	FLeX2	0.676		
		FLeX3	0.587		
		FLeX4	0.618		
		FLeX5	0.520		
	Factor 4	FD1	0.737	0.846	0.645
	Feedback	FD2	0.830		
		FD3	0.729		
		FD4	0.686		

Meanwhile, the results of the CFA instrument development process analysis for students are shown in Table 11.

To ensure that the measurement instrument has validity and reliability, a further evaluation was conducted by reviewing the extent to which the latent constructs can be well measured. This is indicated by the Composite Reliability (CR) and Average Variance Extracted (AVE) values, which have met the established criteria. Based on these results, the model is deemed to fit the empirical data and is capable of providing consistent outcomes, while indicators with loading values below 0.05 were eliminated and not retained in the analysis.

Table 11. Students` CFA Instrument Proses

Variables	Factor	Code Item	Loading	CR	AVE
Teacher perception	Factor 1	FD1	0.687	0.855	0.497
	Feedback	FD2	0.739		
		FD3	0.698		
		FD4	0.695		
		FD5	0.717		
		FD6	0.691		
	Factor 2	Cri1	0.690	0.821	0.479
	Critical	Cri2	0.691		
		Cri3	0.727		
		Cri4	0.671		
		Cri5	0.679		
	Factor 3	Rel1	0.667	0.829	0.494
	Relevance	Rel2	0.692		
		Rel3	0.728		
		Rel4	0.735		
		Rel5	0.691		
	Factor 4	Eng1	0.705	0.829	0.493
	Engagement	Eng2	0.717		
		Eng3	0.694		
		Eng4	0.699		
		Eng5	0.677		

All CR values are > 0.7, indicating good construct reliability, while the AVE values are mostly close to 0.5 → still acceptable (≥0.5 is ideal, ≥0.45 is still acceptable according to Fornell & Larcker, 1981).

3.2 Qualitative Result

The introduction to the research findings provides a general overview of the qualitative analysis results regarding perceptions of students and teachers of the development of evaluation instruments based on Design for Change (DfC) in mathematics learning at inclusive vocational schools. Qualitative analysis is important to reveal the real experiences, views, and expectations of teachers as both designers and implementers of learning, as well as students as the main actors in the learning process (Maulani et al., 2024; Agustianti et al., 2022). One of the math teachers said,

> *"So far, assessments have only focused on whether the answers are right or wrong. However, some students have unique ways of thinking; even if their final answers are not always correct, they actually demonstrate extraordinary potential."*

This view indicates that teachers need instruments that can capture process skills, such as critical thinking, problem-solving, creativity, and collaboration, which are highly relevant to the needs of the vocational workforce (Siregar, 2024; Febriana, 2017). Meanwhile, students expressed similar perspectives, especially regarding their experiences with the conventional evaluation system. Some students felt that their efforts were in vain when they were only assessed based on the final answers. Below are excerpts from interviews with several students,

> *"I often try my best when working on problems, but if the final answer is wrong, I'm immediately considered incapable. In fact, I do understand the method; it's just that some parts are not quite right, so the result isn't correct yet.."*

> *"Actually, I already understand the method, but when I make a mistake in one part, the whole answer becomes wrong, so I often feel it's pointless and choose to give up from the start"*

The interview excerpts highlight the importance of evaluation instruments that not only measure outcomes but also appreciate the process, effort, and learning strategies undertaken by students. The conceptual design of the DfC-based evaluation can be seen in Table 12.

Table 12. Concept of DfC-Based Evaluation

DfC Steps	Evaluation Aspects	Success Indicators	Evaluation Methods
Feel	Students' ability to recognize real problems that are contextual and relevant to life	Students are able to identify real problems that can be analyzed using mathematical concepts	Observation, reflection journals, guided interviews
Imagine	Solution ideas designed based on relevant mathematical concepts	Students propose solutions based on their understanding of the mathematical concepts studied	Idea presentations, creativity rubric, group discussions
Do	Implementation of ideas in real activities based on mathematics	Students carry out real actions such as calculations, simulations, or mini projects	Authentic assessment, portfolio, project rubric
Share	Reflection and publication of learning outcomes	Students reflect on their thinking process and explain the application of mathematical concepts communicatively	Presentations, reflective reports, documentation videos

Based on the table, the qualitative research findings show that the implementation of DfC-based evaluation helps students connect mathematics with real-world problems. At the Feel stage, one student expressed,

> *"When asked to find a problem, I thought about the large number of plastic bottles in the cafeteria. Then I calculated the average number of bottles per day based on observation data.."*

The Imagine stage generates solution ideas based on mathematical concepts. The teacher stated,

> *"They tried using ratios and percentages to calculate how many bottles could be recycled each week."*

At the Do stage, students begin to carry out more detailed calculations. One student said,

> *"We used data from 5 days to create a graph of the amount of plastic waste, then calculated the projection for a full month"*

Meanwhile, the Share stage strengthens reflection and mathematical communication. The teacher noted,

> *"During the presentation, students were able to explain the graphs and tables they created, although some errors in scaling were still present."*

Overall, this interview excerpt shows that DfC-based evaluation not only measures conceptual understanding but also encourages the application of mathematics in real-world contexts. This approach trains students to collect data, perform calculations, present graphs, and reflect on their thinking process, thereby fostering a "I Can" mindset that strengthens their role as agents of change. Similar findings were observed in students from other schools, who emphasized that DfC-based instruments provide them with space to express themselves through various forms of assessment, such as projects, presentations, and reflections. This makes them feel more confident and motivated. One student stated,

> *"If assessed through presentations or projects, I can better showcase my abilities. So it's not just through exam scores.."*

These findings show that the diverse forms of assessment offered by DfC not only enhance inclusivity but also build a sense of ownership and independence in learning. Teachers' initial understanding of Design for Change (DfC) in mathematics learning evaluation is generally focused on the importance of active student involvement and emphasis on the learning process, not merely on the final outcome. One teacher stated,

> *"For me, DfC is an assessment method that doesn't just look at right or wrong, but how students try, dare to express ideas, and are willing to learn from mistakes."*

This indicates that teachers interpret DfC as a more humanistic evaluation approach that appreciates the courage to experiment and self-reflection. From the students' perspective, DfC is understood as a more flexible form of assessment that is closer to their real-life experiences. One student expressed

> *"With this method, I feel freer. My grade doesn't drop immediately if I make a mistake, because*

> *effort and the process are also taken into account.."*

This view indicates that DfC provides students with space to interpret mistakes as part of learning, so evaluation is no longer seen as frightening but rather as a motivator. Teachers' initial understanding of Design for Change (DfC) in mathematics learning evaluation is closely related to how they see DfC as a new approach that emphasizes active student participation, the courage to try, and the importance of reflection. One teacher expressed,

> "*I see DfC as a way of thinking about assessment that is fairer because it gives students space to show the process and ideas, not just the results.."*

This view confirms that teachers do not merely see DfC as an evaluation technique but as a more inclusive assessment framework that values student diversity. From the students' perspective, DfC is interpreted as a form of evaluation that feels fairer and closer to everyday learning experiences. One student said,

> *"With the DfC approach, I feel that my efforts are appreciated. So even if my results are not perfect, I am not immediately considered a failure*."

This indicates that students' perceptions of DfC are largely related to feeling valued, motivated, and having opportunities to learn through the process. Furthermore, teachers also expressed the benefits they see from implementing DfC, especially in encouraging student creativity, providing space for reflection, and fostering connections with the vocational world that demands real problem-solving. However, some teachers still expressed doubts. One teacher said,

> *"If the time is limited, it's somewhat difficult to fully implement DfC, especially in inclusive classes with students who have very diverse abilities.".”*

These challenges lead teachers to view DfC as a promising approach but one that requires adaptation. Nevertheless, teachers place great hope on the perception instrument that has been developed. They expect this instrument to accurately capture how teachers and students assess the relevance, benefits, and challenges of DfC. One teacher emphasized

> *"We believe that having an instrument capable of measuring our and the students' perceptions can provide a clear picture of how teachers and students view DfC—whether they feel helped, motivated, or rather challenged."*

Thus, these findings show that both teachers and students have diverse perceptions but equally view the importance of an instrument that can systematically capture their perspectives. In the implementation of evaluation using DfC, inclusivity is an important aspect in both teachers' and students' perceptions of DfC-based evaluation. Most teachers believe that the DfC approach has the potential to accommodate student diversity, especially because it provides space for them to express their abilities in different ways. One teacher stated,

> *"DfC can accommodate various student learning styles. Some prefer writing, others are stronger in practice or presentations, and all can be demonstrated."*

This view confirms that teachers see DfC as a more flexible evaluation model compared to rigid traditional assessments. From the students' perspective, especially those without learning difficulties, DfC-based evaluation is perceived as fairer because they feel that effort and process are valued, not just the final result. However, for students with special needs, responses vary. Some students feel helped because DfC allows them to demonstrate their abilities through group work or projects, as expressed by one student,

> *"I feel more comfortable when there is group work because we can help each other.."*

Nevertheless, there were also students who expressed challenges, especially when having to present or openly share ideas in front of the class. One student with special needs said

> *"Sometimes I find it hard to explain, so I feel left behind compared to my friends"*

This indicates that although DfC is viewed as more inclusive, adjustments in strategy are still necessary so that every student, including those with learning difficulties, can fully participate in the evaluation. Thus, the inclusivity aspect in teachers' and students' perceptions emphasizes that the success of implementing DfC heavily depends on how flexibly the evaluation is applied in real practice within inclusive vocational classrooms. DfC-based evaluation is perceived positively by both teachers and students in inclusive vocational schools. Teachers see DfC as an evaluation approach that is beneficial for encouraging creativity, reflection, and relevance to vocational needs, although they also highlight challenges such as limited time and the diversity of student abilities. Meanwhile, students view DfC as a fairer form of evaluation that provides opportunities for constructive feedback and increases involvement and motivation in learning mathematics.

4. Discussion

This study uses a questionnaire as a tool to explore teachers' and students' views on the implementation of the DfC approach in learning at inclusive vocational schools. The questions are focused on various aspects, such as the effectiveness of implementation, obstacles faced, and the flexibility of DfC in practice. Additionally, the instrument addresses the role of DfC in providing feedback, its relevance to learning needs, and the extent to which the approach can enhance student engagement in the mathematics learning process (Dewi et al., 2025; Wiggins & McTighe, 2005; Smith & Brown, 2021; Sumandya et al., 2023; Suryawan et al., 2025; Kamalia & El-Yunusi, 2024). From the teachers' perspective, the instrument assesses how far DfC helps improve students' conceptual understanding and skills (Widana, 2020; Pardimin, 2018; Sudiarta & Widana, 2019). During the research implementation, several challenges arose due to limited time and insufficient training for teachers regarding the application of the DfC approach. Furthermore, some teachers had yet to fully understand DfC's capacity to provide space for adaptive assessment. Other challenges related to teachers' perceptions of the benefits offered by this approach. Meanwhile, from the students' perspective, the questionnaire evaluates the clarity and usefulness of DfC, its impact on critical and creative thinking abilities, the relevance of assessments to real-life situations, and the extent to which student involvement in the process can boost motivation, confidence, and learning outcomes. Overall, this instrument aims to understand the benefits, challenges, and implementation of DfC in inclusive mathematics learning at the vocational education level. The alignment of the instrument with theoretical models and empirical data demonstrates that this instrument can serve as a measurement tool to assess teachers' and students' perceptions regarding DfC-based learning evaluation in inclusive schools (Connell et al., 2018; Polit & Beck, 2014; Fornell & Larcker, 1981; Hair et al., 2010). This finding supports the statement by Smith and Brown (2021) that DfC plays a role in enhancing conceptual understanding and critical thinking skills.

The DfC instrument demonstrates a robust and consistent factor structure across both teacher and student respondent groups (Joshi et al., 2015; Harerimana & Mtshali, 2020; Mulyono, 2022). Based on the EFA results, the measurement model for teachers comprises several key constructs, including usability, flexibility, challenges, feedback, engagement, relevance, and critical thinking, all of which represent essential dimensions of differentiated learning environments. Meanwhile, the student model encompasses eleven constructs that collectively capture cognitive, social, and emotional aspects of learning, indicating that learners experience DfC not only in terms of academic processes but also through motivation, interaction, and self-regulation (Febriana, 2017; Kamalia & El-Yunusi, 2024). This multidimensional configuration suggests that the instrument is sensitive to the complex nature of differentiated instruction and inclusive classroom practices.

Subsequent CFA findings further validated the factorial structure, with strong factor loading values and acceptable goodness-of-fit indices confirming that the observed data align well with the theorized measurement model (Fornell & Larcker, 1981; Harerimana & Mtshali, 2020). These results provide empirical evidence supporting the construct validity of the instrument. In addition, the reliability analysis revealed Cronbach's alpha coefficients exceeding the threshold of 0.7 for all identified constructs, demonstrating satisfactory internal consistency and indicating that the items consistently measure the intended latent variables. Taken together, these statistical outcomes reinforce that the instrument is both psychometrically sound and theoretically grounded. Overall, the DfC instrument can be regarded as a valid and reliable tool for assessing the implementation of DfC in inclusive school contexts (Nurfadhillah, 2021; Putri et al., 2025; Santosa, 2025). Its stable factor structure across teacher and student groups highlights its suitability for capturing perceptions of instructional differentiation from multiple stakeholder perspectives (Kurniawan, 2025; Daga, 2025). This contributes to the broader effort of developing evaluation instruments that not only reflect pedagogical innovation but also accommodate the diversity of learners and instructional conditions present in inclusive educational systems.

The qualitative findings derived from teacher and student interviews, as well as classroom observations, reveal that the DfC approach is perceived as a constructive framework for fostering inclusive, participatory, and differentiated learning in vocational school contexts. Teachers emphasized that DfC encourages them to rethink assessment practices by integrating flexibility, feedback, and student agency, enabling assessments to be adapted according to individual learning profiles and developmental progress rather than relying solely on uniform evaluative standards (Suryawan et al., 2025; Widana, 2020; Sumandya et al., 2023; Dewi et al., 2025). They also highlighted perceived challenges such as the complexity of designing adaptive assessments, limited time for preparation, and the need for professional development to fully operationalize DfC in inclusive environments. From the students' perspective, DfC was regarded as supportive of learning motivation, clarity of expectations, and opportunities for collaboration, with many expressing that reflective activities and feedback cycles helped them better understand their own strengths and areas for improvement (Febriana, 2017; Kamalia & El-Yunusi, 2024; Lailiyah et al., 2021; Dina, 2025). Observational data further supported these narratives by showing increased learner engagement, peer interaction, and willingness to participate in tasks requiring critical thinking and problem-solving. Taken together, the qualitative insights suggest that while DfC implementation necessitates systemic teacher support and structured training, it contributes to more student-centered and equitable learning conditions by validating diverse learning needs and encouraging active participation within inclusive classroom settings (Thahir et al., 2024; Phytanza et al., 2022).

In addition, the questionnaire enables teachers and students to better comprehend the challenges, adaptability, and learning impact associated with implementing DfC (Florian & Black-Hawkins, 2011; Roos, 2019). Validating this instrument further establishes a basis for educators and policymakers to design evaluation approaches that are more inclusive and contextually grounded. Studies by Widana et al. (2023) and Wanabuliandari et al. (2025) highlight that teachers' local wisdom shapes the autonomy of special needs schools and influences assessment adjustments, emphasizing the necessity of culturally and context-sensitive instruments. Independence and creativity in mathematics assessment are regarded as essential components to enhance the flexibility of DfC across varied learning settings (Suryawan et al., 2025; Sumandya et al., 2023). In the same vein, Widana (2020) and Pardimin (2018) argue that digital literacy enables teachers to develop assessments aligned with higher-order thinking skills (HOTS). Furthermore, research by Sudiarta and Widana (2019) indicates that students' character and mathematical competencies improve through contextual approaches, including blended learning. Therefore, the validated instrument serves as a valuable reference for teachers and policymakers in formulating inclusive, effective, and culturally relevant assessment strategies tailored to diverse learning needs.

5. Conclusion

This study successfully developed and validated an instrument designed to measure teachers' and students' perceptions of mathematics learning evaluation based on the DfC approach in inclusive vocational schools. Through multi-stage psychometric procedures, namely CVI, EFA, and CFA the instrument demonstrated strong content validity, factorial validity, and internal consistency, confirming that the constructs reflected by teachers (usefulness, challenges, flexibility, and feedback) and students (feedback, critical thinking, relevance, and engagement) were empirically sound. The validation outcomes provide evidence that the instrument functions as a reliable measurement tool to capture perceptual dimensions of DfC-based evaluation across heterogeneous respondent groups within inclusive settings. While sampling constraints may limit generalizability, the resulting instrument offers a scalable foundation for future measurement studies, cross-group validation, and educational assessment research in inclusive and vocational contexts. Accordingly, this work contributes primarily to the measurement literature by supplying a rigorously validated tool for evaluating perceptual constructs that were previously undocumented or insufficiently measured in DfC-oriented learning environments.

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Authors contributions

I Putu Pasek Suryawan were responsible for study design and revising. I Gusti Ngurah Pujawan was responsible for data collection. Gusti Ayu Mahayukti drafted the manuscript and revised it. Padrul Jana contributed to the statistical data analysis, including data processing and the selection of appropriate analytical methods. Mohamed Nor Azhari Azman contributed to the review and language editing (proofreading) of the manuscript to ensure clarity, accuracy, and consistency in accordance with academic publishing standards. All authors read and approved the final manuscript. In this paragraph, also explain any special agreements concerning authorship, such as if authors contributed equally to the study.

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