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Developing a Cultural Dimensions Scale to Evaluate Science Teachers' Formative Assessment Practices

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Abstract. This study derived Hofstede's interpretations and predictions of his cultural dimensions in the context of schools and classrooms to develop a cultural dimensions scale and identify its psychometric properties and then evaluate its effect on science teachers' formative assessment practices. Data were obtained from 425 Cycle 2 school science teachers in Oman who were selected randomly by using a two-stage cluster sampling design. A questionnaire was utilized, and the primary data were analyzed using SPSS 26.0 and Smart PLS 4.0. A structural model was utilized to evaluate the effect of cultural dimensions on formative assessment practices, and the psychometric properties of the developed scale were ascertained with a measurement model. The study derived good psychometric properties of the developed cultural dimension scale. Additionally, this study revealed a large positive effect ($F^2 = 0.41$) of cultural dimensions on the formative assessment practices of science teachers. This study contributes empirically and theoretically by developing an original scale. Additionally, valuable practical implications are offered to policymakers and educators, who are advised to consider cultural challenges when they embark on strengthening teacher competencies and skills to enhance their formative assessment practices.

Keywords: Hofstede's cultural dimensions; formative assessment dimensions; formative assessment practices; Oman Cycle 2 schools

1. Introduction

Formative assessment is defined as the gathering of information on students' learning, which is analyzed and communicated by teachers, and serves as constructive feedback for themselves and their students, with the intention of improving instruction and student learning (Black & William, 2010). The fundamental objective is to promote teaching and learning, which are two

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correlated processes. However, from evaluations of the effectiveness of formative assessment implemented in different parts of the world, scholars have concluded that science teachers struggle to implement effective formative assessment because of shortcomings in their conception of formative assessment and in the actual deployment of formative assessment practices in science classrooms (Griffin et al., 2016). Moreover, teachers' formative assessment practices are influenced by several cultural traits (Barke & Nakamura, 2012; Cagasan et al., 2020).

About two decades ago, the government of Oman, through the Ministry of Education, embarked on major education reforms by replacing its general education with basic education, with the aim of improving student learning. A highlight of this reform was the reevaluation of assessment practices in classrooms, which led to the adoption of formative assessment practices to inform teachers' instructional practices. However, compared to international assessment of learning outcomes, especially in math and science, Omani students have low performance levels in these subjects (Al Shabibi & Silvennoinen, 2018).

An area that has not received adequate attention in literature is the influence of cultural dimensions on assessment. As argued by Sutton et al. (2017), local cultural dimensions are likely to affect the way assessment methods are applied. Similarly, Troncon (2004) concludes that the effect of assessment practices on student performance could be influenced by local cultural aspects, because students sometimes perceive assessment as a tool that supports and praises some students and underestimates others. The effect of cultural dimensions has not been investigated fully. As a result, it was considered important to empirically validate the influence of cultural dimensions on formative assessment practices with a research-based study.

This importance resonates with the Omani context, where an inherited tendency to do summative assessment dominates over formative assessment (New Zealand Education Consortium, 2017). This trend could be attributed to the influence of certain cultural values in the community regarding science teachers' formative assessment practices, which are related to beliefs about and conceptions of formative assessment, and roles played in assessment by the Ministry of Education, schools, students, communities, and parents.

This study posits that the challenges associated with formative assessment practices can be explained when the practices are viewed through the lens of Hofstede's cultural dimensions. Cultural dimensions pose challenges to science teachers during their practice of formative assessment. The main purpose of this study was to empirically evaluate the effect of Hofstede's cultural dimensions on formative assessment practices of science teachers. Accordingly, this study aimed to address the following research questions:

- What are the psychometric properties of the adapted instrument that measures formative assessment practices and cultural dimensions?
- Do cultural dimensions have a significant effect on the formative assessment practices of science teachers in Oman Cycle 2 schools?

Based on the purposes of this study and the research questions, a conceptual framework was developed to test the following hypothesis:

H₁: Cultural dimensions have a significant effect on formative assessment practices of science teachers in Cycle 2 schools in Oman

2. Literature Review

2.1 Formative Assessment Practices: Conceptual View

Academic researchers delineate formative assessment into two broad categories: formal and informal. Formal formative assessment refers to structured evaluation processes that are explicitly integrated in a curriculum and instructional plan. It typically involves assessment tasks such as written assignments, quizzes, worksheets, or projects that have been deliberately designed by the teacher as part of lesson planning. Students complete these tasks, and teachers systematically evaluate students' performance and provide written or oral feedback that addresses specific learning targets (Grob et al., 2021; Yin et al., 2014).

In contrast, informal formative assessment is less structured and occurs more spontaneously in classroom interactions. While it is not tied to preplanned curriculum tasks, it still supports curricular goals by responding directly to students' emerging needs during learning. Informal strategies include teacher questioning, classroom discussions, think-pair-share activities, observing students' problem-solving processes, and monitoring participation in groupwork (Furtak et al., 2017).

The feedback, in such cases, is often immediate, dialogic, and adaptive, and involves clarifying misconceptions, scaffolding student reasoning, offering hints, or providing encouragement (Can Daşkın & Hatipoğlu, 2019; Rached & Grangeat, 2020). This distinction aligns with the acknowledgment of the Ministry of Education in Oman that students learn at different paces and benefit from multiple modes of assessment that have been tailored to their individual learning processes.

Formative assessment encompasses vital and unique constructions that are discussed in the education literature and include the following: addressing learning gaps, sharing learning objectives and assessment criteria, communicating constructive feedback, engineering good classroom discussion and effective questioning, and activating self and peer assessment (William & Thompson, 2008).

As for addressing learning gaps, Kumpas-Lenk et al. (2018) explain that teachers must be aware of their students' current performance levels by analyzing students' abilities and skills in specific subjects and providing appropriate interventions to tailor teaching and assessment methods to meet students' needs. With respect to sharing learning objectives and assessment criteria, scholars of formative assessment propose applying agreed-upon standards or criteria of a subject to evaluate achievement and determine subsequent steps in the learning process (Akpan, 2020; Lambert & Lines, 2013; Sadler & Reimann, 2018). Providing

constructive feedback is a key element of formative assessment. Researchers emphasize the importance of providing regular constructive feedback that is specific to the task at hand (Al-Hattami, 2019; Irons & Elkington, 2021; Owen, 2016; Wiliam, 2013), and the need to focus on key skills, knowledge, and attitudes relevant to the subject being studied by students (Singh, 2015). Engineering good classroom discussion is also a substantial element of formative assessment.

It is argued that, when teachers use assessment strategies, such as questioning, and the ways they respond to their students' thinking, could help them develop effective assessment practices for science lessons (Black & William, 2018). Finally, activating self and peer assessment has become an essential process in contemporary formative assessment. Samuel et al. (2019) suggest that teachers empower students to internalize assessment criteria, understand how to utilize this information for self or peer assessment, and effectively communicate their thoughts and feedback to their peers.

2.2 Cultural Dimensions and Teachers' Formative Assessment Practices

Phillips (2003) defines culture as the collection of practices and values shared among a group of people. However, it is essential to note that these shared practices and values are not static, but rather dynamic in nature and continuously evolve over time. This concept is supported by the work of Ovchinnikova et al. (2018) and Orey and Rosa (2021). According to Amir (2019), teaching practices are culturally bound. This means that teachers bring their cultural backgrounds, experiences, and histories into the classroom. Sturdivant and Alanís (2019) and Fitriyah (2020) support this notion with a substantial body of research. They suggest that teachers' beliefs and values about teaching and learning, which are shaped by their cultures and experiences, have a profound effect on their teaching practices.

Teaching is viewed as a metacognitive process (Lin et al., 2005) through which teachers actively develop teaching strategies according to their beliefs and shaped by social and cultural interactions, traditions, values, experiences, professional growth, and scholarly literature (Orey & Rosa, 2021). According to Sturdivant and Alanís (2019), teachers' beliefs about how learning occurs and their understanding of how students learn have a significant effect on the teaching methods they choose to implement.

Recent studies have started to empirically examine the influence of Hofstede's cultural dimensions on formative assessment practices in science education. While earlier research suggested that culture could affect formative assessment, there is a notable shortage of validated instruments and cross-cultural investigations to substantiate these claims. A significant contribution to this field is the study of Al Sulaimani and Lim (2025), which employed Hofstede's cultural dimensions to investigate how cultural factors influenced formative assessment practices of 91 science teachers. The findings are that teachers' formative assessment practices were significantly shaped by dimensions such as power-distance, collectivism versus individualism, masculinity versus femininity, uncertainty avoidance, and long-term versus short-term orientation.

This study will provide empirical validation of theoretical assertions regarding the impact of cultural dimensions on assessment practices. By using a structured questionnaire, this study offers a robust methodological approach to address the gap in the literature concerning the application of validated instruments to evaluate the effects of cultural influences on formative assessment practices. By focusing on science teachers, the research provides context-specific insights that promote understanding of how cultural values permeate educational practices. For instance, power–distance may influence hierarchical structures in classrooms, thereby affecting how feedback is delivered and received. Similarly, the collectivism versus individualism dimension could impact the emphasis on group-based assessments versus individual evaluations.

In a recent study, Brown et al. (2019) assert that teachers' conceptions of assessment are directly predictive of their assessment practices, and these conceptions are shaped by cultural values, which confirms that cultural orientations not only influence broad pedagogical practices but also, specifically, shape how assessment is designed and enacted in classrooms. Similar cultural challenges have been observed in the Omani higher education context. Cultural norms, motivation, and academic integrity are closely intertwined with teaching and assessment practices. Awashreh and Al Ghunaimi (2025) argue that, to foster student motivation and integrity, which are critical conditions for the effective adoption of formative assessment, it is essential to bridge cultural gaps in Oman's universities. Their findings suggest that cultural sensitivity in assessment design reduces resistance and enhances student engagement with feedback.

Despite these advancements, literature still lacks comprehensive studies that examined the interplay between Hofstede's cultural dimensions and formative assessment practices across diverse cultural contexts. Most research remains confined to theoretical discussions or single-nation studies, which limits the generalizability of findings. Therefore, future research should aim to employ triangulated data sources and combine quantitative and qualitative methods to explore how cultural dimensions influence formative assessment practices in various educational settings. Such studies would enrich the theoretical framework surrounding formative assessment and provide practical insights for educators and policymakers seeking to implement culturally responsive assessment strategies.

In conclusion, while recent studies have started to empirically investigate the impact of cultural dimensions on formative assessment practices, there remains a pressing need for more cross-cultural research employing validated instruments. Addressing this gap will enhance our understanding of how cultural contexts shape assessment practices and contribute to the development of more inclusive and effective educational strategies. Finally, the literature review informs the construction of a theoretical framework that illustrates how Hofstede's cultural dimensions model situates formative assessment in a cultural context by explaining how values such as power–distance, collectivism, uncertainty avoidance, and long-term orientation influence teachers' practices. In this relationship, cultural dimensions serve as the independent variables, while

teachers' formative assessment practices represent the dependent variables. Thus, the framework acknowledges both the pedagogical rationale of formative assessment (explained by social constructivism) and the cultural conditions that shape its enactment (explained by Hofstede's model), thereby providing a comprehensive lens for understanding science teachers' formative assessment practices.

2.3 Hofstede's Model of Cultural Dimensions

As relations across cultural barriers have become increasingly common in recent decades, the need to understand others has increased. In the 1970s, several models were developed to predict behavior. However, the one by Geert Hofstede has become the most influential and has been used in several empirical studies.

Hofstede (1986) identified four cultural dimensions to compare the dominant value systems of national cultures. According to Bissessar (2018), Hofstede's four original cultural dimensions are: i) Power-distance – the degree to which a society accepts the idea that power and authority can be distributed unequally; ii) Collectivism versus individualism – the relationship between the individual and collectivists that prevails in a particular culture; iii) Masculinity versus femininity – the degree to which a society emphasizes achievement, assertiveness, and competition as opposed to quality of life issues, nurturing, group solidarity, and cooperation; and iv) Uncertainty avoidance – the degree to which a society feels threatened by ambiguity or unexpected situations, which indicates the extent to which a society tries to avoid uncertainty by rules and the level of tolerance for deviation from those rules or established procedures.

A fifth dimension of culture, long-term orientation versus short-term orientation, was added by Hofstede in 1991 to incorporate an oriental view in the cultural dimensions model (Hofstede, 1986). While short-term orientation is more traditional and gives priority to the past and present against the future, the long-term orientation is futuristic and tends to emphasize positive and ethical perspectives (Cidral et al., 2020).

3. Methods

This was a cross-sectional quantitative study that adopted a postpositivist philosophy in a deductive approach and used a questionnaire survey to examine the effect of cultural dimensions on the formative assessment practices of science teachers in Cycle 2 schools in the Sultanate of Oman.

3.1 Research Sample

The sample of this study (N = 425) was selected using a two-stage cluster sampling design. This design is generally employed by dividing the population into geographically distinct clusters at the first stage, then, selecting a sample of clusters from such schools randomly and surveying members of the selected clusters at the second stage (Ross, 2005). The sample consisted of science teachers with teaching experience of three years and more at Cycle 2 (Grades 5–8) schools in the 11 educational governorates of Oman for the academic year 2022–2023. We believed that teachers had to have at least three years' experience to provide the

required primary data, because such teachers were assumed to have developed the required levels of conception of formative assessment and had employed various formative assessment practices in their classrooms.

Science teachers in Cycle 2 schools (Grades 5–8) were selected to participate in this study for several reasons. Firstly, Cycle 2 school teachers are prepared at Education Colleges to specialize in science, unlike the Cycle 1 school teachers (Grades 1–4), who are prepared to teach math and science and are referred to as field teachers. Secondly, teachers of Grades 9–12 were excluded because science subjects in those grades are divided into three streams (physics, biology, chemistry), and the intent of this study was to select teachers who taught general science and had access to multiple formative assessment methods that they could use to assess both students' achievement and their learning. Moreover, previous, similar studies mostly used a similar grade range.

3.2 Research Instrument

A self-administered structured questionnaire served as the research instrument to gather quantitative cross-sectional primary data. Responses were anchored on a 4-point Likert scale of Strongly disagree (1), Disagree (2), Agree (3) and strongly agree (4). Before articulating the components of the instrument, it is vital to highlight the stages of adaptation that were made in response to the limitations of the previous instruments and to improve the quality of the instruments in this study. For the section on formative assessment (Appendix 1), the items were adapted from Samuel et al. (2109).

Yet, because of the sets of formative assessment practices measured by the adapted instrument were not comprehensive, new items were added for each construct of the questionnaire, based on the characteristics of best practices of formative assessment discussed in the literature (Bailey & Heritage, 2008; Black & William, 2018; Furtak et al., 2017; Heritage, 2007; Leahy et al., 2005; Ruiz-Primo & Furtak, 2007). For example, all the items in the construct 'Addressing learning gaps' are new (Appendix 1). The researcher followed the scaling procedures of Netemeyer (2003) to formulate the new items.

In addition to the formative assessment constructs applied by Samuel et al. (2019), this study used another construct, namely 'Learning gaps.' This construct was perceived to be important and is discussed by Furtak et al. (2017), Heritage (2007), Liu et al. (2017), and Ruiz-Primo and Furtak (2007). The researchers advocate for the addition of this construct because it encompasses important formative assessment practices that were not addressed in the adapted instrument. The five items of this construct were also formulated according to the guidelines of Netemeyer (2003).

In the section relating to cultural dimensions (Appendix 1), specifically, the effect of cultural dimensions on formative assessment practices, information related to cultural dimensions as found by a validated quantitative study were lacking in the context of teachers' formative assessment practices in the classroom. Therefore, this study utilized a cultural dimensions scale derived from Hofstede

et al. (2010). The survey items used by Hofstede in the popular IBM study across three decades and his predictions and interpretation of the key differences of each dimension in the context of education and schools were utilized in the classroom context to reflect on values and behaviors embraced by science teachers, and, accordingly, the 25 cultural dimension items were also formulated according to Netemeyer's (2003) scaling procedures.

Because this study aimed to identify the psychometric properties of a newly developed scale, the content of the scale was validated before the scale was applied to the target sample by applying two steps, namely evaluation by an expert panel, and a translation panel. The agreement between the experts was determined using the content validity index (CVI), which is the most widely used method of quantifying content validity for multi-item scales. For the present study, the nominated expert panel consisted of six experts with experience of teaching and competency in psychometric and educational evaluation, as well as science or math education.

A summary of the questionnaire survey instrument is shown in Table 1.

Table 1: Survey questionnaire measures

Dimensions	Construct	Number of items	Sources
Formative assessment practices	Addressing learning gaps	5	Samuel et al. (2019)
	Sharing learning targets	5	
	Engineering good classroom	5	
	Communicating constructive feedback	5	
	Activating self and peer assessment	5	
Cultural dimensions	Power-distance	5	Hofstede et al. (2010)
	Individualism-collectivism	5	
	Masculinity-femininity	5	
	Uncertainty avoidance	5	
	Long-term orientation versus short-term orientation	5	
Total number of items		50	

Subsequently, the survey questionnaire that was used to collect quantitative data was piloted with a sample of science teachers who were not included in the data collection sample. The survey was entered in Google Forms and disseminated electronically by sending its link to the selected sample. Official permission to conduct the study was issued by the responsible department in the Ministry of Education. About 90 science teachers with at least five years teaching experience responded to the electronic survey. The reliability scores represented by the

internal consistency of Cronbach alpha s for all the constructs ranged from 0.60 to 0.87, thereby demonstrating moderate and good reliability.

3.3 Data Analysis

To address the first research question, which is related to the psychometric properties of the adapted instrument that enquired into formative assessment practices and cultural dimensions, the psychometric properties were evaluated using reliability and validity measurements as recommended by Hair et al. (2019). These measurements were carried out using the measurement model of the Smart PLS-SEM technique in the following ways.

Firstly, reliability was tested using composite and internal consistency reliability parameters. Secondly, the validity was evaluated by examining convergent validity and discriminant validity. These tests were carried out using average variance extracted (AVE) with a cut-off value of 0.5 and by examining the outer loadings of the constructs with a cut-off value of 0.5. Discriminate validity was determined using cross-loadings between the constructs of formative assessment practices and the cultural dimensions.

For research question 2, Do cultural dimensions have a significant effect on the formative assessment practices of science teachers in Oman Cycle 2 schools? the Smart PLS technique was used to examine the structural model. The bootstrapping technique with 10,000 bootstrap samples was used to examine the significant path coefficient of the relationship between cultural dimensions and formative assessment practices. Then, the coefficient of determination (R-square) was used to evaluate the proportion of variance in formative assessment practices that can be explained by cultural dimensions. Afterwards, the Stone-Geisser test of predictive relevance was used to determine the goodness-of-fit of the structural model.

4. Analysis and Results

4.1 Descriptive Statistics of Demographic Data

Table 2 provides a summary of the descriptive statistics of the demographic profiles of the survey respondents. The demographic statistics show that, out of a total number of 425 respondents, more women (50.8%) than men (49.2%) completed the questionnaire survey.

The demographic statistics also report a largely well-educated respondent sample, with 88.7% having bachelor's degrees, 8.0% having master's degrees, 2.8% possessing diplomas, and 0.5% having doctorate degrees. Regarding years of experience as a teacher, the descriptive results show that most of the sample respondents (54.6%) had more than 15 years of teaching experience, 19.8% had spent 3–5 years as teachers, 14.3% had 11–15 years of experience as teachers and 11.3% had teaching experience of between 6 and 10 years.

The demographics conclude that the science teachers involved in this study are well educated—the majority have bachelor's degrees—and most of them have relatively long teaching experience. These findings were expected to have positive

impact on the formative assessment practices that teachers implemented with their students in their classrooms every day.

Table 2: Demographic profile of survey respondents

Demographic Characteristic	Categories	Frequency	Percentage (%)
Gender	Male	209	49.2
	Female	216	50.8
	Total	425	100
Highest academic qualification	Diploma	12	2.8
	Bachelor's	377	88.7
	Master's	34	8.0
	Doctorate	2	0.5
	Total	425	100
Years of experience as a teacher	3-5 years	84	19.8
	6-10 years	48	11.3
	11-15 years	61	14.3
	More than 15 years	232	54.6
	Total	425	100

4.2 Science Teachers' Level of Practice of Formative Assessment

As shown by Table 3, the mean ratings for the five constructs that represent the formative assessment practiced by the science teachers ranged from 3.05 (Self and peer assessment) to 3.22 (Engineering good classroom discussion). These mean scores were above the neutral midpoint of 2.5, thereby indicating general agreement about the formative assessment practices they applied in their science classrooms. Additionally, the standard deviation for all the five constructs ranges from 0.65 to 0.67, which indicates a moderate level of variability in responses.

Therefore, it can be inferred that the responses obtained from the participants in this study, which exceeds the midpoint of 2.5, indicates a satisfactory and acceptable level of practice of the five formative assessment constructs in classroom science sessions in Cycle Two schools in the Sultanate of Oman (Tastle & Wierman, 2007).

Table 3: Levels of the formative assessment practices implemented by science teachers

Formative assessment constructs	N	Mean	Minimum score	Maximum score	Standard deviation
Learning gaps	425	3.15	1	4	0.65
Sharing learning objectives	425	3.16	1	4	0.67
Engineering good classroom discussion	425	3.22	1	4	0.67
Constructive feedback	425	3.14	1	4	0.67
Self and peer assessment	425	3.05	1	4	0.67

In summary, the results of the mean scores of teachers' level of formative assessment practices, which were above 3.0, indicate substantial levels of effective formative assessment practices as claimed by the surveyed science teachers. However, these quantitative results could be validated by triangulating them with qualitative data such as classroom observations.

4.3 Inferential Statistics using Partial Least Square Structural Equation Modeling

The present study employed a two-step approach, consisting of (1) evaluating a measurement model, and (2) evaluating a structural model, as depicted in Figure 1.

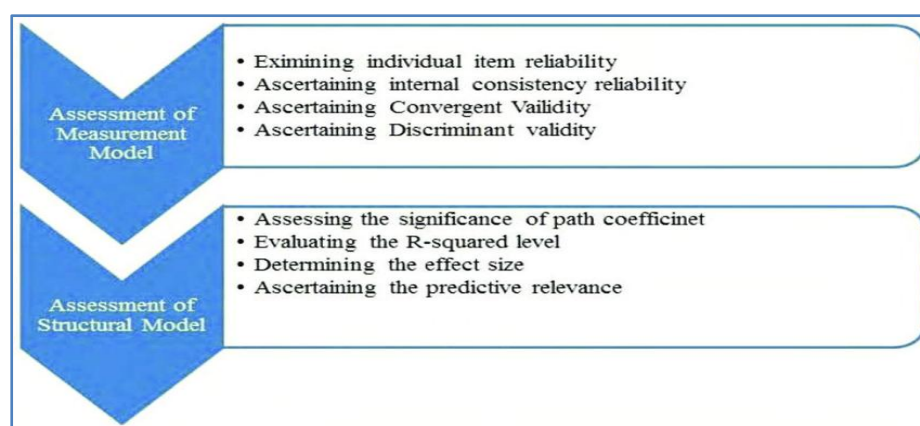


Figure 1: Two-step partial least square structural equation modeling (Henseler et al., 2009)

4.3.1 Measurement Model: Research Question 1

Research question 1 is, what are the psychometric properties of the adapted instrument that measures formative assessment practices and cultural dimensions? The measurement model, otherwise known as confirmatory factor analysis, was used to identify the psychometric properties (outer loadings, reliability and their validity) of the instrument.

A) Outer Loadings: First Order and Second-Order Constructs

A disjoint two-stage approach was used. This approach is often employed in models with reflective constructs, like the present study. It is considered an effective alternative to the repeated indicators approach. Firstly, the model was estimated without the inclusion of the second-order constructs (formative assessment practices and cultural dimensions). The outer loadings for each measurement item of the first-order reflective constructs were analyzed. Of the original 50 items, 40 had significant loadings above the recommended minimum threshold value of 0.7.

There are no standard accepted percentages for deleted items with low loadings, yet most studies recommend not more than 20% of deleted items from the model. Consequently, the remaining 10 items with insignificant loadings were deleted from the model (Hair et al., 2017). The items that were deleted from the model were not serious enough to change the content of the constructs as they were

conceptualized. Secondly, the second-order constructs were incorporated in the trimmed model, and the model was rerun with the first-order constructs now serving as indicators for the second-order constructs (formative assessment practices and cultural dimensions).

Table 4 displays the psychometric properties of formative assessment practices, and the cultural dimensions measurement model at the second-order level. The results are that all the indicators' outer loadings were above the accepted threshold value of 0.7.

Table 4: Outer loadings of second-order reflective constructs

Second-order reflective constructs	First-order reflective constructs	Outer loadings
Formative assessment practices	Addressing learning gaps	0.91
	Sharing Learning objectives	0.90
	Engineering good classroom discussions	0.92
	Communicating constructive feedback	0.90
	Activating Self and Peer Assessment	0.85
Cultural dimensions	Power-distance	0.91
	Individualism-collectivism	0.91
	Masculinity-femininity	0.90
	Uncertainty avoidance	0.82
	Long-term orientation versus short-term orientation	0.79

B) Reliability and Validity of Constructs and Measures

Firstly, before administering the sample, the values of CVI for each item, section, and overall survey were above 0.90, which indicates that the content of the questionnaire was substantially valid. Secondly, based on content validation, the results of the Cronbach alpha reliability and the composite reliability are summarized in Table 5.

The results show that the composite reliability values exceeded the conventionally accepted critical threshold value of 0.7 for all constructs, as recommended by Bagozzi and Yi (1988). The composite reliability values of the constructs ranged from 0.92 to 0.94. Moreover, Cronbach's alpha values, which describe the internal consistency, ranged from 0.92 to 0.94, which are above the threshold of 0.7, as suggested by Nunnally and Bernstein (1994). Therefore, we conclude that all the constructs studied are reliable.

Table 5: Reliability of reflective constructs at the second-order level

Constructs	Cronbach's alpha	Composite reliability
Formative assessment practices	0.92	0.92
Cultural dimensions	0.94	0.94

To ascertain the convergent validity, the factor loadings and AVE were determined for each construct measure and construct, respectively, as shown in Table 6. The results show that the AVE ranges from 0.73 to 0.75, which is above the cut-off value of 0.5 for all constructs, as suggested by Nunnally and Bernstein (1994).

Table 6: Convergent validity of constructs

Constructs	Indicators	Outer loadings	AVE	AVE (construct)
Formative assessment practices	Addressing learning gaps	0.91	0.78	0.75
	Sharing learning objectives	0.90	0.73	
	Engineering good classroom discussions	0.92	0.79	
	Communicating constructive feedback	0.90	0.76	
	Activating self and peer assessment	0.85	0.71	
Cultural dimensions	Power-distance	0.91	0.77	0.73
	Individualism-collectivism	0.91	0.74	
	Masculinity-femininity	0.90	0.78	
	Uncertainty avoidance	0.82	0.74	
	Long-term orientation versus short-term orientation	0.79	0.61	

Discriminant validity of the constructs was examined by evaluating their cross-loadings. To examine the discriminant validity of the constructs on cross-loadings with other constructs or dimensions of partial least square structural equation modeling (PLS-SEM), the various first order subconstructs or items were evaluated to ascertain if they possessed low loadings on irrespective constructs.

Consequently, for a deduction to be made about the discriminant validity at the first-order constructs or at item level, an interpretation of weak correlation between first-order constructs or items of a different construct had to be established (Henseler et al., 2009). It can be observed in Table 7 that the cross-loading for each subconstruct was low, thus giving an indication of good/acceptable discriminant validity. This result demonstrates that no discriminant validity problems exist in the data set (Hair et al., 2019).

Table 7: Cross-loading discriminant validity between constructs of formative assessment practices and cultural dimensions

Cultural dimensions	Formative assessment practices				
	Addressing learning gaps	Sharing learning objectives	Engineering good classroom discussions	Providing constructive feedback	Activating self and peer assessment
Power-distance	0.68	0.59	0.55	0.62	0.56
Individualism-collectivism	0.62	0.67	0.54	0.63	0.59
Masculinity-femininity	0.54	0.64	0.53	0.55	0.54
Uncertainty avoidance	0.57	0.53	0.55	0.57	0.51
Long-term orientation-short-term orientation	0.63	0.64	0.57	0.60	0.61

In conclusion regarding the psychometric properties, the findings reveal that all measurements of reliability and validity confirm the quality of the utilized instrument to address the objectives of this study.

4.3.2 Structural Model: Research Question 2

Research question 2 is, do cultural dimensions have a significant effect on the formative assessment practices of science teachers in Oman Cycle 2 schools? The structural model involved Stage 2 of the PLS-SEM. The structural model details the relationships among the research constructs by showing and specifying the links between the exogenous (independent) and endogenous (dependent) research variables (Hair et al., 2006; Ho, 2006). The PLS technique, as part of the SEM, was carried out and bootstrapped with 10,000 replications.

A) Path Analysis of the Structural Model

The direct effect relationship is depicted by hypotheses 1 (H_1):

H_1 : The five cultural dimensions have direct effect on formative assessment practices of science teachers in Cycle 2 schools of Oman

The results of testing this hypothesis were used to address research question 2. The result of path coefficient (0.88) of the hypothesized model reveals a direct positive influence relationship between cultural dimensions and formative assessment practices (see Table 8). The significant value (which is represented by the t -value and the p -value) of the influence of cultural dimensions on formative assessment practices was t -value = 43.55 and p -value < .001. Therefore, H_1 is confirmed.

Moreover, the path coefficient value of 0.88 suggests a positive influence, which indicates that, when the cultural dimensions score increases by 1 standard deviation, the formative assessment practices score increases by 0.881 of a

standard deviation. In addition, the effect size value of cultural dimensions, which adequately influenced formative assessment practices, was large ($F^2 = 0.41$) (Cohen, 2013). The coefficient of determination (R^2) value for the dependent variable, formative assessment practices, was 0.78. This R^2 value indicates that 78% of the variance experienced in formative assessment practices can be explained by variation in the independent variable (cultural dimensions). In general, the findings reveal that the value for R^2 satisfies the condition for conventional acceptance, which Nagelkerke (1991) suggests can be 0.30.

The suggested value of predictive relevance (Q^2) for formative assessment practices is 0.49; the value of predictive relevance obtained by this study far exceeded zero; thus, suggesting acceptable fit and a high predictive relevance of the model, as recommended by Chin (2009). In addition, the results indicate that the model's goodness-of-fit measure for the structural model analysis is 0.59, which is higher than the recommended minimum cut-off value of 0.1 suggested by Wetzels et al. (2009). As a result, it can be affirmed that the goodness-of-fit model of this study is big enough to reflect an adequate global PLS model validity.

Table 8: Results of path coefficient of the hypothesized effect

Hypothesis	Path analysis	Path coefficient	<i>p</i> -value	<i>t</i> -value	F^2	Effect size	Hypothesis remarks
H1	CD → formative assessment t P	0.88	< 0.001	43.55	0.41	large	supported

Note. D = Cultural dimensions; formative assessment *p* = Formative assessment practices; * $p < .05$, ** $p < .01$, *** $p < .001$

To sum up, the results above emphasize the large positive effect of cultural dimensions on formative assessment practices, which, accordingly, suggest vital empirical and practical implications that are expected to enrich the body of literature on cross-cultures and inform educators in the Omani context.

5. Discussion

The results of science teachers' formative assessment practices obtained from the questionnaire, with mean values above the midpoint of 2.5 for all five constructs, reveal that science teachers claimed to include satisfactory and acceptable levels of formative assessment practices in the five formative assessment constructs during their classroom science sessions.

In the context of Omani classrooms, the rationale behind the substantial practice of formative assessment as claimed by science teachers could be inferred from the long exposure of science teachers to the continuous formative assessment system adopted in the Omani education system in 2002, coupled with the many years of experience of the majority of science teachers (more than 15 years). In Oman, science teachers in Cycle 2 classrooms (Grades 5–8) are required to integrate a structured system of continuous formative assessment alongside summative examinations, with 60% of student achievement derived from formative methods (Ministry of Education, 2018). These formative methods are not abstract, but

operationalized through specific classroom strategies such as oral work, homework, projects, practical laboratory activities, quizzes, and short tests. Teachers are expected to use these tools for grading and diagnosing students' knowledge, application, and reasoning skills, as well as for providing timely feedback to inform instruction.

Therefore, when teachers claim to use satisfactory levels of formative assessment across constructs, it is likely to represent their familiarity and long-standing engagement with these mandated assessment methods. For example, oral questioning and oral presentations are used to foster communicative competence and reasoning, while projects and practical performance tasks encourage scientific inquiry and application of knowledge to real-world problems. Similarly, quizzes and short tests are routinely employed to monitor understanding and provide immediate feedback, which align with formative purposes when implemented as part of daily instruction.

These findings reinforce Black and Wiliam's (2010) view that formative assessment is most powerful when it is embedded in collaborative learning, as echoed by recent studies. Almusharraf and Bailey (2021) demonstrate that inquiry-based teaching fosters peer assessment and feedback, while AlAli and Al-Barakat (2025) found that science teachers' formative practices improved when learners were positioned as co-constructors of knowledge. The present study shows that the same pattern holds in the Omani context: student-centered pedagogy is fertile ground for formative assessment, whereas teacher-centered methods limit formative assessment to superficial routines.

Nevertheless, while teachers claim to employ these methods extensively, scholars caution that reported practices may not always equate to authentic formative use (Heritage, 2022; Klenowski & Wyatt-Smith, 2014). In some contexts, methods such as quizzes or homework risk being implemented primarily as accountability tasks, rather than as diagnostic tools to inform instruction. Thus, while the findings suggest the use of strongly espoused practices in Omani science classrooms, further investigation is needed to determine the extent to which these claimed practices are enacted formatively to support student learning.

While carrying out the analysis of the measurement model of the present study, each of the research constructs was subjected to examination of its psychometric properties (outer loadings, reliability and validity). The findings reveal good qualities of all psychometric properties of the instrument – above the threshold cut-off values, thereby confirming the robustness and suitability of the instrument to address the objectives of this study. These significant results confirm the good quality of the empirical validation of the study instrument, which produced a tool that met the necessary reliability and validity requirements (Gaion Rigoni et al., 2018). These good qualities of the adapted instrument are the result of carefully formulating the items and consistently applying substantial adaptation procedures during the adaptation process by focusing on addressing the limitations of the adapted instrument (Samuel et al., 2019). More specifically, comprehensive sets of formative assessment practices that had been applied in

previous studies were supplemented by new items for each set of construct measures of the questionnaire, based on best practices discussed in the literature, which improved the adapted instrument significantly (Bailey & Heritage, 2008; Black & William, 2018; Furtak et al., 2017; Heritage, 2007; Ruiz-Primo & Furtak, 2007; Willaim & Leahy, 2016).

Additionally, the careful formulation of the items in each cultural dimension, built on the predictions and interpretations of Hofstede's results in the IBM study in education and school context, produced good validity and reliability measures. To conclude, the good psychometric properties of the study instrument confirm its suitability to fulfill the purposes of this study and mitigate the gaps in the literature pertaining to formative assessment practices and the influence of cultural dimensions on formative assessment practices, by addressing the research questions.

Through the path analysis of the structural model, the findings relating to the second research question indicate a positive significant effect of all five cultural dimensions on formative assessment practices, with large effect size and high values of coefficient of determination and predictive relevance. This finding confirms that cultural values remain a key explanatory factor for teachers' instructional and assessment practices. In the Omani context, where classrooms are embedded in a high-context culture that places considerable emphasis on respect, tradition, and collective identity, these results illustrate how deeply entrenched cultural orientations can either enable or constrain formative assessment practices.

For example, the survey responses indicated that many Omani science teachers encouraged individual participation and provided support for weaker students, which reflects dimensions of individualism and femininity, respectively. At the same time, their emphasis on clear rules and structured procedures, and attribution of low performance to students' lack of effort rather than teaching practices, reflects the influence of uncertainty avoidance and long-term orientation.

These findings not only reaffirm Hofstede's theoretical framework but also extend it by demonstrating how these cultural orientations manifest in the enactment of formative assessment in science classrooms. Recent scholarship highlights that perceptions of assessment are strongly shaped by cultural values and institutional norms, and that, in high power-distance contexts, teachers are more likely to maintain directive practices that limit reciprocal feedback and dialogic engagement (Brown et al., 2019). In Oman, where teachers continue to be perceived as authority figures, this hierarchical relationship often leads students to seek permission before contributing to class discussions, thereby restricting the spontaneous and interactive feedback processes that are central to formative assessment. This tension mirrors the broader challenges identified by research in other countries, where formative assessment practices often conflict with examination-oriented cultures that privilege summative outcomes over learning-oriented feedback (Schildkamp et al., 2020).

At a deeper interpretive level, the study highlights how formative assessment cannot be understood as a culturally neutral pedagogical technique but is a practice situated in social and cultural contexts. In Oman, the cultural emphasis on social harmony, collective responsibility, and respect for authority shapes both teacher practices and student responses. Awashreh and Al Ghunaimi (2025) recently demonstrated how cultural norms such as collectivism and respect for tradition influence students' motivation and attitudes toward assessment and often result in procrastination or reliance on external direction.

This resonates with the findings of the present study, which suggests that teachers' attempts to use formative strategies may be undermined by student's culturally influenced expectations about the teacher's role and their own limited agency in the classroom. Similarly, Furtak and Deverel-Rico (2025) argue that formative assessment practices are most effective when they are culturally responsive and explicitly connect to student's lived experiences, thereby suggesting that, in Oman, successful formative strategies must draw on local traditions, values, and communication styles to promote meaningful engagement.

The influence of cultural dimensions is not without contradictions. While collectivism and femininity encourage supportive teacher–student interactions that align with the principles of formative assessment, the persistence of high uncertainty avoidance and power–distance may limit flexibility, reduce opportunities for co-construction of knowledge, and reinforce teacher-directed pedagogies. This paradox reflects what Clark (2011) suggests: that formative assessment leads to deeper understanding only when its essential components are integrated with cultural responsiveness. More recent evidence reaffirms this point, and shows that, without such responsiveness, formative assessment risks being perceived as an additional burden rather than as a tool for learning (Furtak & Deverel-Rico, 2025; Schildkamp et al., 2020).

To recap, Oman is a developing Middle Eastern country with a high-context culture that holds significantly different cultural and ideological differences than the national identities of other low-context cultures. As a result, the challenge may lie in cultural influence, which is yet to be properly addressed in the literature. Unsurprisingly, the findings of the present study portray cultural learnings, shortcomings and challenges facing science teachers regarding the way they practice formative assessment with their students in classrooms.

These cultural challenges are in line with the challenges reported in other countries; however, cross-cultural differences could also emerge from community values, which are reflected in the philosophy and objectives of education in a country such as the Sultanate of Oman, which basically emphasizes the Omani cultural identity and the traditions, customs, and historical heritage of Omani society alongside its commitment to the Islamic religious belief in equality between all citizens and social justice for all (New Zealand Education Consortium, 2017). Accordingly, these Islamic cultural values, coupled with customs and

traditions, are expected to be adopted and incorporated by both teachers and their students in science classrooms.

From another angle, the necessity to employ effective formative assessment practices in classrooms is disputed, because the previous examination-based culture might still be dominant and could lead teachers and students to perceive formative assessment methods as extra burdens that are used to assess student learning, rather than to inform learning and teaching.

6. Implications

This study contributes to the growing academic body of knowledge on formative assessment, particularly on the practice of science teachers in a non-Western context. In addition, the findings of an evaluation of the effect of cultural dimensions on formative assessment practices adds to the literature on cultural dimensions that affect teaching and learning in Oman.

The findings are likely to have implications for policymakers, by refining their understanding of how the cultural inclinations of teachers influence their implementation of formative assessment practices in the classroom. This would also be useful to the government for devising better strategies for implementing formative assessment while considering the cultural realities of Oman. For researchers, the findings of this study add to the literature on cross-cultural differences in teaching and learning.

As for the implications deduced from the findings of the psychometric properties of the instrument utilized in this study, which yielded good qualities of validity and reliability that ensured the appropriateness of the scale to test the hypothesis of this study, this validated scale gives credence to the present study, which is conceived to enrich the body of literature in the field of formative assessment. This study is likely to encourage other researchers to replicate or adapt this validated instrument in other cultures and settings.

Moreover, this study highlights the need for culturally responsive assessment practices. Education policies and training programs should be designed to accommodate the cultural dimensions that influence teaching and assessment practices in Oman. For example, strategies to reduce power-distance in the classroom, promote student autonomy, and encourage collaborative learning may help improve practices of formative assessment.

Nevertheless, to achieve this, the Ministry of Education in Oman is urged to provide healthy teaching and learning environments in schools and the resources required to support teachers practice effective formative assessment with their students and address the cultural and contextual factors that hinder them from practicing crucial and effective formative assessment that encourages student engagement and activity-based learning. These factors include class large sizes, excessive workloads, and the burden of administrative tasks.

7. Conclusion

This study responded to the gaps in literature pertaining to the influence of cultural dimensions on teachers' formative assessment practices. The main contribution of this research is developing a cultural dimensions scale to evaluate the effects of cultural dimensions on formative assessment of science teachers. The validated adapted instrument used in this study, with its verified good psychometric properties, could encourage educators and scholars in Oman and elsewhere to adopt or adapt it for future research.

As for the effect of cultural dimensions on formative assessment, the R^2 value indicates that 78% of the variance experienced in formative assessment practices can be explained by variation in the independent variable (cultural dimensions). Likewise, the large size positive effect of cultural dimensions on formative assessment ($F^2 = 0.41$) found by this study confirms the role of cultural inclinations and values in affecting the level of teachers' formative assessment in science classrooms. This finding calls for acknowledging these influencing cultural aspects, recognizing them, being responsive to them, and planning the best ways and adaptations to address them, to reach an appropriate compromise between the cultural aspects and effective practice of formative assessment in classrooms.

Finally, the bottom-line message that can be concluded from this study is that Omani teachers should be equipped with knowledge, competency, and skills to use assessment data formatively through the application of various assessment strategies and methods, as discussed in this study and the literature, to enhance teaching and learning after recognizing and addressing the intervening cultural aspects. This message should be aligned with the Oman Vision 2040 that rests on the need for students and national educators acquiring the skills needed for success in the 21st century.

This provides a framework that intersects with the recommendations of this study, in striving to ensure educators acquire the competencies and the skills needed to implement formative assessment and to encourage teachers to implement student-centered teaching methods that are integrated with the employment of various assessment methods that focus on creating a balance between assessment *of* learning and assessment *for* learning.

8. Limitations

The study has certain limitations. For example, the data in the present study were collected from only three out of 11 governorates. Although it is believed that these three governorates are representative of all governorates, generalization of the results is still limited. However, the findings from the data acquired from the three governorates is, to an extent, valid and reliable, because all 11 governorates in Oman follow the same education system and are equipped with similar educational and human resources. Additionally, this study relied on quantitative data gathered from a questionnaire field survey. The findings would have been more robust if the quantitative data were complemented and triangulated by qualitative data such as classroom observations, which are expected to yield

valuable information about teachers' enacted formative assessment practices. Nevertheless, the present quantitative study offers a robust methodological approach to address the gap in the literature concerning the application of validated instruments to evaluate the effect of cultural dimensions on formative assessment practices.

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APPENDIX: SURVEY QUESTIONNAIRE

SECTION A: BACKGROUND DATA

Please tick (✓) the appropriate box

1. Gender: Male Female

2. Highest academic qualification

Diploma
 Bachelor
 Master
 PhD

3. Years of experience as a teacher

3-5
 6 - 10
 11 - 15
 Above 15

SECTION B: FORMATIVE ASSESSMENT PRACTICES

In this section, the researcher is interested in your opinions about Formative Assessment Practices you carry out in your science classroom.

Please mark with "x" one answer that best represents your experiences and opinions for the following statements.

Index	Survey Statement	Strongly disagree	Disagree	Agree	Strongly agree
<i>Learning Gaps</i>					
1.1	I identify students' prior knowledge before I start teaching a particular topic.				
1.2	I support every individual student to meet the learning objectives.				

1.3	I ensure that the students have achieved the teaching objective before moving to the next one.				
1.4	I let students know to what extent they are progressing towards the learning objectives.				
1.5	I collect evidence about students' progress towards the learning objectives.				
<i>Sharing learning objectives</i>					
2.1	I will let my students know what they will be learning for the day.				
2.2	I will let my students know what they will be assessed for the day.				
2.3	I will explain to my students what standards they should be aiming for to reach their learning objectives.				
2.4	I share the learning objectives with my students in a simple language.				
2.5	I engage students to set out criteria for a particular learning objective.				
<i>Good Engineering Classroom Discussions</i>					
3.1	I employ questioning techniques to gauge my students' understanding of science content.				
3.2	Even if my students have given me the right answer, I will still ask them to explain their answers.				
3.3	I give the opportunity to other students in the classroom to provide the right answer instead of correcting the incomplete or wrong answer given by a student.				
3.4	I ask knowing questions to the students to retrieve the information being taught.				
3.5	I ask open-ended reasoning questions to identify students' high order thinking skills.				
<i>Constructive Feedback</i>					
4.1	I withhold the right answers and encourage further students' inquiry.				
4.2	I give feedback to students in the class for their classroom activities.				
4.3	I inform students about their strengths in their performance.				
4.4	I inform students about their weak points in their performance.				

4.5	I assess students' understanding of a particular learning objective before moving to the next one during instruction.				
<i>Self and Peer Assessment</i>					
5.1	I guide my students to reflect on their performance.				
5.2	I guide my students to record their progress after they finish doing the activities.				
5.3	I engage students to set assessment criteria for the assigned tasks.				
5.4	I give students the opportunity to assess their classmates' work.				
5.5	I give students the opportunity to comment about the quality of their classmates' work.				

SECTION C: CULTURE DIMENSIONS

In this section, the researcher is interested in your opinions and experience in the science classroom.

Please mark with "x" one answer that best represents your experiences and opinions for the following statements.

Index	Survey Statement	Strongly disagree	Disagree	Agree	Strongly agree
<i>Power-distance</i>					
1.1	My students feel free to express disagreement with me.				
1.2	I expect initiatives from my students in the classroom.				
1.3	My students will learn better if they communicate more with me.				
1.4	I relate in the same manner with all students in the classroom.				
1.5	My students show respect to me, even outside the class.				

<i>Individualism-Collectivism</i>				
2.1	I prefer to follow my own classroom teaching methods.			
2.2	My focus in the classroom is to teach students how to learn.			
2.3	I encourage my students to speak up in the class without specifically choosing a particular student to speak.			
2.4	I prefer to address my students' learning needs individually rather than collectively.			
2.5	I believe that the training opportunities I get, help improve my skills or make me learn new skills.			
<i>Masculinity-Femininity</i>				
3.1	I praise weak students in the classroom.			
3.2	I expect the students to see their education as priority in their lives.			
3.3	I like to deal with students in a friendly manner.			
3.4	If students' opinions conflict with mine, I expect them to discard theirs and follow mine.			
3.5	I think that failing in school is a minor incident.			
<i>Uncertainty Avoidance</i>				
4.1	I like to be addressed in a manner that differentiates me from other teachers.			
4.2	When using a new teaching method, it is important to me that there are clear guidelines about how to use it.			
4.3	I want to continue teaching for many years.			
4.4	I'm supposed to have all the answers for students' questions.			
4.5	I prefer to inform parents about their children's progress rather than involving them in their learning.			
<i>Long-term orientation (LTO) and short-term orientation (STO)</i>				
5.1	I believe that students should have talents to do better in applied science unlike theoretical and abstract science.			
5.2	I think that students' low marks in science is attributed to less effort.			
5.3	I prefer to use a teaching method for a short period rather than using the same method over a long period of time.			

5.4	I prefer the temporary efforts exerted by my students that would produce quick results rather than sustained efforts toward slow results.				
5.5	I get disturbed when a student disrupts the order in the classroom.				

Thanks for your time