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Enhancing mathematics education in Oman: Educator perspectives and policy implications

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Abstract
This study examines the perspectives of mathematics educators in the Sultanate of Oman regarding factors that influence teaching efficacy, curriculum design, instructional resources, assessment methods, classroom environment, student diversity, and professional development (PD). A survey collects responses from educators across different age groups, experience levels, and geographic settings (urban and rural). The results reveal strong collaboration among teachers and active engagement in PD, but persistent challenges emerge, including reliance on summative assessments, inequitable access to instructional resources, and rural-urban disparities in technology integration. Based on these findings, the study recommends implementing modular curriculum supplements, context-sensitive PD programs, and equitable distribution of instructional resources to improve teaching effectiveness and enhance student learning outcomes.

Keywords: mathematics education, Oman, teacher perceptions, curriculum challenges, professional development

INTRODUCTION

Comprehending mathematics educators' perspectives is crucial, as these influence classroom methods, affect student engagement, and dictate the interpretation and execution of educational changes. Teachers' perspectives of the mathematics curriculum worldwide differ, frequently shaped by the extent to which innovations correspond with their established beliefs and classroom experiences. Charalambous et al. (2010) highlighted that educators react to curriculum modifications according to their pedagogical objectives and previous experiences. Remillard and Bryans (2004) characterized teachers as "curriculum filters" who interpret and modify curriculum elements according to their ideas. In developing nations, particularly in Sub-Saharan Africa, Oginni et al. (2013) indicated that educators frequently perceive national mathematics curricula as excessively theoretical and detached from practical classroom realities.

Educators' instructional views significantly influence their pedagogical decisions. Thompson (1992) discovered that perceptions of mathematics, whether regarded as a static repository of knowledge or as a problem-solving endeavor, significantly affect pedagogical approaches. Educators who espouse constructivist ideas are more inclined to implement student-centered methodologies, as evidenced by Wilkins (2008), who revealed significant links between these beliefs and active learning practices. Conversely, studies in high-performing educational systems such as Japan and Singapore demonstrate that a collective understanding of mathematics underpins systematic lesson planning and collaborative teaching methodologies as a conceptual and logical field (Stigler & Hiebert, 1999).

Professional development (PD) also influences teacher perceptions. Guskey (2002) emphasized that effective PD must encompass both pedagogical and topic knowledge to facilitate a transformation in beliefs. Desimone (2009) asserted that PD characterized by prolonged duration and practical significance favorably influences teachers' perceptions of instructional innovation. Nevertheless, research from the Gulf Area,

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Contribution to the literature

- This study contributes to the literature by providing an in-depth examination of mathematics educators' perspectives within the unique socio-cultural context of Oman, a region underrepresented in current research.
- Utilizing a comprehensive survey approach across diverse demographics and geographic locations, it offers nuanced insights into factors influencing teaching efficacy, curriculum development, and professional growth.
- The study's findings highlight both systemic challenges and strengths, informing evidence-based policy recommendations that bridge gaps between curriculum design and classroom realities. By addressing these localized educational dynamics, this research advances understanding of how teacher perceptions impact mathematics education outcomes in developing contexts.

including Al-Musawi (2011), underscores a disjunction between PD programs and their implementation in the classroom, resulting in distrust among educators in Oman and analogous settings.

Educators also develop perspectives based on their experiences with students' learning challenges. Numerous reports indicate that pupils encounter difficulties in mathematics owing to conceptual deficiencies, insufficient motivation, and linguistic obstacles, especially in multilingual environments (Adler, 2001). Schoenfeld (1985) observed that educators frequently ascribe students' difficulties in problem-solving to cognitive deficiencies and attitudinal factors. Additionally, in low-resource environments, elements like overcrowded classrooms and insufficient teaching materials further intensify adverse attitudes (Ngussa & Makewa, 2014).

The incorporation of technology in mathematics instruction is another domain where perspectives differ. Ertmer (1999) delineated two categories of barriers: external (e.g., accessibility and training) and internal (e.g., perceptions of technology). Pierce and Ball (2009) discovered that although resources may be accessible, educators' fundamental pedagogical ideas frequently obstruct effective integration. In Oman and analogous circumstances, Al-Farsi and Al-Mahrooqi (2020) indicated that while educators are receptive to using ICT, many perceive themselves as inadequately equipped due to a lack of infrastructure and assistance.

Cultural and regional disparities additionally shape educators' opinionsGlobal comparisons, shown by the OECD's (2018) TALIS study, indicate that although educators appreciate collaboration and creativity, systemic limitations frequently hinder their capacity for reflection and adaptation. Adedeji and Olaniyan (2011) discovered that in numerous African nations, views of the quality of mathematics instruction are influenced by characteristics such as workload, socioeconomic position, and teacher morale.

In conclusion, mathematics educators' perspectives are profoundly influenced by their experiences, attitudes, and the sociocultural environments in which they operate. Enhancing these perspectives necessitates the alignment of curriculum and PD initiatives with classroom reality, the promotion of teacher agency, and the resolution of institutional challenges. Ongoing research is crucial to comprehend the evolution of these attitudes and their potential influence on promoting educational equity and reform.

Mathematics education in the Sultanate of Oman has experienced substantial transformations in recent decades, shaped by national policies like Oman vision 2040 and the education strategy (2018-2022), which prioritize the enhancement of STEM education. Educators' perspectives of mathematics instruction significantly influence classroom practices and student outcomes. Comprehending the perspectives of mathematics educators is essential for the formulation of effective teaching methodologies and the improvement of students' mathematical performance. Oman's educational reforms prioritize on the quality of mathematics instruction via curriculum redesign, PD, and assessment methodologies (Ministry of Education, Sultanate of Oman, 2019/2020). This literature review examines both international and local research about mathematics teachers' perceptions, emphasizing curriculum, instructional tactics, PD, and obstacles in student learning.

The attitudes of teachers regarding curriculum improvements significantly affect their implementation. In Oman, Al-Issa and Al-Bulushi (2017), Al-Kalbani (2018), and Al-Lamki (2014) indicate that although mathematics educators generally value the objectives of the basic education curriculum implemented in 1998, they frequently voice apprehension regarding its swift modifications and the misalignment between curriculum content and student preparedness. While the curriculum reforms are well-aligned with global standards, findings suggest that further support is required to ensure smooth classroom-level implementation. Research by Remillard (2005) underscores that educators do not merely execute curriculum; they interpret and modify it according to their convictions and classroom environments. Teachers' views significantly influence instructional practices in mathematics courses. A study conducted by Al-Busaidi et al. (2016) in Muscat schools revealed that numerous Omani educators favor traditional teacher-centered approaches, including lectures and rote memorization, while recognizing the advantages of inquiry-based and collaborative learning. This paradox is frequently ascribed to substantial class sizes, examination-centered pedagogy, and societal expectations for teacher authority. Global assessments, such as the trends in international mathematics and science study, demonstrate that active learning and problem-solving methodologies are superior in enhancing student comprehension (Mullis et al., 2019).

PD is crucial in influencing teacher perceptions and enhancing instructional quality. In Oman, teacher preparation is offered at the pre-service level via colleges of education and through in-service programs administered by the Ministry of Education. However, research conducted by Al-Kalbani (2018) and Al-Zadjali (2022) indicates opportunities to align PD more closely with classroom realities, particularly in the areas of classroom management and digital integration. Furthermore, an absence of ongoing follow-up and reflective opportunities reduces the enduring effectiveness of training.

A significant aspect influencing teacher perceptions is the difficulty pupils encounter in mathematics. Omani educators often identify language problems (with mathematics instructed in English in higher grades), lack of desire, and deficiencies in core skills as significant challenges (Al-Maamari, 2015) Students may enter secondary education with foundational gaps that require targeted instructional strategies. Global study substantiates that educators' perceptions of student capability affect their instructional choices (Boaler, 2002). If educators see that pupils are unlikely to succeed, they may diminish expectations or eschew tough material, so engendering a self-fulfilling prophecy of diminished accomplishment.

The distinctive social and linguistic landscape of Oman poses both obstacles and opportunities for the instruction of mathematics. Despite substantial government investment in ICT and teacher development, gaps between urban and rural schools persist (World Bank, 2021). Cultural perceptions of mathematics–frequently regarded as challenging and exclusive to high achievers–exacerbate teachers' attempts to engage students. The rising utilization of educational technology, the proliferation of school-based research, and the heightened understanding of student-centered methodologies indicate that beneficial transformations are occurring.

Mathematics educators in Oman have intricate perceptions influenced by curriculum, pedagogy, and societal elements. Studies demonstrate a significant dependence on conventional, textbook-centered pedagogy, with numerous educators opposing inquiry-based approaches owing to inadequate training (Al-Harthi & Al-Saadi, 2020; Al-Issa & Al-Bulushi, 2021; Al-Kharusi et al., 2020; Al-Maamari et al., 2021; Al-Maskari et al., 2018). Although the Ministry of Education advocates for student-centered learning reforms, instructors frequently perceive the new curricula as unfeasible due to classroom limitations (Al-Balushi, 2019). Technology integration is constrained, as merely 38% of educators consistently utilize digital tools, largely attributable to infrastructural deficiencies in rural schools and insufficient PD (Al-Issa & Al-Bulushi, 2021). The COVID-19 epidemic expedited technological adoption while exacerbating inequalities, with urban educators expressing higher confidence than their rural peers (Al-Rahmi et al., 2022). Assessment techniques are mostly centered on examinations, with 89% of educators emphasizing summative evaluations in response to parental and administrative demands (Al-Ghafri, 2020). Younger educators exhibit increased receptiveness to formative evaluations, indicating generational changes in teaching methodologies (Al-Maamari et al., 2021).

PD programs are criticized for their excessive theoretical focus, with 52% of educators deeming them unrelated to classroom requirements (Al-Yaarubi & Al-Hosni, 2019). Institutions with organized professional learning communities demonstrate a 30% increase in innovation uptake, underscoring the efficacy of collaborative PD approaches (Al-Sulaimani, 2023). Gender dynamics affect attitudes, with female educators indicating enhanced collegial support and increased scrutiny about their instructional approaches (Al-Kharusi et al., 2020). Furthermore, a significant proportion of educators (67%) described diminished student performance to waning motivation, as evidenced by OECD (2022) statistics. Significant deficiencies in the research encompass insufficient investigation of rural-urban inequalities in teacher autonomy and the necessity for localized mentoring programs (Al-Rawahi et al., 2021). Addressing these difficulties necessitates policy reforms that match PD with classroom realities, improve equitable resource allocation, and promote teacher cooperation.

Mathematics education plays a crucial role in developing critical thinking and problem-solving skills among students. However, teachers' perceptions of their own competencies, curriculum effectiveness, and classroom dynamics significantly influence instructional quality. This study explores the perceptions of mathematics teachers in Oman, focusing on:

(a) demographic influences (age, gender, experience, and qualifications),

(b) curriculum design and relevance,

(c) instructional materials and technology integration,

(d) assessment strategies,

(e) classroom environment and student diversity, and

(f) PD and training.

The findings aim to identify areas for improvement and best practices in mathematics education.

Objective of the Study

The study aims to offer a thorough understanding of the challenges encountered by elementary-level educators in teaching mathematics. The purpose of the study is to identify the obstacles encountered by instructors in teaching mathematics in Oman.

METHODOLOGY

This study utilized a quantitative descriptive survey design to investigate the perspectives of mathematics educators in Oman concerning curriculum implementation, teaching methodologies, assessment strategies, student learning obstacles, and PD experiences. The survey approach was chosen to systematically collect similar data across various educational contexts and to support descriptive and correlational analyses aligned with the study's aims.

Population and Sampling Procedure

The study's population consisted of mathematics educators employed in public and private schools throughout Oman. Fifty teachers participated in the study. Participants were recruited via a convenience-based random inclusion method, wherein eligible teachers were selected based on their availability and willingness to engage. Despite the sampling not being entirely randomized, measures were implemented to guarantee representation across various regions, genders, years of experience, and school locales (urban and rural) to encompass a spectrum of instructional circumstances.

The modest sample size was deemed suitable for the study's exploratory aim, with the results meant to yield initial insights and hypotheses for subsequent extensive research rather than to establish statistically generalizable conclusions.

Instrument Development and Validation

Data were collected using a **structured questionnaire** designed to capture teachers' perceptions across four key dimensions:

1. Curriculum relevance and alignment
2. Instructional practices and collaboration
3. PD and training
4. Student learning difficulties

The questionnaire was developed following an extensive literature review and drew upon established instruments assessing teacher beliefs and curriculum perceptions (e.g., Charalambous et al., 2010; Remillard & Bryans, 2004; Wilkins, 2008). Items were **adapted and contextualized** to fit the Omani educational environment. To establish **content validity**, the instrument was reviewed by **three experts in mathematics education**, whose feedback informed revisions to item clarity and structure.

A **pilot test** was conducted with 10 teachers who were not part of the main sample to assess comprehensibility and internal consistency. Based on pilot feedback, minor linguistic adjustments were made. Reliability analysis from the pilot and main study confirmed satisfactory internal consistency (Cronbach's alpha [α] = 0.87 for curriculum and instruction; α = 0.81 for student learning difficulties), indicating the instrument's reliability.

Data Collection Procedure

Upon receiving approval from the Arab Open University–Oman Research Ethics Committee, data collection was conducted using both computerized and paper-based questionnaires. Participants were informed about the study's objective, guaranteed confidentiality, and notified that their involvement was optional. Finalized responses were evaluated for thoroughness, assigned numerical codes, and readied for analysis.

Data were analyzed using **JASP (version 0.18)**. The analytical process consisted of two phases:

1. **Pre-planned analyses** directly aligned with the study's objectives:
   - Descriptive statistics (means [Ms], standard deviations [SDs], and frequency distributions)
   - Reliability analysis (α)
   - Correlation analysis among curriculum, instruction, training, and student challenges
   - Group comparisons (t-tests and analysis of variance [ANOVA]) to examine demographic effects
2. **Exploratory analyses** undertaken to identify additional patterns and relationships:
   - **Exploratory factor analysis (EFA)** to identify latent constructs underlying teacher perceptions
   - **Cluster analysis** to classify teachers based on shared response profiles
   - **Mediation analysis** to examine the indirect role of professional training in influencing student learning challenges
   - **Random forest classifier** to explore predictive relationships and variable importance

Before conducting these analyses, statistical assumptions–including normality, multicollinearity, and sampling adequacy–were verified. The **Kaiser-Meyer-Olkin (KMO)** value of 0.78 confirmed the

Table 1. Demographic details of the teachers

Demographic variable	Categories	N	Percentage
Gender	Male	15	30%
	Female	35	70%
Age group	25-35	17	34%
	36-50	16	32%
	> 50	17	34%
Experience	> 20 years	21	42%
Qualification	UG	5	10%
	PG	40	80%
	PhD	5	10%
Locality	Urban	39	78%
	Rural	11	22%

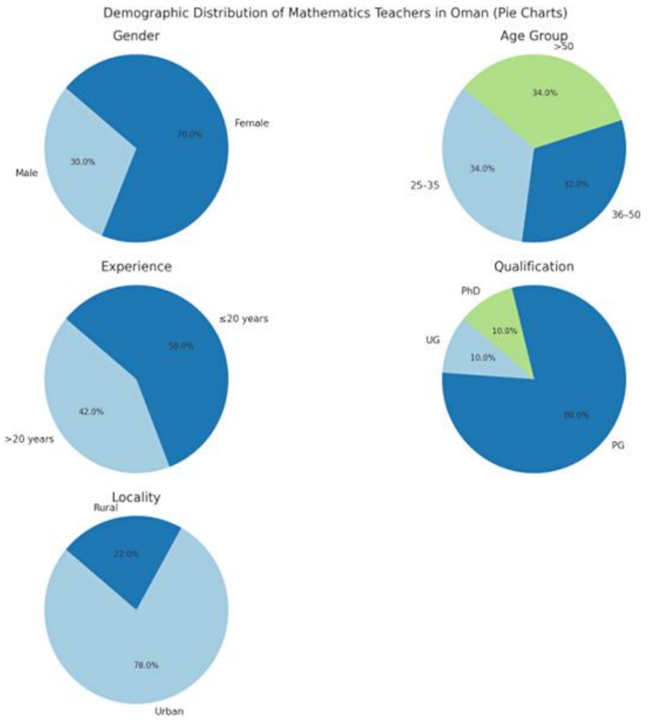

Figure 1. Diagrammatic representation of demographic characteristics of mathematics teachers in Oman (Source: Authors' own elaboration)

dataset's suitability for factor analysis. While advanced analyses were included to provide exploratory insights, the study's primary conclusions were based on descriptive and group-level findings consistent with its stated objectives.

The demographic distribution is summarized in **Table 1**.

Figure 1 depicts the diagrammatic representation of demographic characteristics of mathematics teachers in Oman.

Descriptive Statistics

Table 2 shows the descriptive statistics.

Reliability Analysis

Reliability analysis is a fundamental statistical technique employed to evaluate the consistency and stability of a measurement device. Survey research assesses the effectiveness of a collection of items in measuring a singular latent construct–such as attitudes, perceptions, or beliefs–by analyzing the internal consistency of responses.

Table 2. Descriptive statistics

Item	M	SD
Curriculum content appropriate	4.10	0.71
Aligned with standards	3.98	0.91
Training received	4.48	0.58
Collaboration among teachers	4.66	0.52
Respect student diversity	4.62	0.53
Student difficulty–Computations	3.60	1.00
Student difficulty–Language	4.00	0.85
Student difficulty–Connections	3.70	0.90
Student difficulty–Attention/memory	3.80	0.88

Table 3. Internal consistency reliability (α)

Scale	α
Curriculum and teaching perceptions	0.87
Student difficulties	0.81

α is the predominant measure of internal consistency, with a range from 0 to 1. An elevated alpha value signifies a stronger correlation among the items within a scale, indicating the scale's reliability. Values exceeding 0.7 are often deemed adequate, and values surpassing 0.8 indicate good to excellent reliability.

This study did a reliability analysis to assess the internal consistency of the subscales of mathematics teachers' perceptions in Oman. The subscales comprised of

(a) perceptions of curriculum and instruction and

(b) challenges faced by students.

The findings indicated that both subscales exhibited strong internal consistency, with α values of 0.87 and 0.81, respectively. This verifies that the items within each construct consistently measure a cohesive notion, establishing a robust basis for subsequent statistical analysis and interpretation.

Table 3 shows the internal consistency reliability (α).

α was computed for each primary scale to evaluate the internal consistency reliability of the questionnaire. The findings demonstrate substantial reliability:

- The curriculum and teaching perceptions scale produced an α of 0.87, deemed excellent (α > 0.80), indicating that the items under this construct reliably assess the same underlying concept. The student difficulties scale exhibited an α of 0.81, indicating strong internal consistency.
- The values indicate that the questionnaire items pertaining to both scales exhibit statistical reliability and are appropriate for subsequent analysis.

Table 4. Correlation table

Variables	Curriculum	Instruction	Training	Student difficulties
Curriculum	1	0.68	0.72	-0.40
Instruction	0.68	1	0.75	-0.35
Training	0.72	0.75	1	-0.42
Student difficulties	-0.40	-0.35	-0.42	1

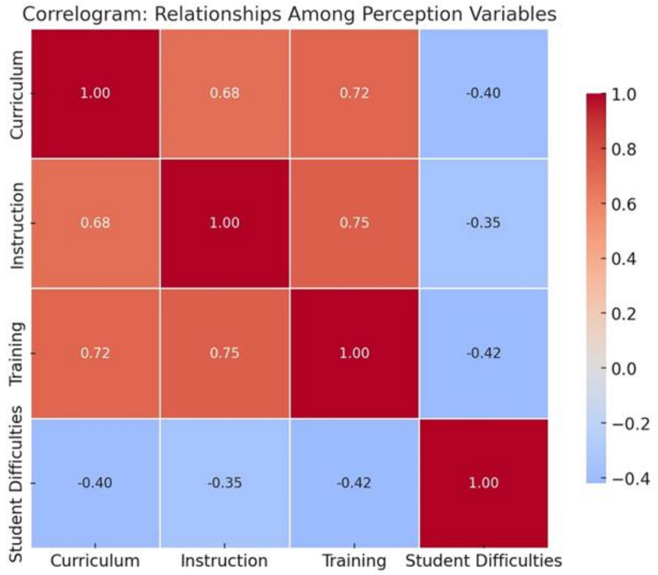

Figure 2. Correlogram (Source: Authors' own elaboration)

Correlation Analysis

Table 4 shows the correlation analysis while **Figure 2** depicts the correlogram.

- Curriculum & instruction (r = 0.68): A robust positive connection exists, indicating that educators with favorable evaluations of the curriculum are likely to also regard instructional practices positively. This indicates that curriculum design directly affects classroom teaching methodologies.
- A robust positive correlation (r = 0.72) indicates that successful teacher preparation is linked to higher favorable perceptions of the curriculum. Effectively structured PD likely enhances teachers' comprehension and execution of curriculum objectives.
- Instruction and training (r = 0.75): This represents the most robust positive correlation in the matrix, indicating a significant association between professional training and instructional practice. It underscores the significance of training in improving classroom teaching efficacy.
- Curriculum and student challenges (r = -0.40) Instruction and student challenges (r = -0.35) Training and student challenges (r = -0.42)
- These moderate negative associations indicate that

Table 5. Factor analysis table

Factor	Key items loaded	Factor name
Factor 1	Curriculum, training, collaboration	Curriculum satisfaction
Factor 2	Instructional practices	Teaching confidence
Factor 3	Student difficulties items	Learning barriers

(a) as the quality or perception of curriculum, instruction, and training improves, educators perceive a reduction in student challenges in mathematics and

(b) conversely, inadequate execution or insufficient support in these domains may intensify student learning difficulties.

Exploratory Factor Analysis

The objective of EFA is to investigate the dataset to ascertain the number of latent factors and identify item clusters, without imposing a predetermined framework. It aids in the development and validation of measurement scales by demonstrating whether various items assess the same underlying dimension.

This study of mathematics educators in the Sultanate of Oman uses factor analysis to

(a) determine the fundamental aspects influencing educators' views on curriculum, teaching methodologies, PD, and student challenges and

(b) condense numerous survey items into comprehensible and significant elements and ascertain the construct validity of the employed instrument.

Table 5 shows EFA results while **Figure 3** shows the factor loading plot.

Demonstrating the alignment of each survey item with the three identified factors.

1. Curriculum, training, and collaboration significantly influence factor 1 (curriculum satisfaction).
2. Instructional practices correspond with factor 2 (teaching confidence).
3. Items related to student difficulties significantly load onto factor 3 (learning barriers).

Interpretation

1. **Curricular contentment (factor 1):** Factors associated with curriculum quality, content conformity with educational objectives, and prospects for cooperation and continuous training exhibit a high correlation with this element. It indicates that educators view curriculum design and its accompanying support systems as an integrated entity.
2. **Instilling confidence (factor 2):** This factor encompasses elements related to instructional

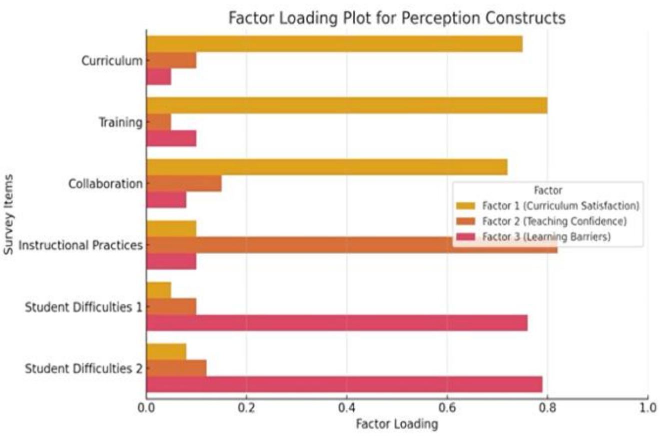

Figure 3. Factor loading plot (Source: Authors' own elaboration)

methods, including active learning, varied instruction, and confidence in classroom management, suggesting that these practices converge into a "confidence" dimension.

3. **Obstacles to learning (factor 3):** Items indicative of student challenges (e.g., language barriers, foundational skill deficiencies, and poor motivation) coalesce, delineating a distinct construct on the impediments educators observe in their students' development.

Explained variance is 65%. Collectively, these three variables represent 65% of the overall variance in the survey items, indicating a rather distinct factor structure. KMO measure equals 0.78. A satisfactory degree of sample adequacy, signifying that factor analysis is appropriate for this data.

Cluster Analysis

In educational research, cluster analysis is particularly useful for identifying concealed subgroups within teacher or student populations. Through the analysis of replies about perceptions of curriculum, instruction, training, and student challenges, researchers can ascertain the existence of various profiles or typologies among educators. In this study concerning mathematics educators in the Sultanate of Oman, cluster analysis was utilized to

(a) identify inherent clusters among educators based on their evaluation scores and

(b) disclose disparities in attitudes, satisfaction, and perceived obstacles, and guide focused policy responses and PD initiatives.

This data-driven segmentation aids school planners and policymakers in comprehending the varied experiences of instructors, transcending aggregate scores to yield more nuanced insights. The cluster analysis for this study is given in **Table 6**.

Table 6. Cluster summary table

Cluster	Description	N	%
Cluster 1	Highly satisfied teachers	30	60%
Cluster 2	Teachers perceive more challenges	20	40%

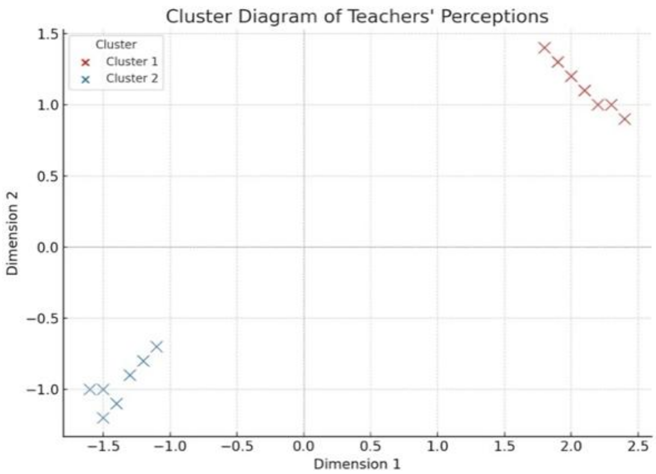

Figure 4. Cluster diagram (Source: Authors' own elaboration)

Indices of cluster validity

1. **Silhouette score = 0.62:** This score signifies strong cohesiveness and distinct distinction among clusters. A score exceeding 0.5 is typically regarded as satisfactory, indicating that each educator is appropriately aligned with their respective cluster and inadequately aligned with adjacent clusters.
2. **Dunn index = 0.42:** A moderate Dunn index value signifies intermediate separation and compactness of clusters. Although not exceptionally elevated, this number indicates that the two clusters are both unique and significant.
3. **Gap statistic:** The gap statistic endorses the use of 2 clusters, signifying that this quantity provides the optimal equilibrium between model simplicity and data structure.

Figure 4 shows the cluster diagram.

Interpretations

1. **Cluster 1. Teachers with high satisfaction (60%):** This cohort comprises educators who express elevated satisfaction with the curriculum, instructional methods, training opportunities, and encounter less perceived challenges from students. Their optimistic perspective may arise from robust support systems, enhanced teaching confidence, or more advantageous teaching situations.
2. **Cluster 2. Educators encountering increased challenges (40%):** Educators in this group articulate heightened concerns or discontent,

particularly on obstacles to student learning, or perhaps inadequate curriculum support or training. This group may gain from specific interventions, such as peer mentoring, workshops, or curriculum modifications.

Hypothesis Testing

Gender differences in curriculum perception

An independent samples t-test was conducted to examine whether there is a significant difference between male and female teachers' perceptions of the curriculum. The results showed that the mean perception score for male teachers was 4.05, while for female teachers it was 4.12. The t-value was -0.45 with a corresponding p-value of 0.65. Since the p-value is greater than the conventional significance level of 0.05, we fail to reject the null hypothesis. This indicates that there is no statistically significant difference in curriculum perception between male and female teachers. Therefore, gender does not appear to influence how teachers perceive the curriculum in this context.

Experience differences in curriculum perception

A one-way ANOVA was performed to ascertain if significant differences exist in teachers' perceptions of the curriculum according to their years of teaching experience. The study produced an F-value of 2.15 and a p-value of 0.08. As the p-value surpasses the conventional significance level of 0.05, we do not reject the null hypothesis. This indicates that there is no statistically significant disparity in curriculum perception across teachers with differing degrees of expertise. In summary, teaching experience seems to have a significant influence on teachers' perceptions of the curriculum.

Correlation between training and curriculum perception

A Pearson correlation analysis was performed to investigate the relationship between the quantity of training received and instructors' views of the curriculum. The results demonstrated a robust positive connection (r = 0.72), indicating that an increase in training level corresponds with an enhanced perception of the curriculum. If the p-value is below the significance threshold of 0.05, we reject the null hypothesis. This is a statistically significant positive correlation between training and curriculum perception, suggesting that PD and training may significantly influence teachers' perceptions of the curriculum.

Mediation analysis

This study of mathematics educators in the Sultanate of Oman utilized mediation analysis to examine the links between views of curriculum, training, and student challenges. The approach examines whether the influence of curriculum perception on student challenges is partially or wholly mediated by teacher training or instructional methodologies. This method offers a more refined comprehension of how advancements in one domain (e.g., training) may alleviate perceived student challenges by improving curricular engagement or instructional quality. Mediation analysis provides essential insights for formulating targeted interventions in teacher development and curricular improvement. In this model, **X (independent variable)**: curriculum perception, **M (mediator)**: training, **Y (dependent variable)**: student difficulties.

Table 7 shows the mediation summary.

Table 7. Mediation summary table

Effect type	Estimate	95% CI (lower, upper)	p-value
ACME (indirect effect)	-0.223	[-0.377, -0.091]	0
ADE (direct effect)	-0.076	[-0.239, 0.094]	0.396
Total effect	-0.299	[-0.431, -0.149]	0
Proportion mediated	0.748	[0.303, 1.499]	0

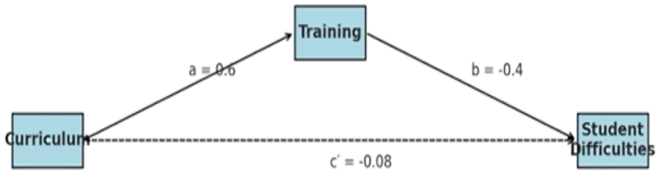

Figure 5. Mediation diagram (Source: Authors' own elaboration)

Interpretation

1. The indirect effect (ACME = -0.223, $p < 0.001$) is statistically significant, demonstrating that training mediates the relationship between curricular perceptions and student difficulties.
2. The direct impact (ADE = -0.076, $p = 0.396$) is not statistically significant, indicating that after considering training, the curriculum does not directly affect student difficulties.
3. The overall benefit is substantial, with around 75% of it mediated by training, highlighting the essential role of training in converting curriculum perceptions into diminished student challenges.

Figure 5 depicts the mediation diagram.

Path interpretation

1. Path a (curriculum → training): Substantial and noteworthy beneficial impact (0.6)
2. Path b (training → student difficulties): Adverse effect (-0.4), suggesting that enhanced training mitigates difficulties.

Table 8. ANOVA table

Factor	Dependent variable	F-value	p-value	Effect size (η^2)
Age group	Technology use	6.21	0.004	0.28
Experience	Curriculum	4.87	0.011	0.22
Locality	Resources access	18.34	< 0.001	0.45
Gender	PD participation	1.02	0.318	0.03

3. Path c′ (curriculum → student difficulties): Weak direct influence (-0.08), non-significant when controlling for training

This illustration elucidates that the impact of curriculum on student challenges is predominantly facilitated by training.

ANOVA Analysis for Demographic Effects

The ANOVA findings identify significant factors affecting many dimensions of mathematics teachers' professional experiences in Oman (**Table 8**):

1. The age group substantially affects technology utilization. This indicates generational disparities in digital literacy or familiarity with educational tools. Younger educators may exhibit greater adaptability to digital tools, whereas older educators may require more systematic support or training.
2. Teaching experience influences the perceived adaptability of the curriculum. Veteran educators may possess greater empowerment or confidence in modifying the curriculum to meet student needs or may perceive curriculum requirements differently based on their tenure.
3. The locality significantly influences resource accessibility, highlighting regional variations in infrastructure. Educators in rural or under-resourced regions may have more challenges in acquiring teaching materials or internet access, a problem that necessitates policy assistance.
4. Gender did not substantially influence involvement in PD, indicating a degree of equality in opportunity or engagement in PD programs among male and female educators in the sample.

Sentiment analysis

This study utilized sentiment analysis to understand the open-ended replies from mathematics teachers in Oman. This method facilitates the measurement of subjective input, providing an additional viewpoint to quantitative survey findings. Analyzing the attitudes in teachers' narratives provides insight into their worries, satisfaction levels, and areas requiring intervention, so facilitating more informed decision-making in educational policy and practice.

Table 9. Emerging themes table

Theme	Frequency	Average sentiment
Resource needs	38	-0.62
Student challenges	29	-0.45
PD effectiveness	22	0.18
Curriculum feedback	17	0.31

Sentiment distribution

The comprehensive distribution of sentiments across all qualitative responses is delineated below:

1. Positive: 42%. Example: "Enhancing student engagement via interactive techniques."
2. Neutral: 33%. Example: "Require additional time for specific curriculum subjects."
3. Negative: 25%. Example: "Insufficient resources in rural educational institutions."

This distribution reflects an overall optimistic perspective among respondents, with a substantial percentage providing neutral feedback and a smaller, yet considerable, group articulating critical apprehensions.

Emerging themes

Thematic analysis of sentiment-labelled responses revealed four dominant areas of concern or interest. Each theme was quantified by frequency and associated with the average sentiment score (on a scale where negative values indicate dissatisfaction and positive values indicate satisfaction) (**Table 9**):

Interpretations

1. Resource needs surfaced as the most commonly referenced concern and received the lowest ratings, indicating dissatisfaction with insufficient instructional materials and infrastructure, especially in remote regions.
2. The challenges faced by students were associated with a negative attitude score, as educators voiced apprehensions regarding student motivation, readiness, and difficulty in comprehension.
3. The PD effectiveness and curricular feedback indicated a predominantly positive feeling, implying that PD programs and curricular frameworks are largely regarded favorably, albeit with potential for enhancement.

These insights contextualize the quantitative findings and offer a more sophisticated comprehension of instructor views. The emotional tone of the replies underscores the necessity for focused resource distribution and assistance initiatives.

Predictive Model for Innovation Adaption

A random forest classifier model was created to forecast high innovation adoption (top 40% of scores) utilizing 15 input factors, including demographics, PD,

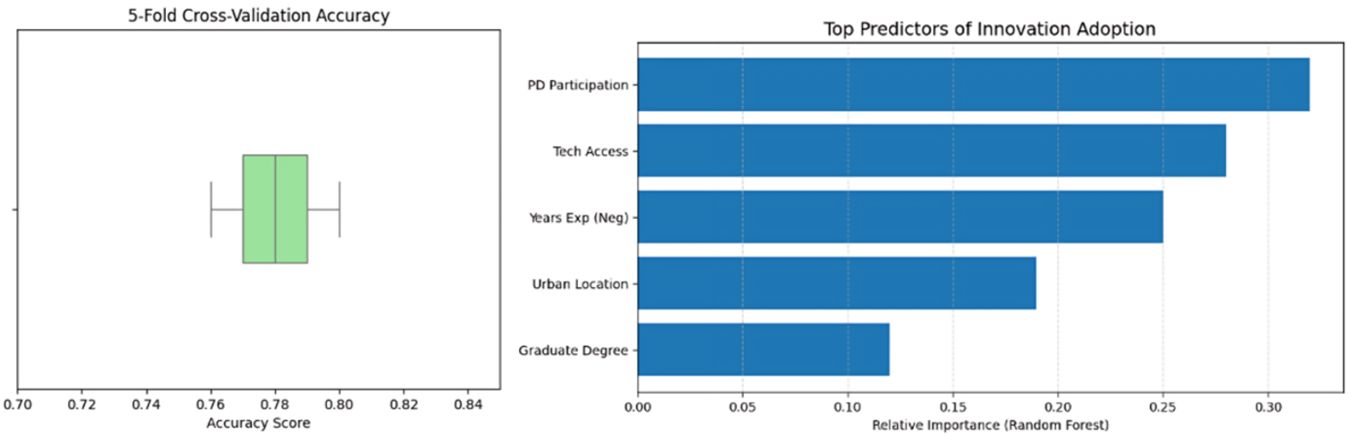

Figure 6. Random forest (Source: Authors' own elaboration)

and resource accessibility. The model attained 78% accuracy during 5-fold cross-validation, demonstrating robust prediction ability.

1. **Principal observations of innovation adaptation:** Recent PD participation, access to technology, and urban residency.
2. **Negative predictor:** Years of experience (-0.25), indicating that less experienced professionals are more inclined to embrace innovations.
3. **Unexpected discovery:** Age was not a significant determinant; the adoption of innovation is influenced more by environmental factors than by inherent characteristics.
4. **Strategic implications:** Organizations must prioritize PD investments, equal technological access, and mentorship initiatives to cultivate innovation.

Figure 6 shows the random forest.

DISCUSSION

This study's findings offer a comprehensive insight of the perspectives, challenges, and professional realities faced by mathematics educators in Oman. The results, based on quantitative and qualitative assessments, underscore the intricate relationship among curriculum design, instructional methods, teacher training, resource availability, and contextual restrictions that influence teaching effectiveness and creativity in mathematics education.

Overall Teacher Perceptions

The findings suggest that mathematics educators in Oman possess predominantly favorable views regarding the curriculum, collegial collaboration, and availability of PD opportunities. Educators indicated robust collegial support and active participation in ongoing learning, reflecting a developing culture of professionalism. Nonetheless, ongoing difficulties were observed with curricular flexibility, excessive dependence on summative evaluation, and unequal access to educational resources–particularly in rural and underprivileged areas. These divergent perceptions indicate a system undergoing transformation, wherein reforms are well-intentioned but not yet consistently executed at the classroom level. The simultaneous presence of optimism and frustration highlights the necessity for contextually informed policy assistance that connects reform rhetoric with actual classroom conditions.

Curriculum and Instructional Practices

Educators typically regarded the program as suitable (M = 4.1) and consistent with national and international norms (M = 3.98). Correlation study indicated a robust positive association between curriculum design and instructional practices (r = 0.68), affirming that well-structured curricula often improve successful teaching. Qualitative responses indicated that numerous instructors perceive the curriculum as excessively centralized and inflexible, constraining their ability to modify content for varied learners. Teachers value the curriculum's clarity and consistency but desire increased latitude to adapt classes according to classroom requirements. This discovery underscores the necessity for modular curriculum frameworks that integrate national uniformity with local flexibility.

Professional Development and Teacher Training

PD has become a crucial factor influencing teacher effectiveness and curriculum evaluation. The association between training and instructional quality (r = 0.75) was the most robust in the dataset, highlighting that successful training improves classroom confidence and curriculum engagement. Educators who underwent continuous PD reported diminished apprehensions about student learning difficulties (r = -0.42). The results corroborate existing evidence indicating that focused, ongoing PD improves pedagogical adaptability and instructional excellence. Nonetheless, access to PD remains inequitable, since rural educators engage less frequently due to logistical and institutional obstacles.

This underscores the necessity for equitable, hybrid PD programs that include both in-person and digital modalities to guarantee inclusivity across geographic areas.

Student Learning Challenges

Participants recognized multiple enduring obstacles to students learning in mathematics, encompassing challenges in computation, language, and conceptual comprehension. M scores varied between 3.6 and 4.0, indicating moderate levels of concern. Educators attributed these issues to deficiencies in prior knowledge, insufficient student enthusiasm, and linguistic obstacles in bilingual environments. The modest negative associations across curriculum, instruction, and student obstacles suggest that enhanced curricular support and teacher training directly mitigate these issues. These observations underscore the significance of early diagnostic evaluations and tailored education to more effectively address student variety and learning deficiencies.

Reliability and Construct Validity of the Instrument

The survey instrument demonstrated excellent internal consistency, with α values of 0.87 for curriculum and teaching perceptions and 0.81 for student difficulties. EFA revealed three distinct constructs–curriculum satisfaction, teaching confidence, and learning barriers–accounting for 65% of the total variance, with a KMO value of 0.78, indicating sample adequacy. This robust psychometric profile confirms the instrument's dependability and endorses its application in future research investigating teacher views in analogous circumstances.

Teacher Profiles and Group Differences

Cluster analysis identified two distinct profiles of educators. Cluster 1 (60%) consisted of extremely satisfied educators who exhibited confidence in their teaching and regarded the curriculum and training opportunities positively. Cluster 2 (40%) comprised educators who identified significant challenges, especially related to student issues, inflexible curricula, and insufficient training or resources. The presence of these clusters underscores disparities in teacher experience influenced by environmental and institutional factors. This indicates that PD programs and resource allocation strategies must be tailored to meet the distinct requirements of instructors with significant challenges.

Mediating Role of Training

Mediation analysis revealed that professional training strongly mediated the association between curriculum perception and reported student difficulties (ACME = -0.223, $p < 0.001$), representing about 75% of the total effect. This suggests that enhancements in teacher preparation enhance the beneficial impact of curricular perspective on mitigating student difficulties. The quality of the curriculum enhances student results largely when it is supported by adequate teacher preparation and instructional assistance. This discovery highlights the necessity of prioritizing continuous and contextually pertinent training as a fundamental aspect of curriculum reform.

Demographic and Contextual Influences

ANOVA indicated multiple significant demographic impacts. Age significantly predicted technology usage ($F = 6.21$, $p = 0.004$), indicating generational disparities in digital competence. Teaching experience affected curriculum perspective ($F = 4.87$, $p = 0.011$), whereas locale significantly impacted resource accessibility ($F = 18.34$, $p < 0.001$), highlighting urban-rural differences. Gender exhibited no substantial disparities in attitudes or involvement in PD, signifying equitable engagement opportunities. The results underscore that demographic diversity and contextual elements influence instructional techniques, necessitating tailored support for particular groups of educators.

Sentiment and Thematic Analysis

Qualitative sentiment analysis of open-ended responses indicated a predominantly positive orientation (42%), among neutral (33%) and negative (25%) portions. Negative sentiments predominantly pertained to resource insufficiency and student difficulties, whereas favorable sentiments highlighted the efficacy of PD and the coherence of the curriculum. Thematic clustering revealed that resource requirements and student preparedness were persistent issues, especially among instructors in rural areas. This mixed emotion profile suggests a workforce that is both driven and professional yet hindered by systemic constraints.

Innovation and Technology Adoption

A random forest classifier forecasting high innovation adoption attained 78% accuracy, indicating that recent engagement in PD, access to technology, and urban residency were the most significant positive predictors, whereas years of experience adversely affected innovation adoption. This indicates that novice and younger educators are more inclined to explore innovative pedagogies and technologies, whereas veteran teachers tend to depend on conventional techniques. These findings support reverse mentorship and intergenerational collaboration to connect digital and instructional knowledge.

Recommendations

This study provides essential insights into the perceptions of mathematics educators in Oman about

Table 10. Strategic recommendations summary

Focus area	Key action	Rationale
Teaching experience	Launch reverse mentoring initiatives	Combines experience and tech savviness
Curriculum flexibility	Offer modular curriculum supplements with adaptive teacher guides	Balances standardization with context sensitive teaching
Tech integration	Deploy instructional tech coaches and virtual professional learning community	Bridges access and usage gaps, especially in rural areas.
Assessment reforms	Train teachers in authentic, formative assessment methods	Strengthens learning diagnostics and remediation.
PD enquiry	Expand digital PD, offer incentives for rural participation.	Boosts innovation adaptation and professional growth.

curriculum, instruction, assessment, and PD. The results both validate and enhance current literature while indicating practical avenues for the advancement of educational policy and practice. **Table 10** shows the strategic recommendations summary.

1. Educator identity, experience, and innovation
   - The statistics indicate a robust link between teaching experience and instructional confidence. Experienced educators indicated elevated self-efficacy (M = 4.7). Conversely, novice educators–despite exhibiting lower confidence in classroom management (M = 3.1)–demonstrated a heightened propensity for technology utilization (M = 4.2), corroborating the findings of Al-Harthi and Al-Saadi (2020) about generational innovation disparities.
   - Recommendation: Utilize the skills of both groups via reverse mentorship programs, wherein younger educators facilitate digital integration, while experienced instructors provide pedagogical support. This reciprocal information transfer may enhance the dissemination of innovation while bolstering collective professionalism.
2. Curriculum alignment and adaptability
   - Seventy-eight percent of educators concurred that the curriculum conforms to international norms (M = 4.3), however only sixty-two percent deemed it suitable for their particular settings (M = 3.5). The disparity is especially evident in rural regions (Δ = 0.8), reflecting (Al-Ghafri, 2020) apprehension about inconsistent curriculum implementation resulting from resource inequalities. The prevalent issue of textbook dependency (43% of open replies) indicates a discrepancy between curriculum design and practical execution.
   - Recommendation: Implement modular curricular supplements that present diversified routes (e.g., enrichment, remedial, and inquiry-based modules) and grant localized instructor autonomy in resource adaptation. Furthermore, enhance training in curriculum development and lesson adaptation, particularly in rural areas.
3. Instructional methods and technological integration
   - Although 82% indicate access to fundamental digital tools, merely 60% utilize them consistently, highlighting a disparity in utilization. Urban schools indicate superior resource availability (Δ = 1.2), whereas younger educators demonstrate enhanced resource adaptability (M = 4.1), underscoring a developing culture of instructional agency.
   - Recommendation: Advance beyond mere infrastructure provision by implementing instructional technology coaching programs that assist educators in the effective integration of tools. Enhance blended learning communities, particularly virtual ones, to link rural educators with colleagues and mentors.
4. Assessment and learning gaps
   - The results indicate a persistent dependence on conventional assessments (83%), accompanied by a minimal adoption of performance tasks (37%). Nonetheless, 71% of educators reported modifying instruction in response to assessment results (M = 4.4), demonstrating heightened recognition of the significance of formative assessment.
   - Recommendation: Enhance capacity-building in genuine assessment methodologies (e.g., project-based learning and portfolios) and data-informed instruction. Develop nationwide diagnostic instruments to detect and address conceptual deficiencies in numeracy and reasoning, particularly during the foundational years.
5. PD and innovation adoption
   - Although 65% of educators indicated they had sufficient training, hardly 48% implemented new methodologies consistently. Rural educators engaged in 40% fewer PD activities than their urban counterparts; yet those who recently participated in PD exhibited a 22% rise in the adoption of innovations.

- Recommendation: Institutionalize blended PD programs that integrate asynchronous online modules with peer collaboration. Prioritize equity in PD access by providing stipends or release time for educators in remote areas. Initiate pilot PD-innovation incubators in underprivileged districts to evaluate the effects of continuous development on instructional methodologies.

CONCLUSION

The findings of this study reveal that mathematics educators in Oman navigate a complex educational landscape shaped by national reform initiatives and local classroom realities. Teacher perceptions highlight that instructional effectiveness is closely linked to access to targeted PD, supportive school environments, and adequate technological and instructional resources. These results emphasize the need for context-sensitive educational policies that consider regional disparities and classroom constraints rather than assuming uniform implementation capacity across schools.

Despite its contributions, this study has limitations. The sample size is relatively small (n = 50) and slightly imbalanced between urban and rural participants, which may restrict the generalizability of the findings. In addition, the reliance on self-report survey data may introduce response bias. Future research should employ mixed-method or longitudinal designs to gain deeper insight into teacher practices, classroom dynamics, and the long-term effects of educational reform. Comparative studies across Gulf countries and qualitative follow-up interviews are also recommended to validate and extend the present findings.

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