

What Mathematics Teachers' Perceptions of the Integration of Educational Drama in Mathematics Instruction: A Mixed-Methods Study

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Abstract

This research aimed to explore mathematics teachers' perspectives on the integration of educational drama in mathematics instruction, specifically focusing on mathematical knowledge, classroom discourse and affective aspects. Using a mixed-methods approach and a sequential explanatory design, the study first employed a quantitative phase, applying a scale to gauge teachers' views on incorporating educational drama into mathematics instruction. The questionnaire covered three key dimensions: the advancement of mathematical knowledge, facilitation of classroom discourse, and emotional elements. The framework was developed based on established theoretical models. Following this, interview protocols were designed, based on the quantitative outcomes, to explore the insights provided in greater depth. The results indicated a predominantly positive reception among mathematics educators for the use of drama in mathematics education, with consistent agreement observed across all aspects of the scale. The mean scores for the development of mathematical knowledge, classroom dialogue and emotional dimensions were notably high, reflecting substantial alignment among the participants. Qualitative analysis of the teacher interviews highlighted the beneficial aspects of employing drama in mathematics education. The teachers noted the role of drama in reinforcing concepts, enhancing specific mathematical skills and positively affecting student engagement. However, concerns were raised regarding the potential for students' focus to be diverted from core mathematical content. In terms of classroom discourse and emotional development, drama was acknowledged for its role in fostering interactive exchanges, refining students' speaking abilities, and nurturing self-confidence and motivation. Nonetheless, there were caveats concerning the suitability of drama for all student cohorts, pointing to the need for tailored approaches.

Keywords: Teachers' Perspectives; Educational Drama; Mathematical Knowledge; Classroom Dialogue; Mixed Methods.

Introduction

Lifestyle changes driven by technology and new media have necessitated adaptation among the educational community, making improvements to curricula and teaching methods that will encourage students to become proactive learners. The integration of science and technology in education is of paramount importance in fostering creativity, innovation and international competitiveness (Al-Ghamdi, 2011; Yamadaa, 2017). Mathematics plays a vital role in addressing universal life challenges and advancing scientific and technological progress, highlighting the need for mathematics education to incorporate cultural and social contexts that align with learners' daily experiences and environments (Holubova, 2008; Ivic, 2016; Kusmaryono, 2014). The demand for diverse teaching methodologies to meet the requirements of a knowledge-based economy is increasing, with an emphasis on innovative approaches, such as activity-based learning, cooperative learning and role-playing.

Educational methodologies such as storytelling, dialogue, role-playing, drama-based learning and simulation exercises offer immersive learning experiences that promote engagement and communication (Nettner, 2005; Podolak et al., 2014). Drama-based instruction makes learning easy and facilitates understanding by providing the opportunity to contextualise geometric concepts and problems, act as a character (role-playing), and communicate and study in a collaborative learning environment. Within this range of approaches, educational drama involves the integration of dramatic activities to enrich learning by encouraging students to articulate narratives creatively and actively portray scenarios, characters and actions. This interactive approach prompts students to assume roles, immerse themselves in the experience and

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communicate curriculum content effectively through verbal expressions, gestures and movements, often with their peers serving as the audience (Joudah, 2017; Khasawneh & Al-Akla, 2012; Zaghoul, 2018).

Incorporating drama in teaching is as a strategy for restructuring educational curriculum content and instructional approaches by transforming the material into practical scenarios. This method emphasises the effective communication of essential elements and concepts, requiring students to assume roles that are relevant to these scenarios. With the guidance of the educator, students actively engage in the interpretation and clarification of educational content, thereby enhancing their understanding and retention of knowledge (Schumacher, 2011). Integrating drama in teaching aligns with the concept of interactive learning, identified by Bruner as a crucial aspect of the learning process. According to this perspective, students acquire knowledge through active engagement with their environment, which involves their response to movement, visualisations and comprehension. These sensory experiences provide a foundation based on which students can progress to language and reasoning, which are fundamental for the development of cognitive representations (Bora, 2017).

Educators are increasingly recognising the potential of leveraging drama as an instructional tool across diverse subjects, such as mathematics, science and language. This approach draws inspiration from educational programmes broadcast on television, where drama is used as an effective means of conveying scientific and social information. It is understood that educational content may fail to captivate students if it is not presented in an engaging and stimulating dramatic context within the classroom environment (Clemson, 2011). Furthermore, Lestari (2018) notes the contemporary trend in education that places the student at the centre of the learning process. In this approach, educators, curricula, educational goals, methodologies and approaches collectively aim to stimulate students' senses, foster their mental and emotional creativity, and promote interaction within the educational setting. By adopting such an approach, the students' cognitive abilities are enhanced and performance and skills development improve. Moreover, the student-centred approach has the potential to inspire students to engage in innovative or artistic endeavours. The significance of drama lies in its ability to imbue recipients with knowledge and information. The comprehensiveness of the knowledge presented correlates with the value and depth of the artistic work and encourages recipients to seek insights into humanity, society and interpersonal dynamics (Clemson, 2011).

Incorporating drama within the school curriculum is an impactful teaching approach grounded in social and communicative learning theories. This method supports the development of essential life skills and social aptitudes, enhancing students' proficiency in public speaking, dialogue and the use of appropriate vocabulary. Research indicates that engaging in narrative-based reenactments improves students' competencies across language domains, including reading, writing and verbal communication (Lestari, 2018). The interactive classroom environment fosters meaningful social exchanges, equipping students with vital communicative and interpersonal abilities. Language plays a central role in this dynamic and the creative element of drama combines imagination and spontaneity, facilitating experiential learning and collaborative exploration among students (Subaşı et al., 2016). According to Clemson (2011), the integration of drama as an innovative instructional tool is based on the concept of knowledge construction, recognising learning as an iterative and active process facilitated by student-driven mechanisms of “representation and harmonization”. In line with this notion, Bora (2017) highlights that educational drama is a leading contemporary educational strategy that instils self-assurance in students as active participants in the learning process.

Dramatic treatments encompass various contexts, including social, economic, cultural and educational domains. Dramatic Structure Education, rooted in scientific principles, uses storytelling through dramatic performance to introduce and reinforce concepts for learners. It plays a crucial role in facilitating the learning of mathematical content and promoting effective interaction between educators and students. Particularly at the elementary level, at which social development is prominent, students can be engaged deeply through interaction, movement, dynamism, activity and emotional connections to the protagonist's character and ideas within the dramatic sequences. Cinematic elements, such as set design, costumes, body language, auditory rhythms and focused lighting, contribute to shaping the dramatic composition within the narrative framework (Geraniou et al., 2010). Educational drama has gained significant recognition as an

integral part of the learning process. Through role-playing and the portrayal of societal scenarios, drama promotes social awareness. By embodying real-life dramatic scenes, students can gain practical experiences that deepen their understanding of social dynamics (Bora, 2017).

To attain a profound understanding of mathematics, it is essential to master mathematical concepts and fulfil learning objectives by establishing a strong foundation in conceptual understanding. This process involves enhancing students' ability to receive mathematical concepts, articulate them effectively, establish connections between different mathematical ideas and foster oral mathematical expression (Darwish, 2016; Dweikat, 2016; Khawar, 2017). Educational drama harnesses the participatory nature of the medium to unlock students' latent potential. Furthermore, Lestari (2018) argues that drama not only improves academic performance but also shapes attitudes, nurtures imagination, fosters creativity, promotes self-awareness, integrates mental and physical engagement, and captures students' attention.

Drama is as a powerful tool for enhancing language comprehension and expanding students' vocabulary. Its alignment with children's natural inclination to engage in play and activity makes learning an interesting and enjoyable experience. By combining elements of education, entertainment, art, excitement and critical thinking, drama enlivens the learning environment and stimulates creativity (Clemson, 2011; Lestari, 2018). Clemson (2011) and Subaşı et al. (2016) view educational drama as an interactive approach that harnesses students' energy, using role-playing in real-life and imaginative scenarios to facilitate learning. Through this approach, students can develop their awareness, boost their self-assurance and enhance their decision-making skills.

Drawing on the aforementioned aspects, the framework provided by dramatic structure can be considered a contemporary educational approach that has promise for fostering active and constructive learning. This framework has the potential to enhance the acquisition of mathematical knowledge by infusing engagement and enjoyment in the learning process, fostering critical thinking and innovation. Moreover, it provides a platform for students to articulate their thoughts and cultivate a keen interest in mathematical concepts by presenting challenges in a compelling and narrative-driven manner.

Research problem

Educational drama has emerged as a promising approach to enhance mathematics instruction, focused on improving student interest and engagement (Ersoy, 2016; Masoum et al., 2013; Özsoy et al., 2017; Sharda, 2014). Previous studies have highlighted its effectiveness in teaching various mathematical concepts, including addition and large/small numbers, as well as challenging students' perceptions of mathematics (Kotarinou & Stathopoulou, 2015; Özsoy et al., 2017). However, there is a dearth of qualitative research in this field, necessitating further investigation (Şengün & İskenderoğlu, 2010).

In traditional mathematics classrooms, the emphasis tends to be overwhelmingly on the cognitive aspect of learning, neglecting the physical, affective and social dimensions of the teaching and learning process (Dawson & Lee, 2018). This approach often fails to connect with students' real-life experiences and contributes to the development of negative attitudes and beliefs concerning mathematics (Lamichhane & Belbase, 2017; Luitel, 2009; Sam, 1999). Many students in basic education face challenges in learning mathematics, attributed by educators and pedagogues to the continued use of traditional teaching methods. Teachers can address these challenges by employing strategies that attract students to the subject, making learning enjoyable, engaging them actively and demonstrating the relevance of mathematics in everyday life. Consequently, there is a pressing need to explore the potential of educational drama in bridging the gap between traditional and innovative pedagogies and creating a more holistic and engaging learning environment for mathematics education.

The Ministry of Education in the Kingdom of Saudi Arabia has made significant efforts to develop curricula and teaching strategies, including seeking to improve mathematics education. However, despite ongoing efforts, weaknesses persist in mathematics learning and it remains a longstanding issue in educational development. This is a particularly pressing concern due to the continuing decline in Saudi students' performance in the Trends in International Mathematics and Science Study (TIMSS) since 2003. The latest

results from the 2019 TIMSS revealed considerable weakness among students in mathematics, with Saudi Arabia ranking 53rd out of 58 participating countries (Mullis et al,2020).

Numerous studies (e.g. Al-Anzi & Al-Natheer, 2022; Al-Saqarat, 2012;; Paksu & Ubuz, 2009; Subaşı et al., 2016) have demonstrated the value of using drama and animations to enhance learning motivation, improve academic achievement and enhance understanding among students. Educational drama is recognised as a modern approach that fosters social interaction in the classroom and attracts students to engage in the learning process. This is particularly relevant in abstract subjects and those that rely on imagination to construct meanings and concepts, which is evident in mathematics topics in the basic education stages.

Given these points, researchers have identified the need for field studies to explore mathematics teachers' perceptions regarding the use of educational drama in teaching mathematics. This study answers the call, seeking to address the following questions:

- What are mathematics teachers' perceptions of the use of educational drama for the advancement of mathematical knowledge?
- What are mathematics teachers' perceptions of the use of educational drama for facilitating classroom discourse?
- What are the mathematical teachers' perceptions of the use of educational drama for addressing emotional elements?
- What are the participants' teachers' opinions of teachers' perceptions regarding the use of drama in mathematics instruction?

Research Methodology

To achieve the study objectives and address the research questions, the study employed a mixed-methods approach. It adopted an explanatory sequential design, which Creswell and Clark (2018) describe as a research approach in which the researcher connects quantitative and qualitative data, This method emerges from specific philosophical viewpoints and integrates both quantitative and qualitative methods by mixing them within a single study.

Research population and sample

The study recruited 178 teachers (82 male and 104 female) for the quantitative survey through simple random sampling. For the qualitative data collection, 10 participants were selected randomly from 178 teachers.

Study instruments

The study employed two instruments for data collection: a questionnaire and semi-structured interviews.

The questionnaire was designed to elicit mathematics teachers' perceptions of the use of educational drama in teaching mathematics. The scale comprised three dimensions: (i) advancement of mathematical knowledge (10 statements); facilitation of classroom discourse (7 statements); addressing emotional elements (9 statements). Responses were given on a five-point Likert scale, anchored ("strongly agree", "agree", "neutral", "disagree", "strongly disagree"), with judgement intervals as shown in Table 1.

Table 1. Judgement intervals for the study scale

Likert scale judgement intervals	Value
1.80	Strongly disagree

1.81–2.60	Disagree
2.61–3.40	Neutral
3.41–4.20	Agree
4.21–5.00	Strongly agree

To ensure validity and reliability, the initial items were presented to seven experts specialising in the fields of curriculum and methods of teaching mathematics, measurement and evaluation, and mathematics teachers. Based on their feedback, several adjustments were made to some items, certain items were deleted and one item was added. This revision resulted in a total of 26 items. The reliability of the scale was confirmed using Cronbach's alpha, which gave an overall reliability coefficient of 0.95, deemed satisfactory for this study.

In the second step, semi-structured interviews were conducted with 10 teachers following the quantitative analysis. The interviews aimed to provide additional insights regarding the teachers' responses to the quantitative scale across the three dimensions. The interview questions consisted of both closed and open-ended questions, directly posed to individual participants. Trustworthiness was ensured as follows:

Ethical considerations: The participants were informed of the study's objectives and given the choice to participate. Confidentiality was assured and the participants' identities were protected using pseudonyms.

Credibility: Interview cards were designed to clarify the purpose, duration and methods of qualitative data collection. The interviews, lasting 10–25 minutes, were audio-recorded and transcribed. The transcripts were cross-checked by the participants for accuracy.

Transferability: Data collection and analysis aimed at diversity of views by recruiting participants who varied in terms of gender, educational stage and teaching experience, allowing for multiple perspectives. The results were reviewed, identifying common elements, and shared with teachers who did not participate in the interviews, ensuring the consistency of the results. Direct participant quotes were integrated into the analysis.

Dependability: The study's dependability was ensured through detailed documentation of the study design, procedures and data analysis. Interviews with non-sample volunteers verified the clarity, suitability and inclusiveness of the questions. Data from various sources were integrated to interpret and discuss the results cohesively, linking them to previous research.

Results

Questionnaire results

To address the research questions, the mean (M) and standard deviation (SD) values were calculated for each item and each dimension of the scale in the questionnaire. The results are reported for each dimension in turn.

Table 2. Perceptions of the use of drama to advance mathematical knowledge

No.	Statement	M	SD	Level
1	Using drama in teaching mathematics helps develop students' comprehension abilities	4.37	0.637	Strongly agree
2	Using drama in teaching mathematics contributes to developing students' conceptual understanding	4.41	0.578	Strongly agree
3	Using drama in teaching mathematics helps students retain mathematical concepts	4.33	0.663	Strongly agree
4	Using drama in teaching mathematics increases students' ability to integrate and link concepts and ideas	4.37	0.609	Strongly agree

5	Using drama enhances the ability to create mental representations of mathematical concepts	4.26	0.643	Strongly agree
6	Using drama helps develop an understanding of mathematical terms and symbols	4.39	0.575	Strongly agree
7	Using drama in teaching mathematics enhances students' ability to employ procedural mathematical skills	4.43	0.592	Strongly agree
8	Using drama in teaching mathematics helps develop students' problem-solving skills	4.39	0.546	Strongly agree
9	Using drama in teaching mathematics aids in developing students' creative thinking skills	4.37	0.620	Strongly agree
10	Using drama in teaching mathematics helps build new knowledge among students	4.45	0.649	Strongly agree
Overall average score		4.377	-	Strongly agree

Table 2 illustrates that the mathematics teachers held positive perceptions of the use of drama in mathematics education for developing mathematical knowledge, evidenced by all scale items attaining the level of “strongly agree” and the overall average for all items ($M = 4.37$).

Table 3. Perceptions of the use of drama to facilitate classroom discourse

No.	Statement	M	Sd	Level
1	Using drama in teaching mathematics contributes to developing students' communication skills	4.41	0.617	Strongly agree
2	Using drama in teaching mathematics helps develop students' listening skills	4.48	0.555	Strongly agree
3	Using drama in teaching mathematics increases students' ability to express themselves clearly	4.29	0.605	Strongly agree
4	Using drama in teaching mathematics helps students acquire body language skills	4.39	0.632	Strongly agree
5	Using drama in teaching mathematics aids in fostering students' respect for diverse perspectives	4.43	0.582	Strongly agree
6	Using drama in teaching mathematics helps students formulate sentences and generate mathematical ideas	4.41	0.588	Strongly agree
7	Using drama in teaching mathematics helps students use their senses effectively	4.39	0.633	Strongly agree
Overall average score		4.4	-	Strongly agree

From Table 3, it is apparent that the mathematics teachers had positive perceptions of the use of drama in mathematics education for developing classroom dialogue and discussion, represented by all scale items attaining the level of “strongly agree”, and the overall average for all items ($M = 4.4$).

Table 4. Perceptions of the use of drama to address emotional elements

No.	Statement	M	Sd	Level
1	Using drama in teaching mathematics helps in developing students' self-confidence	4.65	0.535	Strongly agree
2	Using drama in teaching mathematics contributes to developing students' sense of responsibility	4.43	0.509	Strongly agree
3	Using drama in teaching mathematics aids in better control of students' emotions and feelings	4.15	0.743	Strongly agree

4	Using drama in teaching mathematics contributes to enhancing students' self-esteem	4.22	0.688	Strongly agree
5	Using drama in teaching mathematics helps in creating a comfortable learning environment for students	4.24	0.652	Strongly agree
6	Using drama in teaching mathematics increases students' motivation towards learning	4.28	0.675	Strongly agree
7	Using drama in teaching mathematics makes the educational process enjoyable and engaging in classroom interactions	4.45	0.732	Strongly agree
8	Using drama in teaching mathematics helps in developing students' decision-making skills	4.41	0.579	Strongly agree
9	Using drama in teaching mathematics aids in developing students' ethical values such as honesty, justice, etc.	4.46	0.667	Strongly agree
Overall average score		4.366	-	Strongly agree

As can be seen in Table 4, the mathematics teachers held positive perceptions about using drama in teaching mathematics concerning the affective aspects of learning, with all scale items attaining the level of strongly agree and an overall mean score for all emotional aspect items of 4.36.

Results of semi-structured teacher interviews

The interviews were analysed manually following Braun and Clarke's (2006) steps in thematic analysis. This resulted in three main themes, discussed in turn in the following sub-sections.

Educational drama and the development of mathematical knowledge

The first theme addresses the impact of using educational drama in teaching mathematics on the development of mathematical knowledge among students. It focuses on consolidating concepts in students' minds and helping them grasp mathematical terms, vocabulary and concepts in depth, as well as linking concepts. Moreover, it concerns the impact on the development of some mathematical skills among students. It also addresses some negative aspects mentioned by teachers regarding the use of drama in teaching mathematics.

In the interviews, the teachers noted that using drama in teaching mathematics had an impact on the development of mathematical knowledge, making it easier to convey information to students and thus helping solidify knowledge in students' minds and aiding retention. For example, Teacher 1 reported, "I believe that using dramatic construction is important in the educational process in general and in math lessons in particular. When using drama to explain lessons or convey the concept of the lesson to students through using games or role-playing, it helps solidify those concepts in the student's memory". To illustrate, the teacher described the use of drama to explain the concept of fractions to students, saying:

For example, the teacher can present a play where students play the roles of equal-sized apple slices, then they divide them into different parts to represent fractions. For instance, four students can divide the apple into quarters to represent $\frac{1}{4}$, then two students can divide the apple into halves to represent $\frac{1}{2}$.

Through this example, the teacher illustrated the potential to help students learn by shifting from the traditional method to the use of dramatic construction, which might make it easier for students to understand the topic.

Likewise, Teacher 7 discussed the impact of drama on enhancing students' comprehension of concepts, stating, "When students take on roles in a dramatic scene, they are forced to use mathematical vocabulary repeatedly, which helps them understand it better". This points to an important aspect, namely that one way of ensuring understanding is through the repetition of concepts and terms, in particular presenting them in different roles during the dramatic construction of the lesson. Additionally, giving mathematical aspects characters and engaging in practical, tangible experimentation through dramatic construction

provides an opportunity for students to connect what they have learned with reality through the dramatic scenes. As Teacher 9 highlighted:

In embodying characters for geometric shapes and different types of graphical representations through presenting scenarios and mathematical problems, students can embody abstract mathematical concepts and understand them more deeply. Students can also present scenarios that include explaining different types of graphs and expressing them through movement.

Thus, many teachers highlighted during the personal interviews that the use of drama may play a prominent and important role in helping students understand mathematical terms, vocabulary and concepts in depth, as well as linking concepts. They mentioned that drama helps students understand words and terms and provides the opportunity for the students to apply this knowledge in solving mathematical problems. As Teacher 2 put it:

Using drama in teaching mathematics can help students understand some mathematical concepts deeply by representing and embodying them. This can help them understand the relationships between those concepts. Additionally, drama can help students analyse mathematical concepts by representing them in different contexts, which can help them understand the meanings of words and terms.

Furthermore, in addition to the role of drama in supporting students' understanding of mathematical concepts, some teachers pointed out that it can enhance students' mathematics skills and support the development of higher-order thinking, critical thinking and problem-solving skills. This is due to the transition from sensory learning to abstract learning. In this regard, Teacher 9 stated:

Drama contributes to gaining mathematical knowledge which in turn contributes to the development of mathematical skills. Thus, the student can solve mathematical problems by being able to comprehend the written text and simulate what happens in the drama to what the student encounters in a new situation, making it easier for them to deal with new data.

Furthermore, Teacher 6 noted, “Drama can help students think critically about mathematical concepts by posing questions and searching for answers, and this can help them develop higher-order thinking skills”.

Despite the positive points mentioned above, some teachers identified the potential for certain negative impacts that the use of drama could have on teaching students and their acquisition of mathematical concepts. As Teacher 4 pointed out:

Drama may divert students' attention from the core mathematical content. Focusing on the dramatic aspect may make students more preoccupied with performance and theatrical events rather than focusing on understanding the mathematical concept itself. Therefore, the teacher should balance the use of drama and other traditional methods in teaching mathematics to achieve educational goals in the best possible way.

Teacher 7 further noted:

Creating appropriate dramatic scenarios requires significant effort from the teacher, and some may not have sufficient experience for this. Additionally, there may be difficulties in providing the necessary tools for dramatic activities, and it can be challenging to assess the extent to which the educational objectives in mathematics are being achieved through these activities. Furthermore, some concepts may not be suitable for theatrical representation.

Educational drama and classroom discourse

The second theme concerns the impact of using drama in teaching mathematics on classroom dialogue and discussion, enhancing the students' roles within the classroom and improving their speaking skills. Drama can be used to enable them to express their ideas freely and with confidence. The teachers also mentioned

some negative aspects, such as the potential for students to become distracted and lose their focus on language and mathematical symbols.

The teachers expressed the view that using drama in teaching mathematics could help students acquire many communication skills by providing them with the opportunity to speak, participate and comment on various aspects of the lesson. This can transform students from being passive recipients of information into active participants. Teacher 1 pointed out that “when students role-play mathematical scenarios, they are forced to explain and interpret concepts and procedures more clearly and in more detail. This helps in developing their speaking skills and enhancing their ability to clarify ideas and processes for others”. The change in the students’ roles and greater participation can provide an opportunity for them to demonstrate various creative and innovative aspects as part of their learning while thinking about solving mathematical problems. Moreover, engaging in discussion and interaction with their peers fosters communicative and collaborative skills. Teacher 2 elaborated on this, saying:

Through communication and delving into multiple contexts and when various mathematical scenarios are represented, students are compelled to think in creative and innovative ways to embody concepts and problems. Additionally, through interacting and engaging in dialogue with their peers in dramatic activities, students gain communication and collaboration skills.

In addition to improving communication skills, using drama in the classroom can also give students the confidence to express their opinions and discuss them through dialogue and role-playing in the classroom. As Teacher 4 explained:

Through role-playing activities, students can engage in discussions with their peers, become more courageous, and have the ability to present their ideas and discuss them based on what they have witnessed. This allows students to progress from the imaginative phase in the lesson to a phase of understanding through tangible scenes, which helps them express their opinions about them.

Teacher 4 further emphasised the impact of using drama in mathematics lessons, stating, “It leads to an increase in student questions as simulation and discussion accompanying dramatic activities encourage students to ask questions and engage in effective discussions about mathematical topics”. Additionally, Teacher 9 contended that:

Students are given greater freedom in expression, correction, and the acquisition of general skills. When different roles are assigned to students in dramatic scenarios, they begin to pose questions from diverse perspectives, enabling them to develop collaboration and communication skills.

The use of drama thus not only enhances students' communication skills but also empowers them to share their opinions and engage in discussions with confidence, actively asking questions. It fosters a collaborative and communicative environment within the classroom, allowing students to develop their skills and freely express their diverse viewpoints.

However, it is important to highlight certain negative aspects and potential drawbacks of using drama in mathematics lessons that could lead to adverse impacts. For instance, it may divert students' attention away from focusing on language and mathematical symbols, and thus many of the facets that students need to deepen their understanding could be overlooked. There could also be negative impacts on social interaction, as the focus on performance and dramatic scenes might weaken students' mathematical communication skills. As Teacher 3 pointed out:

...there may be some negative effects, for example, interactions within the lesson and the focus on performance could weaken students' mathematical communication skills, such as writing or problem-solving. While students may gain collective communication skills, they may not develop individual mathematical communication skills to the same extent. Additionally, sometimes dramatic representation may lead to oversimplification of mathematical concepts or hiding some important details.

It is necessary to address these potential drawbacks to derive the benefits of using drama and ensure that the educational goals are achieved effectively. It is important to consider these points when integrating drama into mathematics lessons to maintain a balance between creativity and engagement and a focus on the core mathematical concepts and communication skills.

Educational drama and affective aspects

The third theme addressed the role of educational drama in teaching mathematics and its impact on the development of affective aspects of students' learning. Educational drama can contribute to enhanced self-confidence and motivation among students, helping them overcome barriers such as shyness and instilling some positive qualities. By incorporating drama in mathematics lessons, students can engage emotionally with the material, leading to a more holistic learning experience that nurtures their emotional intelligence alongside their mathematical skills.

The interviews with the mathematics teachers revealed that using drama enhanced their students' motivation and improved their attitudes towards learning. They reported that dramatic activities provided an interactive and enjoyable environment, increasing student engagement. The sense of success and accomplishment boosted the students' self-confidence and increased their inclination to engage with mathematics. Highlighting the importance of mathematics in these activities also stimulated the students' interest in the subject. Teacher 4 stated, "Dramatic activities create an interactive and enjoyable environment for students, increasing their motivation and engagement in learning. This contributes to improving their emotional attitudes towards learning mathematics". This sentiment was echoed by Teacher 1, who emphasised that "The students' sense of success and achievement when mastering and performing mathematical roles in simulation enhances their self-confidence and motivation". Teacher 9 was of the same view, recounting that "Emphasising the importance of mathematics in these dramatic activities will help stimulate students' interest in this subject and their appreciation for its role in their lives". In addition,, the teachers highlighted some important functions of using drama in teaching mathematics, such as breaking down the shyness barrier for some students through performing and participating in various roles. This helps them speak with confidence. Teacher 1 noted:

When students engage in educational drama, they become good speakers, break the barrier of shyness, and enhance social relationships. Practising educational drama in learning mathematics has significant positive effects on the social and affective aspects of students, in addition to academic aspects. It enhances communication and speaking skills, strengthens social relationships and interaction among students through collaborative and cooperative work, and develops self-confidence, the ability to participate, and self-expression in front of others.

Some teachers also expressed the belief that students embodying heroic characters in educational drama enhanced their moral values and positive behaviours. Teacher 5 highlighted this, saying:

When students take on the role of a beloved hero in educational drama, they acquire many virtuous qualities. For instance, when a student portrays the role of a hero in a specific story, they empathize with this character and begin to adopt and practice its positive traits such as courage, responsibility, love for helping others, and selflessness.

Teacher 7 further pointed out:

Educational drama is a powerful tool for developing positive qualities in students if employed correctly, taking into consideration the diverse needs and abilities of students. Through portraying beloved heroic roles, students gain positive traits such as courage, responsibility, love for helping others, and selflessness. To ensure the success of this practice, teachers must be familiar with students' skills, assign roles according to their capabilities, consider individual differences, and acknowledge the diverse attributes of students.

However, some caution is needed as this strategy may not be suitable for all students and there could be negative consequences for those not inclined towards learning through drama. Teacher 9 warned:

But for students who are not interested in dramatic activities, they may feel some confusion or discomfort with using drama in mathematics, leading to a decrease in their motivation and engagement in the lesson. Students who do not enjoy dramatic activities may lose interest in the mathematical subject as a whole.

It is thus essential to consider individual student preferences and learning styles when incorporating drama within the curriculum to ensure that it is beneficial for all students. Also, this approach may not be suitable for all students because of some shy students may have negative reactions, as noted by Teacher 7, who recounted, “Some students may feel anxiety and tension when asked to perform in a dramatic manner in class, especially shy students or those with self-confidence issues. This tension may arise from students' fear of failing to perform roles or making mistakes in front of their peers”.

Discussion

This study aimed to explore mathematics teachers' perceptions of the use of educational drama in developing mathematical knowledge, classroom dialogue and discussion, and the affective aspects of learning for students. The study findings indicated that the mathematics teachers held positive perceptions concerning the use of educational drama in mathematics instruction across all study dimensions. These positive perceptions were evident in the responses to the survey, as well as in the responses gathered through interviews with a sample of the survey participants.

In summary, the participants viewed the use of drama positively, seeing it playing a crucial role in developing students' mathematical knowledge. This is achieved by reinforcing concepts in students' minds, helping them to gain an in-depth understanding of mathematical terminology, vocabulary and concepts, as well as enabling them to make links between concepts. In addition, it has an impact on the development of students' skills. However, some teachers pointed out that the use of drama may distract students from the core mathematical content. Focusing on the dramatic aspect may make students more absorbed in the performance and theatrical events rather than concentrating on understanding the mathematical concept itself. Nonetheless, in general, there was significant agreement among the teachers in their responses concerning the development of mathematical knowledge. The positive effects identified align with most previous studies, such as those of Al-Khatib (2018), Nahhal (2015), Al-Saqarat (2012), and Paksu and Ubuz (2009), which found that the use of educational drama contributes to the acquisition of mathematical and scientific concepts among kindergarten children. Moreover, Paksu and Ubuz (2009) found that drama-based education had a significant impact on students' academic achievement, retention of knowledge and levels of thinking. Regarding problem-solving in arithmetic, Joudah (2017) pointed out the impact of employing drama in improving verbal arithmetic problem-solving skills among students. Additionally, Ersoy's (2014) study showed that students in a creative drama group had a better understanding of the processes of polygon formation and inference and could form a polygon similar to another polygon.

In terms of the second dimension, concerning the role of educational drama in enhancing classroom dialogue and discussion, the responses to the questionnaire were again very positive, as were most of those in the interviews, although some negative aspects were also noted. The findings that incorporating drama led to a change in students' roles within the classroom and improved their speaking skills, helping them express their ideas freely and courageously, align with the results of many previous studies. For example, Al-Anzi and Al-Natheer (2022) demonstrated the effectiveness of using a dramatic approach in developing mathematical communication. Additionally, Paksu and Ubuz (2009) found that drama-based education had a significant impact, making learning easier and improving understanding by providing opportunities for communication and studying in a cooperative learning environment. It helped capture students' attention by offering a stimulating educational environment. Furthermore, as highlighted by Nahhal (2015), drama-based education can aid in developing students' ability to express themselves freely and communicate with their peers and communities through the representation of various social situations and roles.

In terms of the third dimension, which focused on the affective aspects of learning, the study found that the mathematics teachers were almost unanimously positive, expressing the belief that educational drama could play a significant role in affecting the affective aspects of the students' experience. They highlighted

its role in increasing students' self-confidence and motivation, helping them overcome shyness, as well as instilling some positive qualities. However, several teachers pointed out that using drama may not be suitable for all students and could have negative effects on those who are shy. The findings are in line with studies in the literature. For example, Bilicska (2019) reported that students found this method enjoyable and expressed interest in its continued use. Allern and Drageset (2017) reported that drama could contribute to increased activity among the students and deep learning. In terms of mathematics teaching, they identified the potential for enhanced student participation through a greater focus on questions, explanations and arguments. They also found that the learning process was stimulated through changing perspectives and using role categories. Furthermore, in Isyar and Akay's (2017) study, teachers expressed the view that using drama in education is an effective and powerful method and helps the students develop personal attributes. Yuksekyalcin et al. (2016) found that most science and mathematics teachers in their study had positive opinions about applying creative drama in class. The teachers favoured using creative drama in their classrooms to engage students' attention and encourage them to think about their stories in the stages of creative drama creation, such as scenario design and final presentation.

Conclusions

This study aimed to explore the perceptions of mathematics teachers regarding the use of educational drama in developing mathematical knowledge, classroom dialogue, and the affective aspects of learning for students. The study revealed that teachers' perceptions of the use of educational drama were positive in all aspects of the study. They viewed the use of drama in mathematics education as playing a crucial role in helping students understand mathematical concepts and terms, as well as making links between them. Moreover, the use of drama was perceived to affect the development of students' skills. However, some teachers pointed out that focusing on the dramatic aspects could distract students from focusing on the core mathematical content.

The results of this study align with previous studies, indicating that mathematics teachers see the use of educational drama as playing a significant role in the development of classroom dialogue and discussion. Employing drama changed students' roles within the classroom, helping them improve their speaking skills and express their ideas freely and courageously. However, attention should be paid to some negative aspects, such as potential neglect of language and mathematical symbols.

The study also identified that the mathematics teachers believed using drama contributed to students' self-confidence and motivation, helping them overcome shyness and develop positive qualities. Nonetheless, some teachers indicated that using drama may not be suitable for all students and could have negative effects on shy students. In general, the use of educational drama in mathematics education can be effective in developing mathematical knowledge, enhancing communication and discussion skills, and fostering personal aspects of students' learning. However, individual needs and the interests of students should be considered, and a collaborative educational environment that allows for free expression and innovation should be provided.

Limitations and future research

The study was limited in terms of the sample size (178 participants in the quantitative survey and 10 in the qualitative interviews). The survey sought responses to positive statements concerning three dimensions of the influence of using drama in class: mathematical knowledge, classroom dialogue, and affective aspects. Future studies could examine different aspects, such as teachers' perceptions of the effectiveness of teaching drawing on theoretical framings of the use of drama, studying the challenges teachers might face when employing drama in teaching mathematics, and qualitative studies exploring teaching practices and their relationship with activating drama. Studies specifically focusing on using educational drama in teaching mathematics could encompass the following:

- An evaluation of the impact of using educational drama on students' comprehension of various mathematical concepts.

- An exploration of how educational drama stimulates students and increases their participation in mathematics classes.
- An examination of the impact of using educational drama on developing critical thinking skills and problem-solving abilities in students related to mathematics topics.
- An analysis of the using educational drama to enhance student collaboration and social interaction within the classroom.
- An investigation of the use of virtual reality and augmented reality techniques to enrich the educational drama experience in mathematics teaching.
- A study on the use of educational drama as an effective method to boost self-confidence and improve students' psychological stance towards mathematics.
- An exploration of the impact of educational drama on enhancing life skills and 21st-century skills, such as collaboration, communication and problem-solving skills among students.

Recommendations

Based on the findings, the study makes the following recommendations:

- **Teacher training:** Training programmes should be provided for mathematics teachers to enhance their skills in incorporating educational drama within their teaching practices. This training should focus on effective strategies for implementing drama in mathematics education and addressing potential challenges.
- **Curriculum development:** Elements of educational drama should be integrated into the mathematics curriculum to foster a more engaging and interactive learning environment. This could help students better understand mathematical concepts and improve their communication skills.
- **Student engagement:** Active participation and engagement should be encouraged among students by regularly incorporating drama activities in mathematics lessons. This approach could help increase interest in the subject and enhance students' problem-solving abilities.
- **Assessment strategies:** There is a need to develop innovative assessment methods that align with the use of educational drama in mathematics education, assessing students' comprehension of mathematical concepts through performance, role-play, or other creative means.
- **Research collaboration:** Collaboration should be fostered between researchers, educators and curriculum developers to explore the impact of educational drama on students' mathematical knowledge, classroom interaction and emotional development. This collaborative effort could lead to improved teaching practices and student outcomes.
- **Continuous evaluation:** There should be regular evaluation of the effectiveness of applying educational drama in mathematics education through student feedback, classroom observation and academic performance assessments. Such ongoing evaluation would help identify strengths and areas for improvement in implementing drama-based teaching methods.

Ethical statement: Authors stated that ethical approval was not required for the study since no live subjects were used and it is a review of existing literature. However, ethical guidelines were followed throughout the study.

Declaration of interests:

No conflict of interest is declared by authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding authors.

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