

Using Augmented Reality to Enhance Geometric Visualisation and Learning Engagement Among Year 3 Pupils

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ABSTRACT

This action research was conducted to help Year 3 pupils recognise and differentiate between prism and non-prism shapes through the use of Prism Augmented Reality (Prism AR). The study was initiated in response to pupils' difficulties in visualising three-dimensional (3D) shapes, confusion between two-dimensional (2D) and three-dimensional (3D) representations, and limited understanding of the characteristics of prisms. The objectives of the study were to help pupils differentiate between square prisms, rectangular prisms, and triangular prisms using Prism Augmented Reality, enhance pupils' engagement during the intervention, and evaluate the effectiveness of its use in the teaching and learning process. The study employed the Kemmis and McTaggart Action Research Model and involved 23 Year 3 Al-Farabi pupils at Sekolah Kebangsaan Padang Hiliran, Kuala Terengganu. Data were collected through pre- and post-tests, an observation checklist, and a questionnaire. The findings showed improvements in pupils' mastery and positive patterns of engagement and interest following the Prism AR-based intervention. Given the one-cycle action research design, small single-class sample, and absence of a comparison group, these changes are interpreted as intervention-associated rather than as definitive causal effects of Prism AR. This was evidenced by an increase in the mean test score from 31.6% to 57.8%, with 69.6% of pupils achieving the mastery level after the intervention. Furthermore, 91.3% of pupils demonstrated an improvement in their individual scores. The majority of groups were classified as Very Active based on the observation data. The questionnaire findings also indicated that 82% of pupils provided positive responses regarding learning comprehension, while 87% responded positively to the effectiveness of the teacher's instructional approach using Prism AR. In conclusion, the findings provide preliminary classroom-based evidence that Prism AR may support conceptual mastery, active engagement, and interest in Mathematics learning. Further controlled studies are required before its effectiveness can be generalised beyond this classroom context.

Keywords - Action research, Prism Augmented Reality, prisms and non-prisms, intervention effectiveness, Year 3 Mathematics

INTRODUCTION

Quality education is an essential foundation for developing knowledgeable, skilled, and competitive human capital, in line with the aspirations of the National Education Philosophy (Falsafah Pendidikan Kebangsaan), which emphasises holistic human development in terms of intellectual, spiritual, emotional, and physical dimensions. In tandem with technological advancement and the aspirations of 21st-century education, teachers are required to implement creative, innovative, and pupil-centred teaching and learning processes to enhance conceptual mastery, thinking skills, and active pupil engagement. In efforts to improve teaching practices, action research provides an approach that enables teachers to systematically identify learning problems, implement interventions, and make improvements through a continuous process of reflection (Kemmis & McTaggart, 1988).

Mathematics is a subject that emphasises conceptual understanding, reasoning, and visualisation skills, particularly in the field of geometry. Based on an analysis of a pre-test administered to Year 3 Al-Farabi pupils

at Sekolah Kebangsaan Padang Hiliran, Kuala Terengganu, it was found that a considerable proportion of pupils continued to experience difficulties in identifying and differentiating between prism and non-prism shapes. Pupils were also confused about the characteristics of prisms because they found it difficult to visualise three-dimensional shapes when instruction relied primarily on two-dimensional visual materials. This situation resulted in a low level of mastery of geometric concepts and highlighted the need for a more interactive and visually oriented teaching approach.

Accordingly, this action research introduced Prism Augmented Reality (Prism AR) as an intervention to help pupils recognise and differentiate between prism and non-prism shapes through the presentation of interactive three-dimensional models. The use of Augmented Reality (AR) technology enables pupils to explore geometric objects in a more realistic manner, thereby enhancing conceptual understanding, spatial visualisation, and engagement in learning. A systematic review by İslim et al. (2024) demonstrated that the use of AR in Mathematics education can enhance conceptual mastery, motivation, and pupil achievement, while Voulgari et al. (2024) similarly reported that AR can strengthen geometry learning through more meaningful learning experiences. Therefore, this action research employed the Kemmis and McTaggart Action Research Model to evaluate the effectiveness of Prism AR in helping Year 3 pupils master the concepts of prisms and non-prisms.

Reflection on previous teaching and learning

During the implementation of teaching and learning for the topic of three-dimensional shapes, the researcher found that Year 3 pupils continued to experience difficulties in differentiating between prism and non-prism shapes. Although explanations had been provided using textbook illustrations and presentation slides, a considerable number of pupils remained confused when identifying the characteristics of particular shapes. Pupils were frequently observed giving inaccurate answers when asked to classify shapes as prisms or non-prisms. In addition, some pupils continued to confuse triangular prisms with pyramids because they focused primarily on the external appearance of the shapes without identifying the characteristics that distinguish the two forms.

Through reflection on the teaching practices, the researcher realised that the instructional approach used had not sufficiently supported pupils in developing an in-depth understanding of three-dimensional shapes. According to Bruner (1966), learning becomes more meaningful when learners progressively engage with enactive, iconic, and symbolic representations. Through the use of concrete and visual materials, learners can construct ideas before progressing towards an understanding of more abstract concepts. Ahmad and Junaini (2020) also reported that the use of Augmented Reality (AR) can enhance pupils' understanding of mathematical concepts because it enables them to visualise objects interactively.

Accordingly, the researcher considered Augmented Reality (AR) technology to have considerable potential to help pupils visualise three-dimensional shapes more clearly, as objects can be viewed from multiple perspectives and explored virtually. This approach was expected to enhance pupils' understanding of the characteristics of prisms and non-prisms while reducing the confusion experienced during the learning process.

Research Objectives

Through the implementation of this study, the researcher aimed to achieve the following objectives:

- To help pupils differentiate between three types of prisms, namely square prisms, rectangular prisms, and triangular prisms.
- To enhance pupils' engagement during the implementation of Prism Augmented Reality activities.
- To evaluate the effectiveness of the Prism Augmented Reality application in the teaching and learning process.

Research Focus

This action research was conducted to help Year 3 pupils understand and differentiate between prism and non-prism shapes through the use of Prism Augmented Reality (Prism AR) and the Interactive Prism and Non-Prism Board. The intervention was implemented to enhance pupils' understanding of three-dimensional (3D) shapes. The study involved 23 Year 3 Al-Farabi pupils at Sekolah Kebangsaan Padang Hiliran, Kuala Terengganu, in the Mathematics subject, specifically the topic of Prism and Non-Prism Shapes.

Based on observations conducted during the teaching and learning process, the researcher found that a considerable number of pupils experienced difficulties in understanding the concept of prisms because they found it challenging to visualise objects in three dimensions. Most pupils perceived the shapes presented in textbooks or on the whiteboard merely as two-dimensional images, which prevented them from forming a clear mental representation of the actual prism shapes. In addition, pupils were confused between two-dimensional (2D) and three-dimensional (3D) shapes. Consequently, they were unable to determine whether a given shape belonged to the category of prisms or non-prisms. This situation also affected their mastery of the characteristics of prisms, such as the shape of surfaces, number of sides, and vertices.

Furthermore, the researcher found that the use of textbook illustrations alone was insufficient to help pupils develop a clear understanding of the concepts. Some pupils quickly lost concentration and demonstrated limited interest during the teaching sessions. Therefore, the researcher introduced an intervention known as Prism AR, an application that enables pupils to view prism models virtually in three-dimensional form through digital devices. Pupils were also able to observe the prism shapes from different perspectives. This feature helped them develop a clearer visual representation of the characteristics of each shape.

In addition, the researcher used the Interactive Prism and Non-Prism Board as a reinforcement activity to further strengthen pupils' understanding after using the Prism AR application. During this activity, pupils were required to identify shapes and classify their characteristics according to prism and non-prism categories. The use of the Interactive Prism and Non-Prism Board was expected to enhance pupils' active participation and create a more enjoyable learning environment. To evaluate the effectiveness of the intervention, several data collection methods were employed, including pre- and post-tests, an observation checklist, and a pupil questionnaire. Observations were conducted to determine pupils' level of engagement during the activities, while the pre- and post-tests were used to assess improvements in their understanding of prism and non-prism concepts. The questionnaire enabled the researcher to obtain pupils' perceptions regarding the effectiveness of Prism AR and the Interactive Prism and Non-Prism Board in supporting their learning process.

RESEARCH METHODOLOGY

This section describes the methodology employed in the implementation of the action research. The discussion covers the research design, research instruments, and research participants to ensure that the study was implemented systematically and systematically planned. The action research employed the Kemmis and McTaggart Action Research Model (1988), which consists of four main phases: planning, action, observation, and reflection. Based on the findings from the reflection phase, recommendations for improvement were formulated as follow-up actions to strengthen the effectiveness of the intervention in the subsequent cycle. Therefore, this report describes the implementation of the study across five components: planning, action, observation, reflection, and improvement.

Research Design

This study employed a one-cycle action research design to examine changes in Year 3 pupils' recognition and differentiation of prism and non-prism shapes following the implementation of Prism Augmented Reality (Prism AR). The design was selected primarily to improve and reflect on classroom practice within a specific instructional context rather than to establish causal effectiveness or population-level generalisability.

The study adopted a mixed-methods classroom evaluation approach by integrating quantitative achievement and perception data with structured observations. Triangulation across these sources was used to examine whether changes in test performance were accompanied by consistent patterns in pupil engagement and perceptions.

The quantitative component involved pre- and post-tests to describe changes in pupils' mastery before and after the intervention, together with a post-intervention questionnaire on pupils' learning experiences. The qualitative/observational component used a structured checklist to document attention, cooperation, communication, active participation, focus, interest, and task completion. Data were analysed descriptively using scores, percentages, and means. No inferential test was applied; therefore, the observed pre-post differences should not be interpreted as statistically verified causal effects. Because there was no control or comparison group, the study cannot fully separate the contribution of Prism AR from repeated exposure to the topic, teacher guidance, peer interaction, the Interactive Prism and Non-Prism Board, or other classroom influences.

Conceptual mechanism of Prism AR. The intervention was informed by a visualisation-to-conceptual-understanding pathway. First, AR presents manipulable three-dimensional representations that allow pupils to inspect a prism from multiple viewpoints. Second, this interaction supports spatial visualisation by helping pupils connect two-dimensional representations with three-dimensional form. Third, guided comparison directs attention to defining geometric attributes such as faces, edges, and vertices. Finally, active exploration and immediate classroom discussion can support the construction and reinforcement of conceptual understanding. In this study, this pathway is treated as an explanatory framework for interpreting the observed classroom changes rather than as a directly tested mediation model.

Three main research instruments were employed: pre- and post-tests, an observation checklist, and a pupil questionnaire. The instruments addressed complementary outcomes—achievement, engagement, and pupil perceptions—so that findings could be compared across multiple sources. The instruments were developed for this classroom action research and aligned with the targeted learning content and intervention objectives. However, formal psychometric validation and reliability coefficients were not established in the present study; this is acknowledged as a methodological limitation. Consequently, the questionnaire and observation findings should be interpreted as descriptive classroom evidence rather than as results from fully validated standardised measures.

Three main research instruments were employed in this study: pre- and post-tests, an observation checklist, and a pupil questionnaire. These three instruments were used to collect data to evaluate the effectiveness of Prism AR in helping Year 3 pupils recognise and differentiate between prism and non-prism shapes. The data obtained from each instrument complemented one another and provided a comprehensive picture of pupils' achievement, engagement, and perceptions following the implementation of the intervention.

Pre- and Post-Tests

The pre- and post-test tasks were developed with reference to the same targeted learning standards and assessed pupils' abilities to identify, name, and differentiate prism and non-prism shapes. Content alignment was used to support the relevance of the items to the instructional objectives. Nevertheless, because formal indices of content validity and test reliability were not calculated, future studies should involve expert review, pilot testing, item analysis, and appropriate reliability estimation before wider use.

Both instruments were developed based on the same learning standards and assessed pupils' abilities to identify, name, and differentiate between prism and non-prism shapes.

The pre-test consisted of items assessing pupils' basic skills in matching types of prisms with the correct images and identifying prism characteristics using a provided table. The post-test covered the same learning scope, with additional items designed to assess pupils' mastery more comprehensively following the intervention. The skills assessed included matching shapes with the names of prisms, naming different types

of prisms, identifying prism characteristics, completing a table of prism characteristics, and classifying shapes into prism and non-prism groups. A comparison of the pre- and post-test scores was used to determine the effectiveness of Prism AR in helping Year 3 pupils recognise and differentiate between prism and non-prism shapes.

The observation checklist was used to document pupils' active engagement during the teaching and learning process, including participation, cooperation, communication, interest, focus, and task completion. The use of predefined behavioural indicators improved consistency in what was observed. Nevertheless, observations were recorded by the teacher-researcher and no inter-rater reliability estimate was available. Teacher expectancy and observer bias therefore remain possible influences on the engagement findings. Future studies should use at least two trained observers and report inter-rater agreement.

The observation checklist was used to assess pupils' level of active engagement during the teaching and learning process. This instrument enabled the teacher to identify pupils' participation, cooperation, and communication, as well as assess their interest, focus, and commitment throughout the intervention. Observations were conducted by the teacher during or at the end of the teaching and learning session to record pupils' behaviours and responses to the activities implemented. The instrument employed a 'Yes' or 'No' rating scale to facilitate the teacher's recording of relevant observations by placing a (✓) mark against each applicable item. The use of this scale enabled data to be recorded systematically and facilitated subsequent analysis. For example, the teacher marked 'Yes' when a pupil demonstrated the behaviour or response described in an observation item and 'No' when the pupil did not demonstrate the specified behaviour or response.

Based on the recorded data, the teacher was able to analyse and summarise pupils' levels of engagement throughout the implementation of the intervention.

Questionnaire

The questionnaire covered four main aspects: understanding, interest, confidence, and acceptance of technology, using a five-point Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree). The questionnaire was designed to capture pupils' perceptions after the intervention. As no formal construct-validity analysis or internal-consistency coefficient was established for this classroom instrument, the percentages are interpreted descriptively. Future validation should include expert assessment of content relevance and age-appropriate wording, pilot administration, and reliability analysis before the instrument is used with larger samples. The questionnaire consisted of four main aspects: understanding, interest, confidence, and acceptance of technology. Pupils were asked to respond using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The data obtained from the questionnaire were analysed to determine the extent to which the use of Prism AR improved pupils' understanding of prism shapes, stimulated their interest in learning, and enhanced their confidence in identifying prism characteristics.

Research Participants

This study was conducted at Sekolah Kebangsaan Padang Hiliran, Kuala Terengganu, involving 23 Year 3 Al-Farabi pupils as the research participants. The study focused on Mathematics, specifically the topic of Prism and Non-Prism Shapes. The selection of these pupils was based on observations conducted during the teaching and learning process, the results of the pre- and post-tests, and an initial assessment conducted by the researcher. The observations indicated that most pupils experienced difficulties in visualising three-dimensional shapes, frequently confused two-dimensional and three-dimensional shapes, and demonstrated limited understanding of the basic characteristics of prisms and non-prisms.

Research Implementation Plan

The implementation of this action research was guided by the Kemmis and McTaggart Action Research Model (1988), which consists of five main phases: planning, action, observation, reflection, and improvement. This

model was selected because it provides a systematic process for helping researchers identify problems, plan appropriate interventions, implement actions, conduct observations, and evaluate the effectiveness of the interventions. Through this process, the researcher was able to identify the strengths and limitations of the intervention and plan improvements for the subsequent research cycle.

Planning

During the planning phase, the researcher first identified the problems experienced by the pupils through observations during the teaching and learning process and an analysis of the exercises assigned. The observations indicated that pupils experienced difficulties in visualising three-dimensional shapes. In addition, pupils were confused when differentiating between prism and non-prism shapes and demonstrated limited understanding of prism characteristics. Based on the identified problems, the researcher established three research objectives: to help pupils differentiate between three types of prisms, enhance pupils' engagement during Prism Augmented Reality activities, and evaluate the effectiveness of the application in the teaching and learning process.

Subsequently, the researcher planned an appropriate intervention to address the identified problems. The selected interventions were the use of Prism Augmented Reality and the Interactive Prism and Non-Prism Board. The application was used to help pupils view prism models in three-dimensional form from multiple perspectives, thereby facilitating their understanding of the characteristics of each shape. Meanwhile, the Interactive Prism and Non-Prism Board was used as a reinforcement activity to provide pupils with opportunities to classify shapes according to prism and non-prism categories. The combination of these two interventions was designed to create a more interactive, enjoyable, and pupil-centred learning experience.

To ensure that the effectiveness of the intervention could be evaluated systematically, the researcher also prepared appropriate research instruments. The instruments included pre- and post-tests to measure pupils' mastery before and after the intervention. In addition, a teacher observation form was used to assess pupils' engagement throughout the learning activities, while a pupil questionnaire was administered to obtain feedback regarding understanding, interest, confidence, and acceptance of Prism AR in Mathematics learning.

Through systematic planning, the researcher expected the implementation of the intervention to achieve the established research objectives. This planning also served as a guide for implementing the action, observing changes among the pupils, and reflecting on the effectiveness of the intervention based on the Kemmis and McTaggart Action Research Model. With careful planning, the study was expected to improve pupils' understanding of Prism and Non-Prism Shapes and provide a more meaningful Mathematics learning experience.

Action

The action phase represents the second stage in the Kemmis and McTaggart cycle, during which the researcher implemented the intervention planned during the planning phase. At this stage, the teacher first administered the pre-test to measure pupils' initial level of understanding of the concepts to be taught. The pre-test was important for obtaining baseline data before the intervention so that meaningful comparisons could be made following its implementation.

The teacher then implemented the planned intervention, namely the use of Prism AR. Through this intervention, pupils had the opportunity to explore and visualise prism shapes interactively using AR technology. This activity was further supported by the use of an interactive board, which enabled pupils to match shapes with prism characteristics collaboratively, thereby strengthening their conceptual understanding of the topic.

At the end of the action phase, the teacher administered the post-test to assess pupils' level of mastery following the intervention. Pupils' feedback was also collected through the observation form and

questionnaire. This process was important to ensure that the effectiveness of the intervention could be evaluated systematically before proceeding to the observation phase.

Observation

The observation phase represents the third stage of the Kemmis and McTaggart cycle. It was conducted concurrently with or following the action phase to collect data concerning the effects of the intervention. At this stage, the teacher collected various forms of data, including pre- and post-test results, observations during the teaching and learning process, and pupils' responses throughout the activities.

The collected data were subsequently analysed in detail to identify pupils' level of understanding, their engagement in learning activities, and the cooperation demonstrated during group activities. This analysis provided the teacher with a clearer understanding of the effectiveness of the Prism AR intervention.

Through careful observation, the teacher was able to determine whether the intervention successfully achieved the intended objectives. The data and information obtained during this phase served as an important basis for the subsequent reflection phase, in which the overall effectiveness of the intervention was evaluated more comprehensively.

Reflection

During the reflection phase, the researcher evaluated the effectiveness of Prism AR based on findings from the pre- and post-tests, teacher observation form, and pupil questionnaire. The analysis indicated that the intervention successfully achieved the research objectives. The researcher observed an improvement in pupils' mastery of Prism and Non-Prism Shapes following participation in the learning activities using the intervention. In addition, feedback from the questionnaire and teacher observations indicated positive changes in terms of understanding, interest, confidence, and pupils' acceptance of technology in Mathematics learning.

In terms of pupil engagement, noticeable changes were observed throughout the teaching and learning sessions. Before the intervention, some pupils demonstrated limited attention during the teacher's instruction and relied primarily on explanations and textbook illustrations to understand prism shapes. This situation made it difficult for pupils to visualise three-dimensional shapes and reduced their willingness to participate in classroom activities.

Following the implementation of the intervention, pupils appeared more focused on the teacher's explanations and demonstrated improved attention during the activities. They displayed enjoyment and enthusiasm when viewing prism models in three-dimensional form using Prism AR. Pupils also became more active in asking questions, sharing ideas with peers, expressing their views during group discussions, and collaborating to complete the tasks assigned by the teacher. The learning environment became more enjoyable as pupils demonstrated a high level of interest in exploring different prism and non-prism shapes. They were also willing to independently experiment with the application without requiring constant encouragement from the teacher. Teacher observations further indicated that the majority of pupils were able to maintain their focus throughout the activities and were classified as being at the Very Active level.

Improvement

Based on the reflection conducted, the researcher found that the use of Prism AR successfully enhanced pupils' understanding and engagement in learning. Nevertheless, several aspects could still be improved to ensure that the intervention becomes more effective in subsequent research cycles. These improvements were planned based on findings from the tests, teacher observations, and pupils' feedback throughout the action research.

To enhance the effectiveness of Prism AR, the researcher recommends that the AR Studio application be supported by alternative platforms so that learning activities can continue in the event of technical disruptions or Internet connectivity problems. In addition, WebAR should be designed with a more user-friendly interface

so that teachers can operate it easily without requiring basic coding skills. These improvements could facilitate teachers in developing Augmented Reality-based teaching materials and ensure that the teaching and learning process can be conducted more smoothly.

FINDINGS AND DISCUSSION

This section discusses the findings obtained from the research instruments, namely the pre- and post-tests, teacher observation form, and pupil questionnaire, to evaluate the effectiveness of the intervention implemented.

Findings of the Pre- and Post-Tests

Table 1. Mean Scores for the Pre- and Post-Tests

Test	Number of Pupils	Mean (%)
Pre-Test (Before Intervention)	23	31.60
Post-Test (After Intervention)	23	57.80
Improvement		26.20

Table 1 presents a comparison of the pre- and post-test results of 23 Year 3 pupils before and after the implementation of the Prism Augmented Reality (Prism AR) intervention. The pre-test was conducted to identify pupils' initial level of knowledge regarding the concept and characteristics of prisms, whereas the post-test was administered to assess pupils' level of mastery following the intervention.

The table shows that the pupils' mean score increased from 31.60% in the pre-test to 57.80% in the post-test. This represents an improvement of 26.20 percentage points following the implementation of the Prism AR intervention.

Table 2. Pupils' Level of Mastery

Test	Number of Pupils (≥ 50%)	Percentage (%)
Pre-Test (Before Intervention)	0	0.00
Post-Test (After Intervention)	16	69.6

In terms of pupils' mastery level, Table 2 shows that none of the pupils achieved a score of at least 50% in the pre-test. Following the intervention, 16 pupils (69.6%) achieved the mastery level. This finding indicates that the use of Prism AR contributed to improved pupil achievement in the topic of prisms.

Table 3. Improvement in Pupils' Scores

Category	Number of Pupils	Percentage (%)
Improved	21	91.3
No Improvement	2	8.7

Based on Table 3, the score analysis indicates that 21 out of 23 pupils (91.3%) obtained higher scores in the post-test than in the pre-test, while only two pupils (8.7%) did not demonstrate an improvement in their scores. This finding indicates that Prism AR contributed to improved mastery of the prism topic among the majority of pupils.

The pre- and post-test results show a clear descriptive improvement following the intervention: the mean score increased from 31.60% to 57.80%. This pattern is consistent with improved understanding after the Prism AR-based learning activities and is plausibly related to the opportunity to view and explore three-dimensional representations rather than relying only on static images. However, the present design does not permit the improvement to be attributed exclusively to Prism AR.

The proportion of pupils reaching the mastery threshold increased from 0% to 69.6% after the intervention. This is encouraging classroom evidence of learning progress during the intervention period. Nevertheless, the improvement may reflect the combined influence of Prism AR, teacher explanation and scaffolding, repeated exposure to the same topic, collaborative activities, and reinforcement through the Interactive Prism and Non-Prism Board. In the absence of a comparison group, these instructional influences cannot be statistically separated.

Individual score comparisons showed that 91.3% of pupils obtained higher post-test scores, whereas two pupils did not improve. The consistency of improvement across most pupils strengthens the descriptive evidence that learning progressed during the intervention. Even so, the result should be interpreted as an association with the overall intervention package rather than proof of a unique causal effect of Prism AR. Inferential analysis with an appropriate paired-sample procedure could strengthen future studies when assumptions and sample size permit.

This finding is further supported by the individual improvement data, which showed that 91.3% of pupils improved their respective scores following the intervention. Although two pupils did not demonstrate an improvement, the majority of pupils achieved better results compared with their performance before the intervention. This situation demonstrates that the use of Prism AR technology can provide a more meaningful learning experience and support pupils in understanding geometric concepts more effectively.

Overall, the pre- and post-test findings provide preliminary evidence that Objective 1 was achieved within this class: most pupils showed improved performance in differentiating square, rectangular, and triangular prisms after the intervention. The conclusion is intentionally limited to the participating pupils and intervention period; it does not establish that Prism AR alone caused the improvement or that the same magnitude of improvement would occur in other classrooms.

Overall, the pre- and post-test findings demonstrate that the Prism AR intervention successfully improved pupils' mastery in differentiating between prism shapes. Therefore, Objective 1, which was to help pupils differentiate between three types of prisms—square prisms, rectangular prisms, and triangular prisms—was successfully achieved based on the improvement demonstrated in the pre- and post-test results.

Findings from the Observation Checklist

Based on the teacher's observation checklist, the majority of pupils were classified as Very Active. All observation indicators demonstrated positive responses, including attention, cooperation, communication, participation throughout the intervention, task completion, and confidence during question-and-answer sessions with the teacher. These findings also indicate that the use of Prism AR and the Interactive Prism and Non-Prism Board successfully enhanced pupils' engagement and created a more interactive, engaging, and pupil-centred Mathematics learning environment. Table 4 presents the teacher's observation findings for each indicator assessed during the intervention.

Table 4. Teacher Observation Findings

No	Observation Item	Group 1	Group 2	Group 3	Group 4
1	Pupils listened carefully to the teacher's instructions and paid attention during the explanation.	Yes	Yes	Yes	Yes
2	Pupils demonstrated good cooperation within their groups when completing the assigned tasks.	Yes	Yes	Yes	Yes
3	Pupils actively participated voluntarily in group activities.	Yes	Yes	Yes	Yes
4	Pupils were willing to contribute ideas, opinions, or suggestions during group discussions.	Yes	Yes	Yes	Yes
5	Pupils answered questions posed by the teacher or group members confidently.	Yes	Yes	Yes	Yes
6	Pupils demonstrated good communication and respected the opinions of other group members.	Yes	Yes	Yes	Yes
7	Pupils performed their respective roles within the group and assisted other members in completing the tasks.	Yes	Yes	Yes	Yes

8	Pupils demonstrated cooperation and mutual assistance throughout the teaching and learning activities.	Yes	Yes	Yes	Yes
9	Pupils remained focused during the pre- and post-tests without disturbing other pupils.	Yes	Yes	Yes	Yes
10	Pupils demonstrated interest and commitment during the Prism Augmented Reality activities.	Yes	Yes	Yes	Yes
11	Pupils were able to complete group tasks according to the instructions and within the specified time.	Yes	Yes	Yes	Yes
12	Pupils actively participated in the question-and-answer session.	Yes	Yes	Yes	Yes

Overall level of pupil engagement during teaching and learning activities:

Group 1 – Very Active; Group 2 – Moderately Active; Group 3 – Very Active; Group 4 – Very Active.

The observation findings show high levels of pupil engagement during the Prism AR-based activities, with most groups classified as Very Active. Pupils generally attended to instructions, participated in activities, cooperated with peers, and responded to questions. These observations support the feasibility of using interactive AR activities to promote classroom participation. However, because the teacher also served as the observer and no independent observer was used, the findings may be affected by observer expectancy. They should therefore be considered supportive descriptive evidence rather than an independent causal measure of the effect of Prism AR.

The observation findings indicate that the use of Prism AR successfully enhanced the engagement of Year 3 Al-Farabi pupils during the teaching and learning process. Based on the teacher's observations, the majority of pupils were classified as Very Active. They paid close attention while the teacher explained the lesson content, followed instructions appropriately, and actively participated in each activity. In addition, pupils demonstrated good cooperation during group activities, showed confidence in expressing their ideas, and responded actively to questions posed by the teacher.

These findings are consistent with the study by Manikam and Siti Mistima Maat (2023), which reported that the use of Augmented Reality (AR) in Mathematics teaching and learning can enhance pupil engagement, motivation, and understanding because the technology provides clearer visualisations of abstract concepts. In addition, Haliza Idris and Mohd Nazri Abdul Rahman (2022) reported that integrating Augmented Reality technology into Mathematics learning creates a more interactive learning environment, increases pupils' interest, and encourages active participation in learning activities.

Therefore, the observation findings clearly demonstrate that the use of Prism AR represents an effective approach for helping Year 3 Al-Farabi pupils understand prism and non-prism shapes in three-dimensional (3D) form while simultaneously enhancing their engagement throughout the teaching and learning sessions.

Findings from the Questionnaire

The questionnaire was administered to 23 Year 3 Al-Farabi pupils following the implementation of the intervention using Prism AR. The instrument aimed to assess pupils' perceptions of the effectiveness of Prism AR in the teaching and learning process. The questionnaire employed a five-point Likert scale: 1 (Strongly Disagree), 2 (Disagree), 3 (Neutral), 4 (Agree), and 5 (Strongly Agree).

The data were analysed based on the percentage of positive pupil responses, which consisted of the combined scores for 4 (Agree) and 5 (Strongly Agree). **Table 5** presents a summary of the percentage of positive pupil responses for each assessed aspect.

Table 5. Summary of Positive Pupil Responses Towards the Use of Prism AR

Assessment Aspect	Item/Section	Positive Responses (4+5)	Total Responses	Percentage of Agreement (%)
Learning Understanding	Section A	113	138	82
Teacher's Instructional Method	Section B	60	69	87
Pupils understand the characteristics of prisms	Item A3	17	23	74
Pupils enjoy learning	Item A6	20	23	87

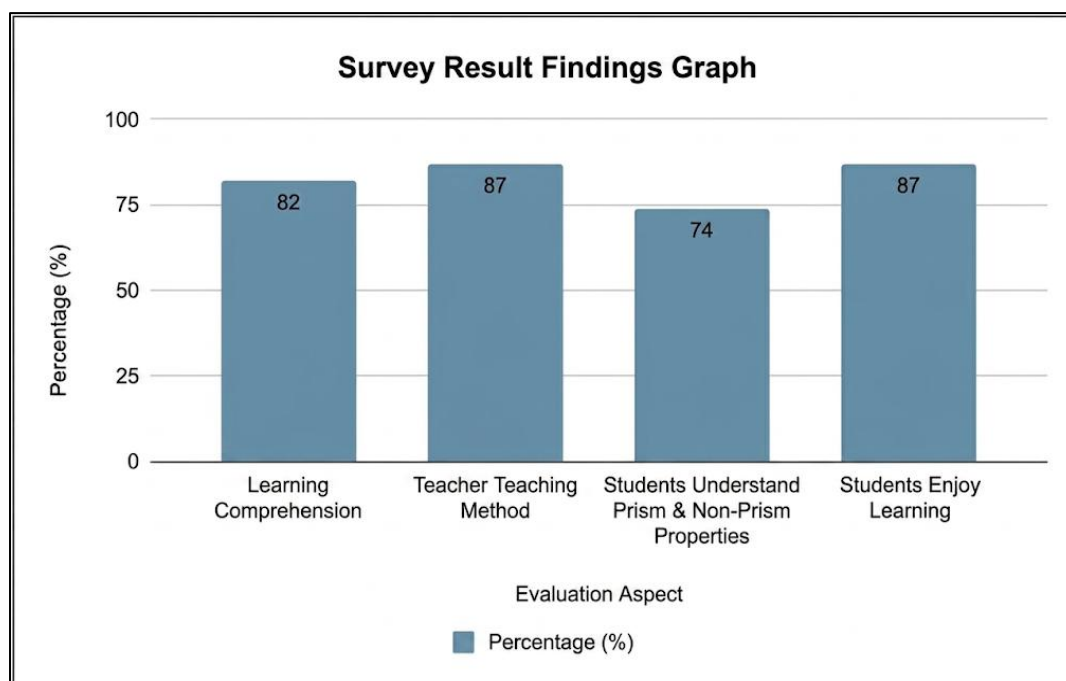


Figure 1. Percentage of Positive Pupil Responses

Based on **Table 5** and **Figure 1**, the findings indicate that the majority of pupils provided positive responses towards the use of Prism AR in learning. The aspects of the teacher's instructional method and pupils' enjoyment of learning recorded the highest percentage, with both reaching 87%. This was followed by learning understanding at 82%, while pupils' understanding of the characteristics of prisms and non-prisms recorded 74%.

Overall, these findings demonstrate that Prism AR was well received by the pupils. The high percentages recorded for enjoyment of learning and the teacher's instructional method indicate that Prism AR can make the teaching and learning process more engaging and interactive while supporting the teacher in delivering the lesson effectively.

The questionnaire results indicate that pupils generally perceived the Prism AR-based lessons positively. Learning understanding recorded 82% positive responses, suggesting that most pupils felt the activities helped them recognise, differentiate, and understand prism and non-prism shapes. These responses represent pupils' perceptions rather than an objective measure of learning gain and should be interpreted alongside the test and observation findings.

Pupil enjoyment and perceptions of the teacher's instructional method each recorded 87% positive responses. These results suggest that the intervention was acceptable and engaging to the participating pupils. However, the questionnaire was administered immediately after the intervention and may be influenced by novelty, social desirability, teacher-pupil relationships, and enthusiasm for using digital devices. The findings therefore support acceptability and perceived usefulness, but do not independently demonstrate causal effectiveness.

In addition, the pupil enjoyment aspect recorded 87%, indicating that the use of Prism AR successfully created a more engaging and enjoyable learning environment. The use of interactive technology enabled pupils to explore objects more actively, thereby increasing their interest and engagement during the learning activities. The teacher's instructional method also recorded 87%, indicating that pupils had a positive perception of the instructional approach employed. This finding demonstrates that Prism AR functioned as an appropriate and effective intervention to assist the teacher in delivering lesson content in a more systematic, clear, and comprehensible manner.

Overall, the questionnaire findings provide positive descriptive evidence regarding pupils' perceived understanding, enjoyment, and the teacher's instructional approach. Accordingly, Objective 3 was addressed at the level of classroom perception and descriptive outcome data. Stronger claims of effectiveness require validated instruments, inferential analysis, and a design capable of comparing Prism AR with an appropriate alternative instructional condition.

Overall, the questionnaire findings demonstrate that the use of Prism AR successfully enhanced pupils' understanding, enjoyment of learning, and perceptions of the effectiveness of the teacher's instructional process. Therefore, Objective 3, which was to evaluate the effectiveness of Prism AR in the teaching and learning process, was successfully achieved.

Taken together, the pre-post tests, observations, and questionnaire suggest that the intervention objectives were achieved within the participating class. The mean achievement score increased from 31.6% to 57.8%, and most pupils displayed positive engagement and perceptions. Nevertheless, these converging data sources do not remove the limitations of the one-group action research design. The observed changes may have resulted from the combined instructional package, including Prism AR, teacher guidance, repeated practice, peer collaboration, and the Interactive Prism and Non-Prism Board.

Based on the findings of the study, the use of the Prism Augmented Reality intervention during the teaching and learning sessions successfully fulfilled all the research objectives. The intervention also produced a positive impact on Year 3 pupils' mastery of the topic of prism and non-prism shapes. Based on the analysis of the pre- and post-tests, the mean achievement score of the Year 3 Al-Farabi pupils increased from 31.6% in

the pre-test to 57.8% in the post-test. This improvement indicates that the intervention successfully helped pupils identify three types of prisms, namely square prisms, rectangular prisms, and triangular prisms.

In addition to the improvement in achievement, teacher observations also revealed noticeable changes in pupils' engagement during the teaching and learning process. Before the intervention, some pupils were less active during the teaching and learning sessions. They provided limited responses to the teacher's questions and experienced difficulties in visualising prism shapes because they relied primarily on two-dimensional images in textbooks. This situation reduced their confidence in identifying the characteristics of and differentiating between prism and non-prism shapes.

Following the intervention, pupils appeared more focused, enthusiastic, and interested in the learning activities. They also demonstrated greater confidence in answering questions, expressing ideas, and collaborating effectively to complete the assigned tasks. Throughout the learning sessions, pupils followed the teacher's instructions appropriately, paid attention during explanations, and actively participated in each activity involving the Prism AR application.

Implementation also highlighted practical issues that should be considered before wider adoption. AR-based learning depends on adequate access to compatible devices, stable Internet connectivity or offline alternatives, and sufficient technical support. Teacher readiness is equally important because educators require time and confidence to prepare AR materials, manage devices, troubleshoot technical problems, and integrate the technology with curriculum objectives rather than using it only for novelty. Sustainability may also be affected by device maintenance, platform availability, software updates, and the time required to develop or revise AR content. Future implementation should therefore include teacher training, device-sharing procedures where necessary, backup non-AR activities, and user-friendly platforms such as WebAR that reduce technical barriers.

Future research should test the intervention with larger and more diverse samples across multiple schools and over a longer period. A quasi-experimental or experimental design with a comparison group receiving the same content and teacher support without AR would help distinguish the specific contribution of Prism AR from repeated exposure and general instructional guidance. Future studies should also report formal evidence of instrument validity and reliability and, where appropriate, use inferential statistics and effect-size estimates to evaluate the magnitude and uncertainty of pre-post differences.

To further enhance the effectiveness of this action research, the researcher recommends strengthening the use of the Prism AR application by providing alternative platforms in addition to AR Studio to ensure that teaching and learning can continue in the event of technical disruptions. In addition, the WebAR platform should be designed with a more user-friendly interface to facilitate teachers' use of the application without requiring prior knowledge or basic coding skills. With a more stable and accessible platform, the use of Prism Augmented Reality is expected to be implemented more effectively and contribute to the enhancement of Mathematics learning in the future.

Overall, this one-cycle action research found improved test performance, high observed engagement, and positive pupil perceptions following a Prism AR-based intervention for prism and non-prism learning. These findings provide useful preliminary evidence for classroom practice, but they should not be interpreted as proof that Prism AR alone caused the observed improvements because the study involved only 23 pupils from one class and did not include a comparison group.

Prism AR has pedagogical potential because interactive three-dimensional representations can support a progression from visual exploration to spatial visualisation, comparison of geometric attributes, and conceptual understanding. Within this study, however, the contribution of AR was embedded within teacher guidance and reinforcement activities. Prism AR should therefore be regarded as a promising digital teaching aid whose effectiveness requires further confirmation under more rigorous research conditions.

The principal limitations are the small single-class sample, one-cycle implementation, absence of a control or comparison group, reliance on descriptive statistics, teacher-led observation, and the lack of formal psychometric evidence for the questionnaire and observation checklist. These limitations restrict causal interpretation and generalisability. Future studies should involve larger samples from multiple schools, longer intervention periods, validated and reliable instruments, independent observers, and quasi-experimental or experimental comparison groups. Inferential analyses and effect-size estimates should also be considered. In addition, future research should examine practical sustainability, including device availability, teacher readiness, technical support, connectivity, platform stability, and the long-term integration of AR into routine classroom practice.

The use of Augmented Reality (AR) technology successfully provided a more interactive and meaningful learning experience through the visualisation of three-dimensional objects, thereby helping pupils understand prism concepts more clearly. The intervention not only improved pupils' understanding of geometric concepts but also enhanced their motivation, confidence, and interest in Mathematics learning. Therefore, Prism AR has the potential to serve as an effective digital teaching aid for teaching prism and non-prism topics in primary schools.

Nevertheless, this study was limited to a single class and was implemented within one action research cycle. Therefore, future studies could involve a larger number of participants, a longer implementation period, and the application of Prism AR to other geometry topics. It is hoped that the findings of this study will provide useful guidance for teachers in integrating digital technology more effectively to create Mathematics teaching and learning experiences that are enjoyable, meaningful, and aligned with the demands of 21st-century education.

REFERENCES

1. Ahmad, N. I. N., & Junaini, S. N. (2020). Augmented reality for learning mathematics: A systematic literature review. *International Journal of Emerging Technologies in Learning*, 15(16), 106–122. <https://doi.org/10.3991/ijet.v15i16.14961>
2. Akçayır, M., & Akçayır, G. (2017). Advantages and challenges associated with augmented reality for education: A systematic review of the literature. *Educational Research Review*, 20, 1–11. <https://doi.org/10.1016/j.edurev.2016.11.002>
3. Bruner, J. S. (1966). *Toward a theory of instruction*. W. W. Norton & Company.
4. Bulut, M., & Borromeo Ferri, R. (2023). A systematic literature review on augmented reality in mathematics education. *European Journal of Science and Mathematics Education*, 11(3), 556–572. <https://doi.org/10.30935/scimath/13124>
5. Erşen, Z. B., & Alp, Y. (2024). A systematic review of augmented reality in mathematics education in the last decade. *Malaysian Online Journal of Educational Technology*, 12(1), 15–31. <https://doi.org/10.52380/mojet.2024.12.1.476>
6. Hidayat, R., Samsudin, S., Wang, X., & Rahman, S. N. A. (2026). Augmented reality in science, technology, engineering and mathematics education: A meta-analysis. *Journal of Computer Assisted Learning*, 42(1), Article e70164. <https://doi.org/10.1002/jcal.70164>
7. Idris, H., Md Nor, M., & Abdul Rahman, M. N. (2022). Modul matematik awal pembelajaran STEM berkonsepkan flipped classroom menggunakan augmented reality. *JuKu: Jurnal Kurikulum & Pengajaran Asia Pasifik*, 10(4), 1–15.
8. İslim, Ö. F., Namlı, Ş., Sevim, N., Özçakır, B., & Lavicza, Z. (2024). Augmented reality in mathematics education: A systematic review. *Participatory Educational Research*, 11(4), 115–139. <https://doi.org/10.17275/per.24.52.11.4>
9. Kemmis, S., & McTaggart, R. (1988). *The action research planner*. Deakin University Press.
10. Kementerian Pendidikan Malaysia. (2026). *Falsafah pendidikan kebangsaan*. <https://www.moe.gov.my/index.php/falsafah-pendidikan-kebangsaan>
11. Manikam, R., & Maat, S. M. (2023). Sorotan literatur bersistematis: Trend augmented reality dalam pengajaran dan pembelajaran matematik. *Malaysian Journal of Social Sciences and Humanities (MJSSH)*, 8(1), e002046. <https://doi.org/10.47405/mjssh.v8i1.2046>

12. Muhammad, H., Musa, N. A., Ahmad, A., Adamu, N., & Adamu, N. (2026). The role of augmented reality (AR) in enhancing conceptual understanding of geometry in mathematics education: Systematic review. *International Journal of Education, Management, and Technology*, 4(1), 29–47. <https://doi.org/10.58578/ijemt.v4i1.8073>
13. Souza, L. P., & Jucá, S. C. S. (2024). Insertion of augmented reality in mathematics teaching: A systematic literature review. *Revista Contexto & Educação*, 39(121), Article e14831. <https://doi.org/10.21527/2179-1309.2024.121.14831>
14. Voulgari, N., Panagopoulos, M., & Garneli, V. (2025). A systematic review of augmented reality in mathematics education: Fostering learning through art integration. *Arts & Communication*, 3(2), Article 4446. <https://doi.org/10.36922/ac.4446>
15. Yang, Y., Du, W., Mavrikis, M., & Geraniou, E. (2026). Spatial skill development through augmented reality in mathematics education: A scoping review. *Digital Experiences in Mathematics Education*, 12, 277–310. <https://doi.org/10.1007/s40751-025-00187-8>