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# Short-Term Changes in Geometry Scores After Using Shapify It!: A Reanalysis of Archived Data from a Malaysian Year Two Classroom

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## ABSTRACT

This paper reanalyses an archived classroom report on Shapify It!, a marker-based mobile augmented-reality activity used with 30 Year Two students in a Malaysian public primary school. The original intervention included four 60-minute sessions over one month. Students scanned cards showing selected two-dimensional and three-dimensional shapes, viewed digital shapes on Android smartphones, and completed structured practice. The original test papers and electronic data were unavailable; therefore, the pretest and posttest percentages for each student were reconstructed from the numerical labels in the archived score chart and verified by reproducing the reported group statistics. The mean score increased from 31.33% (SD = 17.37) to 47.67% (SD = 14.31), and the median increased from 30% to 50%. Twenty-three students improved, six showed no change, and one obtained a lower score. Among the 24 students with a non-zero change, an exact two-sided sign test showed that positive changes were much more common ($p < .001$); sensitivity analyses gave the same direction. The findings show a short-term increase after an instructional package that combined the application, classroom teaching, repeated exposure, and practice. They do not establish that augmented reality caused the increase or improved spatial reasoning. Methodologically, the paper demonstrates a transparent approach to reanalysing an incomplete classroom archive by documenting data provenance, verifying reconstructed values, mapping available and missing evidence, and separating description from causal inference. The one-group design, unclear participant selection, undocumented assessment properties, limited implementation records, absent retention and transfer measures, and unconfirmed original ethics and consent documentation restrict interpretation. The study provides exploratory evidence from a less studied lower-primary context and practical recommendations for stronger research and documentation.

**Keywords**: augmented reality; geometry education; lower-primary education; Malaysia; archived data

## INTRODUCTION

Early geometry learning involves more than naming common shapes. Students need to notice important properties, compare examples and non-examples, view shapes from different positions, and connect drawings, physical objects, gestures, and mathematical terms. Young students may first group shapes by their overall appearance instead of their defining properties (Clements et al., 1999). Teaching should therefore include activities that help students compare, combine, separate, classify, and mentally move two-dimensional (2D) and three-dimensional (3D) shapes (Clements & Sarama, 2011; Sinclair & Bruce, 2015).

These skills are linked to spatial reasoning, which is the ability to understand and mentally change visual information. Spatial reasoning is related to mathematics achievement and can improve through planned teaching. However, the results depend on the tasks and the representations used (Lowrie et al., 2021; Woolcott et al., 2022). For example, a flat drawing of a cube, pyramid, cone, or cuboid does not show depth clearly. Students must imagine its faces, edges, vertices, position, and different views.

Mobile augmented reality (AR) places digital information over a view of the real environment. A printed marker can be scanned to show a digital object on a screen. Reviews and meta-analyses often report positive learning results, but the effects differ by subject, age group, device, and teaching design (Buentello-Montoya et al., 2021; Chang et al., 2022; Garzón et al., 2020; Li et al., 2023). Technology is more useful when it supports a clear mathematics goal instead of being used mainly because it is new or exciting (Aslan et al., 2024; Dilek Eryigit et al., 2025).

There is still limited evidence from lower-primary classrooms, especially for low-cost marker-based applications used in normal school lessons. Recent studies have reported promising results for geometry and spatial learning among younger students (Nadzeri et al., 2024; Wang et al., 2025). However, reviews continue to report weaknesses in assessment quality, explanations of learning processes, usability studies, and long-term evidence (Law & Heintz, 2021; Yang et al., 2026).

In the Malaysian Year Two mathematics curriculum, the Space strand expects students to identify three-dimensional shapes from their characteristics, relate basic shapes to bases and nets, identify and draw specified two-dimensional shapes, and solve routine and non-routine problems in daily contexts. The listed three-dimensional shapes include the cube, cuboid, square-based pyramid, cylinder, and cone, while the listed two-dimensional shapes include the square, rectangle, triangle, and circle (Ministry of Education Malaysia, 2017).

Malaysia's Digital Education Policy also promotes digital fluency, infrastructure, quality content, and educator capacity (Ministry of Education Malaysia, 2023). These national intentions do not, however, establish how commonly AR is used in Year Two mathematics. No nationally representative benchmark for Year Two geometry performance or AR adoption was available to this reanalysis. The Malaysian context is therefore described through curriculum and policy expectations rather than unsupported claims about typical scores or routine AR use.

This paper does not report a new experiment. It reanalyses an archived classroom innovation report on Shapify It!, an Android marker-based AR application used in the Malaysian Year Two topic of Shapes and Space. The archived report included group statistics and a chart of individual scores, but it gave limited information about participant selection, the assessment, and the classroom procedures.

### Research Objective and Question

This study aimed to describe the archived intervention, rebuild the pretest-posttest score pattern, and interpret the results carefully. The research question was: How did the teacher-developed classroom geometry scores change from pretest to posttest after the Shapify It! intervention?

### Contribution of the Study

This study makes four limited but useful contributions. First, it reports evidence from a Malaysian lower-primary mathematics classroom, a context that appears less often in international AR research. Second, it shows that a simple marker-based activity can be implemented in an ordinary classroom, although this does not establish effectiveness or feasibility across schools. Third, it reports the reconstructed paired score pattern openly and distinguishes the evidence that was preserved from information that was not. Fourth, it provides a methodological exemplar for responsible reanalysis of incomplete classroom records: identify the source and provenance of every value, reconstruct only observable information, verify the reconstruction against reported summaries, map available and missing documentation, select analyses that fit the data limitations, and separate empirical description from causal or process claims. The study does not validate Shapify It!, prove a new learning process, or show that AR caused the score increase.

# LITERATURE REVIEW

## Early Geometric Thinking and Multiple Representations

Young students often recognise shapes by their usual appearance before they can explain their defining properties. Clements et al. (1999) found that children's understanding of shapes can change when the shapes are rotated or shown in less familiar forms. Clements and Sarama (2011) therefore recommend learning activities that begin with students' current ideas and gradually develop clearer geometric understanding. Sinclair and Bruce (2015) also argue that primary geometry should go beyond learning names. Students should combine, separate, classify, compare, transform, and mentally move shapes.

Different representations show different parts of a mathematics idea. Physical models can be touched and viewed from several directions. Printed diagrams stay in one place but may not show depth clearly. Digital overlays can show an object on the camera screen. Learning does not happen simply because an image is more colourful or realistic. Students need to connect the representations and notice the properties that stay the same. In this study, AR is treated as one extra visual representation within a wider lesson.

## Marker-Based AR as External Representational Support

A marker-based AR display links a printed card to a digital object on a screen. This may make it easier for students to see depth that is difficult to imagine from a flat drawing. This paper uses the term external visual support instead of formal scaffolding because the archived report did not describe support that changed according to student needs or was gradually removed.

Studies of AR in mathematics have reported positive results for geometry achievement, 3D thinking, learning behaviour, and motivation (Bhagat et al., 2021; Ibáñez et al., 2020; İbili et al., 2020; Koparan et al., 2023). However, the design of the task and the ease of using the technology are important. Small screens, poor tracking, difficult controls, or too much information can make learning harder instead of easier (Law & Heintz, 2021).

## Conditions and Limits of Existing Evidence

Meta-analyses show that the teaching approach affects AR learning outcomes. New technology alone should not be treated as the reason for learning (Garzón et al., 2020). Studies comparing display formats also show that a more immersive display is not always better. Its value depends on the student and the task (Krüger et al., 2022; Walkington et al., 2025). The important question is whether AR provides useful support beyond physical models, drawings, or ordinary digital images.

The archived Shapify It! report supports only a simple sequence. Students scanned printed shape cards, viewed a digital shape on an Android screen, and completed structured practice. The report did not record students' attention, mental images, explanations, or transfer to new tasks. Therefore, this study examines score changes only and does not claim to explain how the learning happened.

## Assessing Early Geometry and Spatial Reasoning

Assessment of early geometry should examine more than the naming of familiar prototypes or a single total score. Young learners may recognise a square, triangle, rectangle, or circle in its usual orientation yet reject an atypical example when orientation, aspect ratio, skewness, or size changes. Stronger assessments therefore use canonical and non-canonical examples, rotated figures, examples and non-examples, and prompts that require students to explain defining properties rather than rely only on visual resemblance (Aslan & Aktaş Arnas, 2007; Clements et al., 1999). Tasks involving composition, decomposition, viewpoint, mental transformation, and transfer are also needed when the intended construct includes spatial reasoning.

Geometry knowledge, geometry problem solving, and visuo-spatial abilities are related but not interchangeable constructs (Fastame, 2021; Woolcott et al., 2022). For a pretest-posttest score to support a clear interpretation, the instrument record should identify the item content, maximum raw score, marking scheme, curriculum mapping, evidence of content validity and reliability, scoring consistency, and whether the same test or an

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equivalent form was administered twice. Without these details, a percentage change cannot be attributed to a specific geometric construct and may also reflect test familiarity, scoring variation, or differences in content coverage.

# METHODOLOGY

## Study Design and Archival Source

This study is a secondary analysis of an archived classroom intervention report. The original activity used a one-group pretest-posttest design in a public primary school in Kuala Selangor, Malaysia. This design can show change within one group, but it cannot rule out other reasons for the change. These may include taking the test twice, normal development, other teaching, teacher attention, practice, participant selection, or regression to the mean. Therefore, the results are described as changes after the intervention, not as proof that Shapify It! caused them.

## Context and Participants

The archived report included complete pretest and posttest scores for 30 Year Two students. Observation, interviews, a diagnostic test, practice questions, and a pretest were used to identify difficulties with 2D and 3D shape questions. However, the report did not explain whether the 30 students were one whole class or were chosen because of low early scores. It also did not report their ages, gender, total class enrolment, attendance, previous technology experience, or withdrawals. Therefore, the sample should not be treated as representative of all Malaysian Year Two students.

## Curriculum Context

The archived report placed the activity in the Malaysian Year Two Shapes and Space topic. The national curriculum expects students to identify three-dimensional shapes from their characteristics; identify basic shapes associated with their bases and nets; identify and draw specified two-dimensional shapes; and solve routine and non-routine problems in daily contexts. It lists the cube, cuboid, square-based pyramid, cylinder, and cone as three-dimensional shapes and the square, rectangle, triangle, and circle as two-dimensional shapes (Ministry of Education Malaysia, 2017). The archive named the square, triangle, pyramid, cone, and cuboid, indicating partial rather than complete coverage of the listed curriculum content. It did not preserve the exact learning standard addressed in each session, the full range of shape properties taught, or an item-by-standard test blueprint. Consequently, the score increase cannot be interpreted as mastery of the complete Year Two Space strand.

## Shapify It! Application and Intervention

Shapify It! was described as a marker-based mobile AR application for Android smartphones. Students scanned printed cards showing selected 2D and 3D shapes, and a digital shape then appeared on the screen. The archive did not show whether students could rotate or move the digital shape or whether it included labels or animation. It also did not report the developer, software version, development system, device compatibility, validation process, public availability, or intellectual-property status.

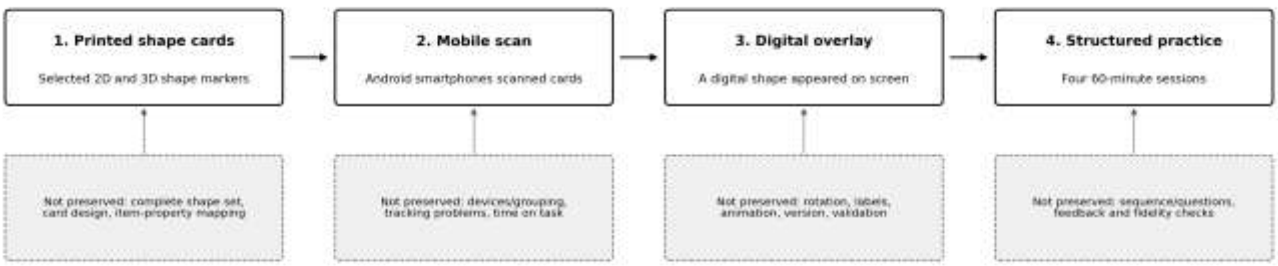


**Fig. 1. Reconstructed sequence and documentation gaps. Solid arrows show documented steps; dashed callouts show details not preserved. The figure is a documentation map, not a tested causal model.**

The intervention included four 60-minute sessions over one month. Students learned how to use the application and completed structured practice. The archive did not keep the objectives for each session, the number of students per device, grouping arrangements, teacher questions, feedback methods, actual AR use time, technical problems, or checks that the intervention was delivered as planned. Table I separates the information that was available from the information that was missing.

**Table I: Available And Missing Information About The Intervention**

| Element | Documented information | Information missing from the archive |
|---|---|---|
| Classroom and content | Year Two classroom; selected 2D and 3D shapes | Exact learning standard and full content coverage |
| Platform | Marker-based Android smartphone application | Developer, version, development system, compatibility, availability, and validation |
| Shapes | Square, triangle, pyramid, cone, and cuboid | Whether other shapes, properties, or interactions were included |
| Duration | Four 60-minute sessions over one month | Attendance, actual AR use time, and checks that the intervention was delivered as planned |
| Learning activity | Scanning cards, viewing digital shapes, and structured practice | Session order, teacher questions, grouping, feedback, and independent practice |
| Test timing | Pretest before the sessions and posttest after the intervention | Exact time interval and whether the same or an equivalent test was used |

### Outcome Measure

A teacher-developed classroom geometry assessment was administered before and after the intervention, and the archive reported percentage scores. The number and type of items, maximum raw score, marking guide, test blueprint, sample questions, content-validation process, reliability evidence, scoring checks, and construct-validity evidence were not preserved. It was also unclear whether the same test or an equivalent form was used twice. These omissions prevent evaluation of item difficulty, curriculum coverage, score precision, form equivalence, and possible practice effects. They also prevent determination of whether the score represented prototype recognition, knowledge of defining properties, two-dimensional and three-dimensional reasoning, spatial transformation, or a mixture of these outcomes. The outcome is therefore described only as a teacher-developed classroom geometry score, not as a validated measure of spatial visualisation, conceptual understanding, or curriculum mastery.

### Data Reconstruction and Integrity Checks

The percentage scores for each student were copied by hand from the numerical labels under the original pretest-posttest chart. Each value was checked twice. The reconstructed data produced the same pretest and posttest means and standard deviations as the archived report. The anonymous paired scores are shown in Appendix A. Because the original test papers and electronic data were not available, this is a reconstruction from a chart, not a reanalysis of the original raw data.

**Data Analysis**

The main analysis used simple descriptive statistics: means, standard deviations, medians, interquartile ranges, score ranges, and the number of students whose scores increased, stayed the same, or decreased. The reconstructed scores were based on a small sample and included repeated values and zero changes. Therefore, an exact two-sided sign test was used as the main test of whether positive changes were more common than negative changes. An exact 95% confidence interval for the probability of a positive change was also calculated.

A Wilcoxon signed-rank test was added as a sensitivity analysis. Zero changes were removed, and tied absolute changes received average ranks. A two-sided normal approximation without a continuity correction was used. A paired-samples t test and a 95% confidence interval for the mean change were also reported as a second sensitivity analysis. The analyses were completed after the data were examined, using Python and SciPy. They were not preregistered and should be treated as exploratory descriptions of the archived score pattern.

**Ethical Considerations**

No new data were collected, and the researchers had no new contact with the students. This secondary analysis used anonymous percentages from an archived classroom report; names, photographs, and other direct identifiers were not used. The Malaysian Code of Responsible Conduct in Research provides a national framework for responsible and transparent research practice (Academy of Sciences Malaysia, 2020), and UPSI's research ethics procedures state that research involving human participants or human-related data and records is subject to ethics review requirements and provides guidance on participant information and consent (Research Management and Innovation Centre, 2026). For prospective school research involving children, formal ethics approval, school authorisation, parent or guardian consent, child assent, confidentiality safeguards, and data-retention procedures should be recorded before data collection. The archive did not contain documents confirming formal ethics review, school permission, parent or guardian consent, or child assent for the original classroom activity. Compliance cannot be inferred retrospectively. The anonymous and non-contact nature of the present secondary analysis reduces current privacy risk but does not repair the missing documentation for the original activity.

## RESULTS

Pretest scores ranged from 0% to 70%, while posttest scores ranged from 20% to 80%. The mean increased by 16.33 percentage points, from 31.33% (SD = 17.37) to 47.67% (SD = 14.31). The median increased from 30% to 50%. Twenty-three students (76.7%) had higher posttest scores, six students (20.0%) had no change, and one student (3.3%) had a lower score.

**Table II: Summary Of Pretest, Posttest, And Score Changes**

| Measure | n | Mean | SD | Median | IQR |
|---|---|---|---|---|---|
| Pretest score (%) | 30 | 31.33 | 17.37 | 30.00 | 20.00 |
| Posttest score (%) | 30 | 47.67 | 14.31 | 50.00 | 17.50 |
| Change (posttest - pretest) | 30 | 16.33 | 16.29 | 10.00 | 17.50 |

Six students had no score change, leaving 24 students with a positive or negative change. Among these 24 students, 23 improved and one obtained a lower score. The exact two-sided sign test gave $p < .001$. The exact 95% confidence interval for the probability of a positive change was [0.789, 0.999]. This result shows that positive changes were much more common than negative changes, but it does not explain why the scores changed.

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The Wilcoxon sensitivity analysis gave a smaller signed-rank statistic of 6.50, $p < .001$. The matched-pairs rank-biserial coefficient was $r_{r\beta} = .957$, which shows that most non-zero differences were positive. The paired-samples sensitivity analysis gave $t(29) = 5.49$, $p < .001$. The mean increase was 16.33 percentage points, 95% CI [10.25, 22.42], and $d^z = 1.00$. These results should be interpreted carefully because the scores were reconstructed and the assessment was not fully documented.

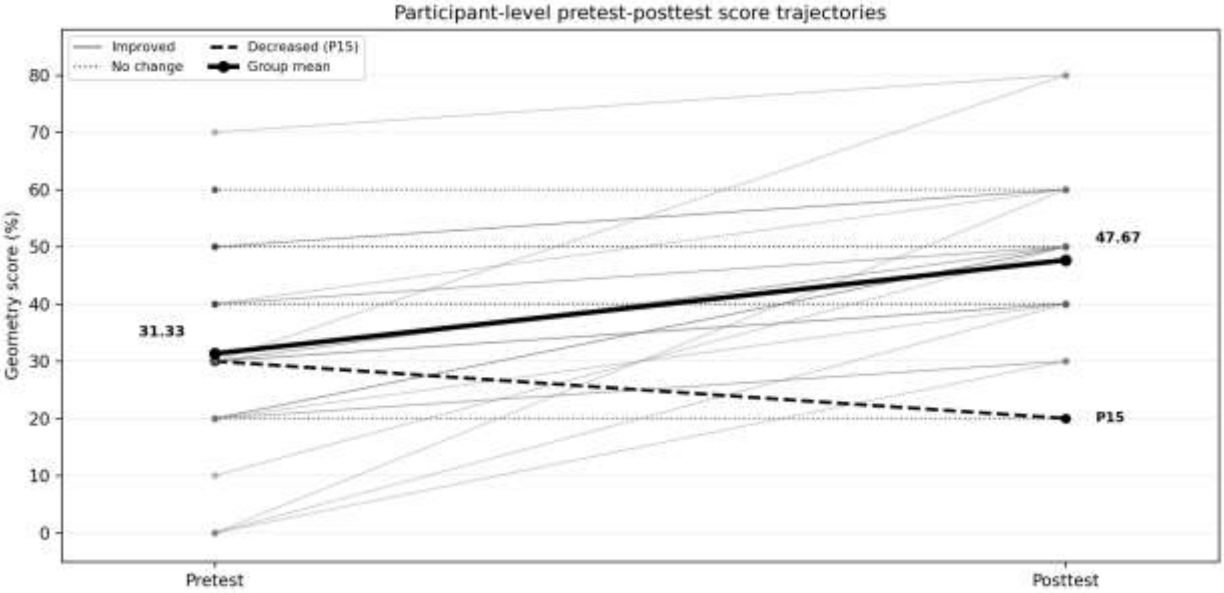


**Fig. 2. Paired pretest-posttest geometry scores for the 30 students. Light solid lines show improvements, dotted lines show no change, the black dashed line identifies the single decrease (Participant 15), and the bold line shows the group mean. The trajectories describe score movement only and do not identify its cause.**

Although the overall scores increased, the posttest mean was still only 47.67%. Therefore, the study shows a short-term improvement in the archived classroom scores, not high mastery or a full solution to the students' learning difficulties.

## DISCUSSION

### Interpretation of the Archived Score Pattern

The clearest result is that classroom geometry scores generally increased after the four Shapify It! sessions. More than three-quarters of the students obtained higher scores. Only one student with a score change had a lower result, and both the mean and median increased. This pattern suggests that the full instructional package may have supported learning. However, the package included the application, repeated exposure, classroom teaching, and practice. The design cannot show which part produced the change.

The posttest mean of 47.67% is also important. A statistically significant increase does not mean that students had developed strong conceptual understanding. Some students may still have depended on familiar shape appearances, struggled when shapes were rotated, or been unable to use their learning in new tasks. These possibilities cannot be examined because the archive did not include item-level answers, interviews, drawings, or transfer tasks.

### Relation to Early Geometry and AR Research

One possible explanation is that the phone display provided an additional visual representation of the selected shapes. This interpretation is consistent with research supporting multiple representations and movement beyond prototype recognition in early geometry (Clements et al., 1999; Sinclair & Bruce, 2015). It also aligns with studies reporting benefits from technology-supported geometry and spatial activities (Aslan et al., 2024; Ibáñez et al., 2020; İbili et al., 2020; Nadzeri et al., 2024; Wang et al., 2025). However, the archived study did not measure spatial reasoning, attention to defining properties, mental rotation, or how students connected the printed marker, digital display, and classroom explanation. The proposed representational explanation is therefore plausible but was not directly tested.

Comparative evidence does not support a universal hierarchy in which AR is automatically better than physical or ordinary digital representations. Gecu-Parmaksiz and Delialioglu (2019) found stronger outcomes for AR-based virtual manipulatives than physical manipulatives on several preschool shape-recognition outcomes, although both groups improved. Demitriadou et al. (2020) reported advantages for virtual and augmented environments over printed material in a primary geometry lesson but no significant difference between the two immersive formats. Other work has directly compared ICT with physical manipulatives for three-dimensional geometry (Đokić et al., 2022), while Wu et al. (2024) found that AR mathematical picture books outperformed ordinary picture books and mathematical texts for geometric thinking, flow, and cognitive load. Studies comparing tablet and head-mounted AR also show that the value of dimensionality depends on the specific outcome and task (Walkington et al., 2025). Taken together, these findings justify a controlled comparison rather than an assumption of AR superiority. The archive did not preserve enough information to determine whether Shapify It! added value beyond a well-designed physical model, printed diagram, or ordinary rotatable digital image.

**Contextual Contribution and Practical Implications**

The main contribution of this study is its contextual and methodological transparency rather than proof of cause and effect. It reports an example from a Malaysian lower-primary classroom, shows that a low-cost marker-based Android activity was incorporated into ordinary lessons, and demonstrates how incomplete classroom records can be reanalysed without presenting missing information as known. This is relevant to teacher-led innovation because classroom projects often preserve summary charts and descriptions but not the documentation needed for reproducibility, ethical verification, or construct-level interpretation. The study therefore contributes both a limited score pattern and an example of disciplined evidential boundaries.

In future classroom use, Shapify It! should be one part of a wider geometry lesson. Teachers could ask students to predict the scanned shape, name its defining properties, compare the digital display with a physical model or drawing, and then complete a similar task without the phone. These suggestions were not tested in the archived intervention. Future studies should record student grouping, access to devices, teacher questions, time on task, technical problems, and whether the planned intervention was followed.

**Methodological Implications for Classroom Innovation Records**

A classroom innovation record should preserve enough information for another researcher or teacher to understand what was done and what the resulting score means. At minimum, the record should include participant flow and selection criteria; dates, attendance, and withdrawals; ethics approval and permission records; parent or guardian consent and child assent where applicable; the complete pretest and posttest instruments, marking guide, item blueprint, and validation evidence; the intervention protocol for every session; grouping and device allocation; application name, version, functions, and technical incidents; teacher questions, feedback, time on task, and fidelity checks; de-identified participant-level data; and an analysis record. Retention and transfer assessments should be planned rather than added only after immediate score changes are observed.

The present reanalysis illustrates a salvage workflow when those records are incomplete: state the archive's provenance, distinguish original from reconstructed data, reproduce reported statistics as an integrity check, publish the reconstructed values, use analyses suitable for the observed score pattern, and identify every unsupported inference. This approach cannot replace a well-documented prospective study, but it can make limited historical evidence auditable and prevent a classroom success narrative from becoming an unsupported causal claim.

**Limitations**

Several limitations affect the conclusions. First, the one-group design cannot separate the instructional package from repeated testing, normal development, concurrent teaching, teacher attention, practice, or regression to the mean. Regression to the mean is particularly relevant because the archive stated that several diagnostic activities and a pretest identified learning difficulties but did not document whether the 30 students were selected because of low initial performance. When a group is selected partly for unusually low scores, some scores may rise on retesting even without an effective intervention. The observed pattern of 23 improvements, six unchanged scores, and one decrease does not remove this possibility. A comparison group, random or clearly documented inclusion, or repeated baseline measurements would be needed to distinguish intervention-related change from this statistical explanation. Second, the sample came from one classroom, and demographic information, total enrolment, attendance, previous technology experience, and withdrawals were unavailable.

Third, the assessment was not described well enough to judge its content coverage, marking consistency, reliability, validity, form equivalence, or sensitivity to repeated testing. The missing items and scoring documentation make it impossible to identify which geometric ideas changed or to compare the scores with a curriculum benchmark. Fourth, the student scores were reconstructed from a chart rather than taken from original data files. Fifth, only an immediate posttest was preserved; retention, transfer, usability, engagement, classroom discourse, and student strategies were not measured. Sixth, the intervention record omitted grouping, teacher prompts, feedback, application functions, actual AR exposure, technical problems, and fidelity. Finally, the archive did not contain enough evidence to confirm the ethical procedures used in the original activity. These limitations restrict the paper to a transparent description of short-term score change.

## CONCLUSION AND RECOMMENDATIONS

This reanalysis of archived data found a clear short-term increase in teacher-developed geometry scores after four classroom sessions that used Shapify It!. Twenty-three of the 30 students improved, six had no change, and one obtained a lower score. The pattern is consistent with the possibility that marker-based mobile AR provided extra visual support as part of the full lesson. However, the study does not prove that Shapify It! caused the improvement or explain the learning process. The findings should be viewed as transparent exploratory evidence that supports a stronger future study, not as proof that the application improves spatial reasoning or geometry mastery.

A stronger future study should use a preregistered design with clearly documented participant inclusion, prospective ethics approval and consent or assent procedures, a validated multi-component geometry assessment, and a delayed posttest. A particularly informative design would compare three otherwise equivalent conditions: marker-based AR, physical models or manipulatives, and ordinary digital or printed representations. Content, teacher guidance, practice time, and assessment timing should be held constant so that the representational format is the main planned difference. The assessment should distinguish shape recognition, reasoning about defining properties, composition and decomposition, spatial transformation, and transfer to unfamiliar tasks. Classroom observations, screen recordings, interviews, student drawings, time-on-task records, technical logs, and fidelity checks could then show how students use each representation and whether any advantage is retained beyond the immediate lesson (Law & Heintz, 2021; Sırakaya & Alsancak Sırakaya, 2022; Yang et al., 2026).

**Data Availability and Ethical Disclosure**

The reconstructed scores for each participant are provided in Appendix A. The original test papers, item-level responses, electronic data, assessment-development records, and implementation logs were not available in the archive. No new data were collected for this paper. The original ethics, school-permission, parent-consent, and child-assent records were also not preserved; therefore, compliance with the original procedures cannot be reconstructed or asserted. This absence is disclosed in accordance with the paper's commitment to transparent reporting rather than replaced with assumptions.

**Funding: No external funding was reported in the archive or used for this secondary analysis.**

Conflict of interest and intellectual property: The archived report did not include a conflict-of-interest declaration or sufficient documentation to verify ownership and permission for Shapify It!. The corresponding author must confirm and insert the final verified declaration before submission of the revised version.

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## APPENDIX A

## RECONSTRUCTED PARTICIPANT-LEVEL SCORE DATA

Anonymous participant numbers 1-30 follow the order shown in the archived pretest-posttest chart. The percentages were copied from the numerical labels below the chart and were used in the analyses reported in this paper.

| Participant | Pretest (%) | Posttest (%) | Change |
|---|---|---|---|
| 1 | 30 | 40 | 10 |
| 2 | 20 | 30 | 10 |
| 3 | 20 | 20 | 0 |
| 4 | 20 | 50 | 30 |
| 5 | 20 | 40 | 20 |
| 6 | 50 | 60 | 10 |
| 7 | 50 | 50 | 0 |
| 8 | 20 | 50 | 30 |
| 9 | 40 | 50 | 10 |
| 10 | 50 | 60 | 10 |
| 11 | 0 | 40 | 40 |
| 12 | 30 | 40 | 10 |
| 13 | 10 | 50 | 40 |
| 14 | 30 | 80 | 50 |
| 15 | 30 | 20 | -10 |
| 16 | 30 | 50 | 20 |
| 17 | 60 | 60 | 0 |
| 18 | 50 | 60 | 10 |
| 19 | 40 | 40 | 0 |
| 20 | 40 | 60 | 20 |
| 21 | 0 | 60 | 60 |
| 22 | 20 | 50 | 30 |
| 23 | 40 | 50 | 10 |
| 24 | 20 | 30 | 10 |
| 25 | 50 | 50 | 0 |
| 26 | 40 | 40 | 0 |
| 27 | 30 | 40 | 10 |
| 28 | 0 | 30 | 30 |
| 29 | 30 | 50 | 20 |
| 30 | 70 | 80 | 10 |