

Powtoon-Based Animated Video for Spatial Visualisation: A Preliminary Study

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Abstract: This article reports a preliminary study conducted to inform the development of a Powtoon-based animated video oriented towards spatial visualisation in Grade X plane geometry. The study represents the Define stage of a 4D research-and-development design and used descriptive qualitative analysis. Evidence was drawn from a semi-structured interview with one mathematics teacher, an interview with one Grade X student, and two open-ended diagnostic tasks concerning angle relationships in a trapezoid and translation on the Cartesian plane at SMA Negeri 3 Ngabang. The documented student work showed correct numerical results and an emerging ability to state geometric relationships; however, explanations remained concise, the dynamic meaning of transformations was not fully articulated, and responses to prompts about animated motion were incomplete. Interview data converged with these findings: instruction relied mainly on the board, textbooks or worksheets, and occasional static presentation slides, while both participants considered dynamic animation useful for displaying changes in shape, position, and direction. The preliminary analysis therefore generated five design requirements: animated geometric transitions, explicit connections among verbal, visual, and symbolic representations, paced narration and labels, worked examples with explanatory prompts, and pause/replay access across common devices. These findings justify proceeding to the Design and Develop stages, but they do not constitute evidence of product validity, practicality, or effectiveness.

Keywords: Animated Video, Plane Geometry, Powtoon, Preliminary Study, Spatial Visualisation

INTRODUCTION

Digital technology has broadened the forms through which mathematical ideas can be represented in the classroom. Text, diagrams, narration, motion, and symbols can now be combined in a single learning resource, enabling students to observe processes that are difficult to communicate through static drawings alone. This opportunity is particularly relevant to geometry, where understanding depends not only on obtaining an answer but also on recognising shape, position, direction, invariance, and change. Learning media are therefore valuable when they make relationships visible and guide students to connect those relationships with mathematical language and notation (Daryanto, 2016; Nurrita, 2018; Mayer, 2009).

Plane geometry in Grade X requires students to coordinate several representations and is part of the mathematical learning outcomes addressed in the Indonesian senior-high-school curriculum (Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia, 2022). In angle problems, students must interpret a diagram, identify relationships among lines, select an appropriate theorem, and explain why a result follows. In transformation problems, they must connect coordinate differences with the direction and magnitude of motion. Duval (2006) argues that mathematical comprehension depends on coordinating representation registers rather than operating within only one register. A student may consequently calculate correctly while still needing support to communicate the visual meaning of the procedure or to predict what happens when a geometric object

moves.

Spatial visualisation is central to these transitions because it involves imagining, interpreting, and manipulating the position or form of objects. In geometry learning, the ability supports the recognition of relationships among lines and angles, the mental movement of figures, and the interpretation of translations, rotations, reflections, and dilations (Sumartini & Hidayat, 2020). The National Council of Teachers of Mathematics (2000) similarly places visualisation and spatial reasoning among the important processes through which students analyse geometric situations. Studies reported in the research design also indicate that visual media can support spatial ability and geometric understanding when visual activity is connected with purposeful mathematical tasks (Prakoso et al., 2015; Khoriyani & Suhendra, 2022).

The initial context at SMA Negeri 3 Ngabang indicated a mismatch between these representational demands and the media commonly used in class. The mathematics teacher described instruction as relying mainly on oral explanation, the whiteboard, textbooks or worksheets, group discussion, and routine exercises. Technology had been used occasionally through presentation slides and simple online videos, but Powtoon-based animated material had not been used. The interviewed student similarly described static pictures, extensive formula presentation, and difficulty maintaining focus when explanations became long or abstract. These accounts do not imply that conventional instruction is ineffective; rather, they identify moments in which a dynamic representation may complement teacher explanation.

Powtoon is a web-based authoring platform that can combine animated objects, text, narration, sound, and transitions. Previous development studies have reported that Powtoon can produce attractive learning media and can increase attention, learning interest, or achievement (Astika et al., 2019; Suhendra et al., 2018; Titin & Safitri, 2021; Tiwow et al., 2022). Its educational value, however, should not be reduced to decorative movement. For geometry, animation needs to show mathematically meaningful motion, preserve relevant properties, label changes clearly, and connect each visual event with verbal and symbolic reasoning. Mayer (2009) cautions that multimedia is most useful when words and pictures are coordinated and extraneous elements are controlled.

An important research gap therefore concerns the translation of preliminary classroom evidence into concrete design requirements for spatially oriented animation. Many reports describe media feasibility or student responses after a product has been created, whereas fewer studies explain what the diagnostic evidence suggests should move, what should remain invariant, how the motion should be narrated, and where students should be prompted to explain. A needs analysis is especially important before claims about product validity, practicality, or effectiveness are made.

Accordingly, this article aims to describe the preliminary learning conditions and spatial-visualisation profile that inform the development of a Powtoon-based animated video for Grade X plane geometry. It asks two questions: (1) what learning and representational needs are indicated by the interviews and diagnostic tasks, and (2) what design requirements follow from those needs? The contribution is a transparent bridge between the Define stage and the subsequent Design and Develop stages of a 4D research-and-development process.

METHODOLOGY

This article uses a descriptive qualitative preliminary-study design embedded

in an educational research-and-development project. The broader project adopts the 4D model—Define, Design, Develop, and Disseminate—but the planned study is limited to the Develop stage. The evidence reported here belongs specifically to the Define stage. Separating the preliminary findings from later product testing prevents the needs analysis from being misrepresented as proof that the proposed medium is already valid, practical, or effective (Sugiyono, 2021).

The study was conducted at SMA Negeri 3 Ngabang in April 2026. The preliminary evidence available in the research design comprised one semi-structured interview with a mathematics teacher, one interview with a Grade X student, and two documented open-ended diagnostic responses. The teacher provided information about the curriculum, learning methods, frequently observed difficulties, and existing media use. The student described classroom experiences, perceived difficulties in plane geometry, and expectations for animation. Participant names were omitted from this article and the sources were coded T1 and S1.

Table 1. Preliminary Data Sources and Analytical Focus

Data source	Evidence documented	Analytical focus
Teacher interview (T1)	Learning methods, recurrent geometry difficulties, technology use, and response to proposed animation.	Instructional context and teacher-identified need.
Student interview (S1)	Learning experience, perceived difficulty, attention, media preference, and expectations.	Learner experience and desired support.
Two diagnostic tasks	Trapezoid angle relations and a Cartesian-plane translation.	Calculation, visual interpretation, spatial change, and explanation.

The first diagnostic task presented a trapezoid with parallel bases, $\angle A = 110^\circ$, and $\angle B = 70^\circ$. The student was asked to determine $\angle D$ and $\angle C$, explain the relationship between $\angle A$ and $\angle D$, and predict how the angles would change if the sloping sides moved towards the centre. The second task presented a translation from $A(2, 2)$ to $A'(5, 4)$. It asked for the translation vector, the direction of movement, a description of the animated trajectory, and an explanation of why animation might support understanding. Together, the tasks elicited calculation, representation interpretation, mental transformation, spatial relationship analysis, and communication.

Analysis proceeded through data condensation, display, comparison, and interpretation, consistent with qualitative educational analysis (Creswell, 2012). Interview statements were coded under instructional practice, geometry difficulty, media experience, and desired support. Written responses were examined for four dimensions: correctness of numerical results, use of geometric properties, description of position or motion, and completeness of explanation. Triangulation compared what the teacher reported, what the student reported, and what appeared in the diagnostic work. Because the evidence is limited to a small, purposively documented preliminary set, the analysis is analytic rather than statistical and is not intended to represent all Grade X students.

RESULTS AND DISCUSSION

Existing Learning Practices and the Need for Dynamic Representation

The interviews consistently depicted a learning environment in which explanation, printed materials, and static representations were dominant. T1 reported using lectures, group discussion, textbooks or worksheets, followed by

exercises. Presentation slides and simple online videos had occasionally been used, but not a purpose-built Powtoon animation. T1 identified drawing geometric figures, determining angle relationships, and understanding changes after transformation as recurring difficulties. These observations locate the problem not only in remembering formulas but in coordinating a figure with the relationships and motion it represents.

S1's account reinforced the same pattern from the learner perspective. The student described plane geometry as difficult when it involved forms, angle or distance calculations, relationships among lines, and transformations. Static board drawings were sometimes hard to follow, particularly when erased quickly, while slides tended to contain text and formulas. S1 expected animation to make the movement of lines and figures more visible and believed that a different medium could reduce monotony. The convergence of T1 and S1 suggests a practical need for persistent, replayable, and paced representations rather than a simple replacement of teacher explanation.

This finding is compatible with multimedia-learning principles: dynamic media are useful when they manage temporal information and coordinate visual and verbal channels (Mayer, 2009). It also accords with studies in the supplied research design reporting positive responses to animated Powtoon media (Astika et al., 2019; Tiwow et al., 2022). The important design implication is that animation should be controlled by mathematical purpose. Movement must reveal the relationship among elements, while narration and labels explain what changes and what remains invariant.

Diagnostic Profile: Procedural Accuracy with Incomplete Dynamic Articulation

Direct inspection of the documented written work produced a more nuanced result than a simple low-versus-high classification. In the trapezoid task, S1 correctly used the supplementary relationship of same-side interior angles, obtained $\angle D = 70^\circ$ and $\angle C = 110^\circ$, and stated that $\angle A$ and $\angle D$ sum to 180° . The student also predicted that moving the sloping sides inward would narrow the top, reduce the upper angles, and enlarge the lower angles. This response demonstrates an emerging capacity to connect a static property with a qualitative transformation.

Nevertheless, the explanation remained compact and was not supported by a sequence of diagrams, explicit constraints, or a description of how parallelism and angle pairs behave throughout the motion. The result therefore indicates a usable conceptual foundation alongside a need for more explicit dynamic reasoning. An animation could slow the change, retain angle labels, display measurements across successive frames, and prompt the learner to explain invariants before a formula appears.

In the translation task, S1 correctly calculated the vector (3, 2) and described the motion as three units to the right and two units upward. However, the documented response did not include answers to the prompts asking how the point would move in an animation and why animation might support understanding. The limitation is therefore not an inability to compute or identify direction; it is incomplete articulation of the trajectory and its connection to the coordinate changes. This distinction matters because a product designed only to remediate calculation would not address the actual representational gap.

Table 2. Diagnostic Evidence and Spatial-Visualisation Interpretation

Task	Demonstrated competence	Development need	Implication for animation
Trapezoid angle relationships	Correct values; correct same-side interior-angle relationship;	Explain the change through successive visual states and	Animate the sides gradually; retain parallel-line and

	qualitative prediction of angle change.	identify relevant invariants.	angle labels; pause for prediction and justification.
Translation A(2,2) → A'(5,4)	Correct vector (3,2) and correct direction: right 3, up 2.	Articulate the complete path and connect each coordinate change to visible motion.	Show x- and y-components sequentially, trace the trajectory, and connect movement with vector notation.

Triangulated Preliminary Themes

Three themes emerged when interview and task evidence were compared. First, the student possessed procedural and relational resources that should be activated rather than treated as absent. Correct calculations and concise property statements provide a foundation for animation-based prompts. Second, the principal gap lies in movement across representations: from a static diagram to an imagined change, from coordinate subtraction to a visible path, and from a result to a complete explanation. This supports Duval's (2006) position that conversion among representations is central to mathematical understanding.

Third, both teacher and student regarded animation as potentially useful, but their expectations emphasised clarity, motion, and attention. The proposed medium should therefore balance conceptual precision with usability. Colour, characters, and transitions may attract attention, yet they should not compete with the geometry. Labels need to remain legible, animation speed should allow observation, and narration should use language appropriate to Grade X students. A replayable video can also preserve a transformation that would otherwise disappear when a board drawing is erased.

The findings support a needs-based interpretation of Powtoon. It is not being selected merely because it is contemporary or visually attractive. It is selected because its motion, narration, text, and timing functions can be aligned with the specific transitions that the preliminary data identified. The resulting evidence-to-design logic is summarised in Figure 1.

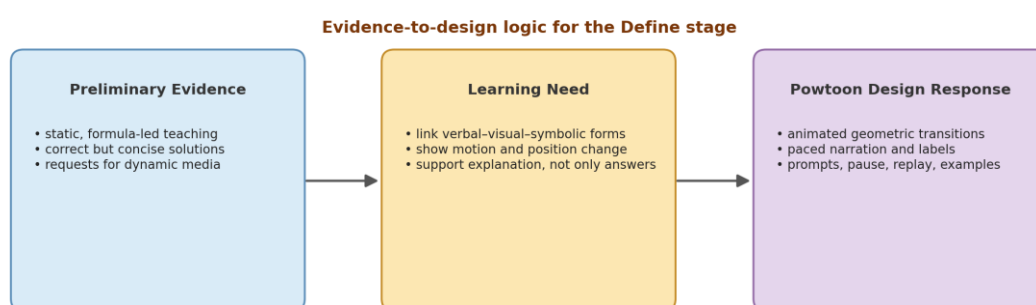


Figure 1. Preliminary evidence-to-design logic for the Powtoon-based medium

Design Requirements for the Powtoon-Based Animated Video

The preliminary findings were translated into design requirements for the next stage of the 4D process. The first requirement is mathematically meaningful motion. In the trapezoid sequence, the two sloping sides should move gradually while the parallel bases, angle labels, and supplementary relationships remain visible. In the translation sequence, the movement from A to A' should be traced on the coordinate

plane, with horizontal and vertical components shown before the vector is written.

The second requirement is representational linkage. Each sequence should coordinate a short verbal statement, the changing visual, and the corresponding symbol. The third is temporal control: concepts should be segmented into short scenes, with pauses for prediction, explanation, and checking. The fourth is explanatory interaction. Although a video is not fully interactive, it can contain prompts such as “What remains parallel?”, “Which angle increases?”, or “How does +3 change the x-coordinate?” before revealing the next step. The fifth requirement is accessibility across laptop, computer, and smartphone, accompanied by clear narration, readable text, restrained sound, and a replay option.

These requirements are consistent with the proposed product specifications in the research design, which call for a structured opening, learning objectives, content presentation, examples, discussion, and conclusion. The preliminary analysis sharpens those specifications by identifying what the content should make visible and what students should be asked to explain. Table 3 provides a practical blueprint for storyboard development and later expert validation.

Table 3. Derived Design Requirements for the Next Development Stage

Requirement	Planned realisation in Powtoon	Expected learning function
Meaningful motion	Gradual movement of sides, angles, points, and translation paths with stable reference elements.	Make change and invariance observable.
Representation linkage	Synchronise narration, labels, diagrams, coordinates, and formulas.	Support conversion among verbal, visual, and symbolic forms.
Paced segmentation	Use short scenes, pauses, and replay points before each conclusion.	Reduce temporal overload and allow prediction.
Explanatory prompts	Insert questions before revealing relationships or procedures.	Elicit justification instead of passive viewing.
Worked examples	Model angle relationships and translations step by step, followed by a parallel practice item.	Connect observation with procedure and transfer.
Device and audio access	Export a legible video for smartphone and computer use, with clear narration and restrained sound.	Enable independent review in and beyond class.

Position of the Preliminary Findings within the 4D Study

The present findings support continuation to the Design stage, where the learning objectives, assessment tasks, storyboard, visual language, narration, and scene sequence can be prepared. The Develop stage should then include content-expert and media-expert validation, revision, and a limited classroom trial. Product validity should be determined from expert judgement; practicality from teacher and student response during actual use; and effectiveness from learning evidence collected through an appropriate pretest–posttest or other planned design. None of those outcomes can be inferred from the preliminary interviews alone.

This boundary is methodologically important. Positive expectations towards animation can support design relevance, but they are not equivalent to observed learning improvement. Likewise, one student’s correct but incomplete responses cannot establish the distribution of spatial-visualisation ability in the full class of 35 students. The preliminary evidence instead serves its intended function: identifying a plausible instructional need, locating specific representational transitions to address, and defining observable criteria for the product and its later evaluation.

When tested in the subsequent phase, the evaluation should therefore examine more than answer accuracy. It should consider whether students can describe angle relationships, predict geometric change, connect coordinate differences with direction and distance, and explain why a representation is valid. Such measures would align the evaluation with the need identified at the Define stage and reduce the risk that the product is judged only by attractiveness or satisfaction.

CONCLUSION

The preliminary study indicates a clear but carefully bounded need for a Powtoon-based animated video in Grade X plane geometry at SMA Negeri 3 Ngabang. Existing instruction relied largely on static explanations and printed materials, while the teacher and student identified difficulty in following geometric relationships and transformations. The documented student work showed correct angle calculations, a correct translation vector, and some appropriate spatial descriptions; the principal need was not basic calculation remediation but fuller articulation of dynamic change and stronger connections among visual, verbal, and symbolic representations.

Five priorities follow for product development: mathematically meaningful motion, explicit representational linkage, paced segmentation, explanatory prompts, and accessible replayable presentation. These priorities provide a defensible basis for storyboard preparation, expert validation, revision, and limited testing in the Design and Develop stages. Because the evidence is preliminary and involves a very small documented set, the study does not yet establish the validity, practicality, or effectiveness of the medium. Future work should test those outcomes with the planned participants and use measures that capture explanation and spatial reasoning as well as numerical correctness.

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- Conflict of Interest Statement: The authors declare that no commercial, financial, or other interests could have influenced the objectivity of this article.