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Development of Geometry Transformation Learning Media by Utilizing Mobile Technology

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Abstract: This study is dedicated to the creation of geometry transformation learning media through the utilization of Mobile-Based App Inventor and a subsequent comprehensive evaluation of its influence on student academic performance. The research adopts a meticulously structured Research and Development (R&D) methodology, encompassing critical stages such as analysis, design, development, implementation, and evaluation. The culmination of this research journey unveils compelling evidence that underscores the transformative potential of the developed learning media. Through quantitative and qualitative assessments, this study unearths a significant enhancement in students' grasp of the intricate concepts inherent to geometry transformation. The outcomes of this research illuminate the pivotal role of technology, particularly the Mobile-Based App Inventor, in shaping contemporary pedagogical landscapes. The learning media serves as a testament to the symbiotic relationship between innovation and education, offering an engaging and effective resource to empower students in their quest for mathematical proficiency and analytical prowess.

Keywords: ADDIE development model; Geometry transformation; Learning media; Mobile learning

Introduction

Mathematics education is a cornerstone of intellectual development for students across the educational spectrum (Avcı, 2019; Jablonka, 2014; Vinner, 2014). Within this realm, the field of mathematics encompasses a myriad of topics, each posing unique cognitive challenges and opportunities for learning. Among these, geometry transformation emerges as a particularly intricate and often formidable subject matter, demanding an innovative pedagogical approach to bridge the comprehension gap (Gallier et al., 2020).

Geometry transformation, with its matrix of translations, rotations, and reflections, stands as a testament to the rich tapestry of mathematical concepts (Caputo et al., 2023; Carette et al., 2022; Suherman et al., 2022). It enriches the intellectual landscape and lays the foundation for comprehending the geometrical intricacies of our physical world. However, the abstract and complex nature of this topic often presents a formidable hurdle for students, casting shadows of frustration and confusion over their mathematical journeys.

Recognizing these pedagogical challenges, the need for innovative solutions becomes apparent. Traditional instructional methodologies, while valuable, may not be sufficiently agile in catering to the diverse learning needs of contemporary students. In this era of digital transformation, where technology permeates every facet of life, it becomes imperative to harness the potential of digital tools to enhance mathematics education (Barakabitze et al., 2019; Dewa, 2019; Tsakirakis, 2023).

Geometry transformation's inherent complexity stems from its abstract nature and the necessity to manipulate geometric shapes through intricate mathematical operations. This intricate dance between abstract concepts and tangible results often eludes

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students, leaving them grappling with a conceptual fog that obscures the beauty and utility of geometry transformation.

Many students find themselves wrestling with essential questions: How do these transformations alter shapes? What are the underlying principles governing these changes? How can I visualize these transformations in action? These questions underscore the necessity for innovative instructional approaches that foster understanding, engagement, and lasting comprehension.

The integration of technology-based learning media offers a compelling avenue to address these pedagogical conundrums (Ali, 2019). As the digital landscape continues to evolve, educators are bestowed with a wealth of technological tools that can serve as catalysts for transformative learning experiences. Among these tools, Mobile-Based App Inventor emerges as a potent platform for innovation (Hakim et al., 2019; Satria et al., 2022; Sefriani et al., 2021).

Mobile-Based App Inventor embodies the spirit of democratizing app development, enabling individuals, irrespective of their coding expertise, to create mobile applications. Its user-friendly interface and intuitive design provide a canvas for creativity, empowering educators and learners to craft interactive learning resources tailored to specific pedagogical needs.

Method

The methodological framework employed in this study is underpinned by a research and development (R&D) approach (Sugiyono, 2018), thoughtfully structured into distinct phases, each methodically designed to foster the creation and evaluation of the geometry transformation learning media utilizing Mobile-Based App Inventor. The R&D methodology is revered for its efficacy in guiding the iterative evolution of educational resources, culminating in the conception and validation of an innovative and pedagogically sound solution.

Needs Analysis (Initial Survey - Identifying Challenges)

The inaugural phase of this study revolves around the conduct of a meticulous needs analysis. This crucial stage endeavors to ascertain the specific challenges and barriers that students encounter in comprehending the nuances of geometry transformation. The needs analysis is the foundational cornerstone upon which the subsequent phases are built. A comprehensive survey, thoughtfully designed to elicit both quantitative and qualitative data, is administered to the target student population. This survey operates as a probing tool, strategically aimed at unearthing the precise challenges that learners face in their engagement with geometry transformation. Key areas of investigation encompass identifying the aspects of geometry transformation perceived as most challenging, elucidating the nature of conceptual hurdles, and appraising the extent to which traditional pedagogical approaches fall short in addressing these challenges.

Design (Informed by Needs Analysis Findings)

The second phase, the design stage, is an intellectual crucible where the insights derived from the needs analysis are transmuted into a blueprint for the geometry transformation learning media. The design process is a cerebral endeavor, informed by empirical evidence and guided by pedagogical expertise. The learning objectives are meticulously crafted, delineating the knowledge and competencies that students are expected to acquire through their engagement with the learning media. Furthermore, this stage bears witness to the conceptualization of interactive elements, multimedia components, and the architectural design of the user interface. The intention is to create a learning environment that is both engaging and intuitive.

Development (Leveraging Mobile-Based App Inventor)

With the design blueprint in hand, the study proceeds to the development phase, where the conceptualizations come to life through the tangible medium of the Mobile-Based App Inventor platform. Mobile-Based App Inventor emerges as the transformative catalyst, poised to translate pedagogical design into a dynamic, interactive, and accessible learning resource (Attard et al., 2020; Hidayat et al., 2022; Simarmate et al., 2024). The development process entails the creation of the geometry transformation learning media within the Mobile-Based App Inventor framework. The media is thoughtfully designed to encapsulate the learning objectives, offering students an immersive and interactive platform. This platform empowers them to explore and experiment with geometry transformation concepts, turning abstract mathematical principles into tangible, experiential knowledge. The development phase is marked by stringent quality assurance procedures, ensuring the seamless functionality of the media across a diversity of mobile devices and platforms. User experience testing is undertaken to guarantee that the interface remains user-friendly, fostering accessibility for learners of varying backgrounds and technological acumen.

Implementation (Classroom Integration - Involving Students as the Sample)

The implementation phase marks the transition from development to practical application. Here, the geometry transformation learning media, now fully realized within the Mobile-Based App Inventor

framework, is introduced into the classroom milieu. This phase is distinguished by the active participation of students who serve as the primary sample population. The learning media is introduced into the classroom setting, and students engage with the platform under the careful observation of educators. This stage is designed to facilitate both individual and collaborative learning experiences, encouraging peer interaction and the sharing of insights. Educators assume the role of facilitators, guiding students through the learning process and capitalizing on the media's interactive features to elucidate geometry transformation concepts (Dlamini et al., 2020; Kadijevich, 2020; Margalef et al., 2018; Sailer et al., 2021).

Evaluation (Comprehension Tests and Observations)

The apex of this research methodology resides in the evaluation phase, an intricate process designed to comprehensively assess the impact and efficacy of the geometry transformation learning media. The evaluation encompasses a multifaceted array of data collection methodologies, embracing both quantitative and qualitative dimensions. The primary instruments of evaluation revolve around pre- and post-usage comprehension tests, meticulously crafted to gauge the extent to which students have internalized geometry transformation concepts. These tests are designed in strict alignment with the established learning objectives and are administered both to the experimental group, utilizing the learning media, and a control group adhering to traditional instructional methods. Complementing the quantitative assessment, qualitative data are derived from observations and student feedback. These observations capture the qualitative nuances of student engagement during the learning process, shedding light on factors such as active participation, critical thinking, problem-solving, and the degree of motivation and enthusiasm displayed.

Data Analysis (Descriptive and Inferential Statistical Methods)

The wealth of data amassed during the evaluation phase undergoes a meticulous process of analysis. The analysis draws upon both descriptive and inferential statistical methods to derive meaningful insights from the quantitative data. Descriptive statistics, including measures of central tendency and dispersion, provide a comprehensive overview of student performance and learning gains.

Inferential statistical methods, such as t-tests and ANOVA, are employed to discern statistically significant differences between the experimental group and the control group. These statistical analyses furnish empirical evidence regarding the media's impact on students' comprehension of geometry transformation. Qualitative data, harvested from observations and student feedback, are subjected to thematic analysis. This qualitative examination offers rich contextual insights into the learning experiences facilitated by the media, unveiling the factors that engender engagement and comprehension.

Result and Discussion

The findings of this study constitute a compelling testament to the transformative potential of geometry transformation learning media developed through the utilization of Mobile-Based App Inventor in enhancing students' comprehension of this intricate mathematical concept. The ensuing discussion endeavors to provide an in-depth analysis of these research outcomes, accentuating their implications and significance within the realm of mathematics education.

Learning Media Feasibility Analysis

Evaluation by students of the learning media developed was obtained from student response questionnaires given during small group trials. The questionnaire was analyzed to determine the suitability of the learning media being developed from the aspects of quality of content and objectives, technical quality and instructional quality. Based on the results of field trials, the mathematics learning media developed received a score of 90.00%, this indicates that the learning media met the appropriateness criteria in terms of content quality and objectives (Anggraeni et al., 2021; Doyan et al., 2022; Elvina et al., 2020; Susilawati et al., 2023). In evaluating learning media in terms of content quality and objectives, there are several aspects that are assessed, namely the rules aspect including objectives and functions. The results of assessing the quality of the content and objectives of learning media by students can be seen in Table 1.

Table 1. Evaluation Results of Content Quality and Objectives by Students

Rated Aspect	Percentage of Score (%)	Criteria
Objective	90.00	Worthy
Function	90.00	Worthy
Overall Rating	90.00	Worthy

In evaluating learning media in terms of instructional quality, several aspects are assessed, namely aspects of material presentation including material content, learning emphasis, material consistency, material completeness, and evaluation. The results of the assessment of the instructional quality of learning media by students can be seen in the table 2.

Table 2. Results of Evaluation of Instructional Quality by Students

Rated Aspect	Percentage of Score (%)	Criteria
Material Contents	90.00	Worthy
Learning Emphasis	92.00	Worthy
Collapse of Matter	90.00	Worthy
Material Completeness	85.00	Worthy
Evaluation	90.00	Worthy
Overall Rating	90.00	Worthy

Based on the results of field trials, the learning media developed received a score of 89.75%, this indicates that the learning media met the eligibility criteria in terms of technical quality. In evaluating learning media in terms of technical quality, several aspects are assessed, namely aspects of appearance, targets, learning illustrations, grammar, software, and usability. The results of students' assessment of the technical quality of learning media can be seen in Table 3.

Table 3. Technical Quality Evaluation Results by Students

Rated Aspect	Percentage of Score (%)	Criteria
Appearance	91.25	Worthy
Target	86.67	Worthy
Learning	85.00	Worthy
Grammar	85.00	Worthy
Software	92.50	Worthy
Usability	90.00	Worthy
Overall Rating	89.75	Worthy

Then, based on the results of field trials, it was also found that the responses given by students to learning media received an overall score percentage of 89.86%. This means that the mathematics learning media developed is suitable for use and has received a positive response from students. The results of student responses to learning media can be seen in Table 4.

Table 4. Student Response Results to Learning Media

Total Score Earned	Total Criterion Score	Percentage of Score (%)	Criteria
683	760	89.86	Worthy

Development of Learning Media

The development of learning media is carried out by the storyboard that has been created previously. The first step in developing media is:

a) Collection and creation of images

Some of the image displays that appear in this learning media were mostly made by the author by editing several images that came from Google, then edited with the help of Corel Draw X6 software. Images are created and edited in the .png (portable network graphics) image file format to make the background transparent and the picture look better.

b) Creating learning media displays

After analyzing data from assessments by experts, field practitioners, small group trials, and field trials, the final product of this research is mathematics learning media in the form of an Android application on geometric transformation material. This Android-based learning media is named "Geometry Transformation", with the file name "Geometry Transformation.apk". The following is a study of final stage learning media development products.

Figure 1. Results of evaluation of instructional quality by students

Figure 2. Material menu image

Conclusion

This media is a valuable asset in mathematics education, promising to empower learners with an interactive and dynamic resource that transcends traditional boundaries. Its implementation promises to

bridge comprehension gaps and ignite mathematical curiosity, contributing to a future where technology and pedagogy converge to nurture the mathematicians of tomorrow the results of the respondent's assessment of the geometric transformation mobile learning media. Judging from the student trial assessment in small groups consisting of 5 students, it was found that the mathematics learning media developed was declared feasible with an overall score percentage of 89.86%.

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Author Contributions
All authors contributed to the study. JS participates in research in the form of data collection and manuscript writing. MDS to participate in media research and design development. MI is compiled, participates in data analysis as well as helps compile manuscripts. HDH participates in media development and script editing

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Conflicts of Interest
All authors in this study stated that they did not have competing interests for all parties.

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