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Contemporary Mathematics Learning: Instagram-based math learning medium increased elementary school students' math literacy

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Abstract

Modern education has shifted from teacher-centred to student-centred. This transition occurs because educators today work as instructional designers, facilitators, trainers, and learning administrators. Globalization and millennial students are destroying traditional schooling. Technology use is rising. This has adverse effects since youngsters are unwilling to utilize books to improve their mathematical literacy. This happens when pupils need help conceiving, applying, and comprehending mathematical concepts. To improve students' mathematical literacy, a teacher must create modern materials. This study is about R&D. This research produced a math learning tool for 12th-graders. The software emphasizes three-dimensional materials and is based on GeoGebra and Instagram. This study uses the Four-D development model: definition, design, development, and deployment. Modern three-dimensional educational materials made with Canva are the results of this research study. These contents will then be posted on Instagram. This essay will comprehensively analyze data collection, analysis, and Instagram content publishing. Currently, this research is in development, not distribution. Test sheets and questionnaires are used. Observation, interviews, questionnaires, and testing collect data. After observation and interviews, a questionnaire is distributed to finish the study. Pre- and post-tests assessed how GeoGebra Instagram content affected students' understanding of "point-to-point distance" in three-dimensional material. The article will detail this media's methods and results.

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1 Introduction

Acquiring knowledge through various forms of media is crucial in facilitating educational instruction and learning endeavours (Hanč, 2011; Putra et al., 2023). Learning media encompass the methods and materials employed to accomplish educational goals (Kay, 2009). Utilizing educational media facilitates the provision of instructional materials by teachers while also enhancing students' comprehension of the taught conten (Syafitri et al., 2018; Takači, 2015) t. Hence, educators play a crucial role in selecting and utilizing instructional materials.

The teacher's choice of suitable educational media will impact the learning process's effectiveness (Osypova & Tatochenko, 2021; Santiago et al., 2023). Nevertheless, the teacher's responsibility is confined to selecting appropriate educational resources for instruction and enhancing those resources (Nasiha et al., 2023a). The objective is to ensure that teachers' educational material aligns with advancements in science and technology (Monge, 2022; Quevedo-Redondo, 2017), providing students with novel learning experiences and ensuring continuous relevance. When selecting learning media, teachers should consider many factors (Nisa et al., 2023), such as the learning objectives, subject matter, student characteristics, learning environment, accessible resources, and the specific type of learning media (E Marpanaji, 2018).

Appropriate educational media facilitates students in the process of instruction and acquisition of knowledge. Educational media can assist teachers in elucidating the learning content that will be presented (Choirudin et al., 2023). In addition, learning media facilitates communication for both the sender and the receiver (Ridho'i et al., 2023). Teachers can effectively use a diverse range of contemporary media to enhance message delivery to pupils (Pandia, Laudra, et al., 2023). Technology support enables genuine learning experiences. Information media and technology use has become pervasive across social, economic, political, and educational sectors.

Mathematics education incorporates several forms of modern media to enhance learning (Khoiriyah et al., 2022), particularly in the delivery method (Pandia, Laudra, et al., 2023), which is greatly influenced by technological advancements. The swift advancement of technology has made individuals accustomed to utilizing technology in their daily lives. The advancements in information and communication technologies have significantly altered the process of learning mathematics.

Generation Z students frequently use the internet for social media daily (Aryaseta et al., 2023), particularly as they are enrolled in secondary institutions (Fatra et al., 2023). Generation Z is characterized by their strong attachment to electronics and preference for a convenient and uncomplicated lifestyle due to their inherent integration with technology (Zamzam et al., 2023a). Given the growing prevalence of the internet and electronic devices (Zahroh et al., 2023), it is imperative to convert learning materials into digital formats (da Silva Santiago & Baiduri, 2023), particularly in mathematics education. The process of digitizing mathematics learning resources is implemented to attract students' attention and facilitate their comprehension of the course material provided by instructors (Vedianty et al., 2023). Digitization of learning resources is necessary due to the ongoing transformation of all educational offerings into digital formats.

The growing prevalence of the internet has also altered human lifestyle patterns. Most human existence during the 4.0 age is dedicated to the virtual realm known as cyberspace (Rizqi et al., 2023). Consequently, there has been a shift in learning habits, transitioning from traditional methods, including paper and textbooks (Rahman, 2023), to the Internet for accessing educational platforms. One platform that can serve as a valuable learning resource is social networking—an analysis of the frequency with which different social media applications are accessed. Individuals in the 4.0 era are expected to have a strong presence on popular social media platforms like YouTube (Gil-Quintana et al., 2020), Twitter (Mendiburo-Seguel, 2022), Facebook (Li, 2015), TikTok (Haenlein, 2020), and Instagram (Weimann, 2023).

The substantial user base of Instagram facilitates the efficient dissemination of information to a broad audience, thereby garnering a significant number of followers, specifically students and teachers, in this context (Syaifuddin et al., 2022). Students opt to utilize social media platforms for learning due to the widespread use of social media and viral platforms such as Instagram among students (Suharsiwi et al., 2023a). Instagram is a multimedia-sharing platform that enables users to capture photos and videos (Winson et al., 2024), apply digital enhancements, and distribute them across many social networking platforms, including Instagram (https://id.wikipedia.org/wiki/Instagram).

A popular social media platform, Instagram shares users' photos and videos and is a potential educational tool (Winson et al., 2023). Users can utilize Instagram to share teaching materials in the form of educational videos, engaging images with educational content, and various features. QnA, or the exchange of questions and answers on Instagram between users and account administrators, serves as a means to enhance mathematics knowledge (Novitasari et al., 2021).

In addition, using technology (Vedianty et al., 2023), namely Instagram (Alsafi, 2021; Tazeen, 2023; Yuniati et al., 2021), can facilitate interactive discussions among students and enhance their cognitive capacities (Vassallo, 2018). Utilizing Instagram as a tool in the mathematics learning process can effectively address the underlying factors contributing to difficulties in mathematics

learning (Laila et al., 2023). These factors include students' negative attitudes toward learning mathematics (Nasiha et al., 2023b), low motivation to engage in the subject, suboptimal physical health, limited sensory abilities, inadequate use of learning media, infrastructure limitations, and students' struggles with comprehension. The difficulty in answering Van Hiele's geometry problems arises from a need to comprehend the concepts and properties of quadrilaterals, a limited grasp of the necessary background knowledge (Sugianto & Khan, 2023), and inadequate proficiency in applying geometric principles to solve mathematical problems involving visualization. This challenge can be surmounted by incorporating diverse software, such as GeoGebra.

GeoGebra is an educational software designed to facilitate students' learning of geometry, calculus, and algebra (Hohenwarter et al., 2008). GeoGebra has recently gained popularity as a mathematics study software (Hidayat & Tamimuddin, 2015). GeoGebra is accessible to users of all ages without restrictions (Suharsiwi et al., 2023b). Utilizing GeoGebra in mathematics education yields numerous advantages. Syahbana (2016) asserts that GeoGebra offers several advantages in educational settings, including (1) instantaneous and precise display of geometric visualizations, (2) provision of visual experiences through animated movements, (3) usefulness as an assessment tool for evaluating geometric image visualization, and (4) facilitation of the identification of mathematical object properties.

Extensive research has been conducted on using Instagram to assist students with learning issues in geometry. This research distinguishes itself by employing three-dimensional materials to instruct class XII pupils on point-to-point distance, thereby addressing their learning challenges. A three-dimensional material is produced through the research and development process using a model devised by Thiagarajan, consisting of four stages. Subsequently, the material is exhibited in photos and videos and shared with other users. Users can submit photos, pictures, and videos from their gallery or by using the camera to take them directly. Users can promptly capture live moments and instantly share them with other users. The camera function on Instagram enables users to apply modern filters based on their preferences (Bossetta, 2023a; Miller, 2020; Sungkawati et al., 2023). In addition, users can include captions (Menon, 2022), tag friends (Ging, 2018), and add locations to the photographs and videos they share on Instagram (Bossetta, 2023b; Klassen, 2018). The research involved uploading content to Instagram postings as posters containing mathematical material (Zamzam et al., 2023b), example problems, and debates. In addition to the three-dimensional mathematics poster and its point-to-point distance feature, we will provide a supplementary learning movie on three-dimensional material. This video will enhance students' comprehension of the material offered in the poster.

GeoGebra software generates content on posters and learning videos (Arif et al., 2023). The teacher facilitates comprehension of the content by initially illustrating spatial shapes and picturing the components within these shapes in three dimensions, enhancing students' understanding compared to just verbal descriptions on the blackboard. Students can perceive all aspects of the image, improving their comprehension of three dimensions and point-to-point distance concepts. Furthermore, the versatility of GeoGebra software extends to mobile devices, allowing a wide range of students to utilize it, not solely those with access to computers. Instagram content also includes Geogebra-based discussions on mathematics issues, backed by relevant material and content. Hence, the objective of this study is to ascertain the effectiveness of mathematics learning materials for twelfth-grade high school students. The software is built upon the GeoGebra and Instagram platforms, specifically emphasizing three-dimensional materials related to Jara materials.

2 Method

The application of this development study is centred around creating a product that has undergone rigorous testing to ensure its validity, practicality, and efficacy. This study used a 4-D development research model, as depicted in Figure 1.

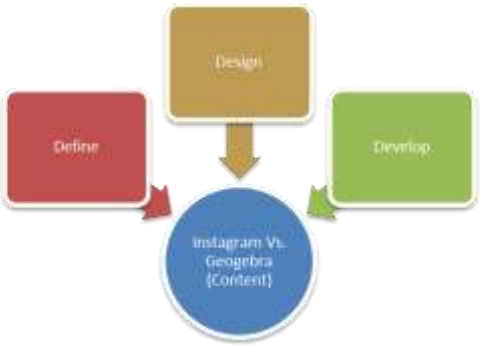

Figure 1. Stage 3-Model Development to Instagram Vs. Geogebra Content

Figure 1 depicts the developmental stages according to the Thiagarajan model (1976), also known as the 4-D model. This model was developed by Sivasailam Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel as part of their research on development. The research process under this approach involves four stages: definition, design, development, and dissemination. Each stage encompasses many analysis tasks, including media selection, initial design of teaching materials, assessment validation, testing, and content rollout.

Stage of the process where the meaning or nature of anything is clearly explained or described. During this phase, an analysis is conducted to ascertain the development goals, research topics, and necessary resources and formulate a plan for managing the development process. The second phase entails the design process, which validates the intended performance and selects suitable testing methodologies. The primary methods employed in this development are frequently linked to the design phase. The prototype I is currently being constructed. The third aspect is development during the developmental phase, where the objective is to build and authenticate the product being developed. The typical procedures employed at this phase involve generating content, choosing complementary media, formulating instructional materials for educators and learners, conducting iterative evaluations, and performing small-scale experimental tests. The outcome of the product redesign at this point is referred to as prototype II. Next, establish the educational setting and engage six class XII students from YALC High School in Pasuruan City for a small-scale experiment. The primary method commonly linked to the implementation phase is equipping instructors and students with the necessary skills to evaluate the quality of the development result.

At this stage, an evaluation is conducted to analyze the 4D development process (Budiarti et al., 2024). The current stage is confined to the development phase; hence, the research does not extend to the dissemination phase. Questionnaire papers and test sheets are the tools utilized. Meanwhile, data collection methods encompass observation, interviews, questionnaires, and testing (Budiarti & Darmayanti, 2020). Before conducting the research, the proceedings commenced with observations and interviews, whereas upon completion of the study, the proceedings concluded with disseminating questionnaires (Pandia, Suharsiwi, et al., 2023). Data was gathered using pre-and post-tests to assess the impact of GeoGebra content delivered via Instagram on students' comprehension of "point-to-point distance" in three-dimensional material. The research's success is demonstrated by validating Instagram content in learning using GeoGebra, indicated by a correlation coefficient over 0.6, practicality exceeding 65%, and efficacy surpassing 0.3 (Lubis et al., 2024).

3 Result and Discusion

Definition Stage (Define)

Definition Stage (Define) The initial phase encompasses several activities, such as comprehensive analysis from start to finish, analysis of students, analysis of materials, analysis of tasks, and specification of learning objectives. This stage aims to establish the objective of development research to enhance students' comprehension of three-dimensional material concepts through Instagram GeoGebra (Ins-GG). Observations and interviews were conducted with class XII mathematics teachers to determine the product to be developed through needs analysis, both at the beginning and end of the study. The collected findings include the provision of WiFi connectivity at school, the presence of LCD projectors in each classroom, the availability of a computer laboratory, and the allowance of smartphone use while studying.

Nevertheless, the current understanding is confined to worksheets, and it is essential to employ GeoGebra technology. This challenges students when comprehending subjects that necessitate imagery, particularly "point-to-point distance." The analysis conducted by students involves collecting and exploring information about students' comprehension of subject concepts. According to instructor ratings, pupils need assistance comprehending mathematical concepts about object visualization. The findings of this research were selected as a foundation for undertaking material analysis. After analyzing the materials, a three-dimensional chapter was chosen, emphasizing the point-to-point distance. The selection of this material as the development medium for Ins-GG was based on the requirement for it to be finished in prior learning. Hence, creating instructional resources is necessary to facilitate students' comprehension and completion of the course.

The material analysis results are subsequently followed by task analysis and the establishment of learning objectives. This activity involves identifying fundamental skills and gathering measurable indicators of academic progress. The distance between two points is subsequently modified based on evidence of comprehension of the idea. Subsequently, the researcher sought further insights

into the subject matter commonly regarded as challenging in high school. Several pupils reported that three-dimensional material was among the challenging materials. This is due to students' challenges in visualizing geometric shapes in a three-dimensional context and articulating the components inside that area. In order to address students' challenges, it is necessary to provide them with educational resources that can convert three-dimensional visuals into two-dimensional representations. This will enable students to identify the necessary processes for solving mathematical issues involving three-dimensional materials.

In the digital age, students are inseparable from their cell phones during leisure time and while learning, except when studying mathematics. Most students had social media accounts, with Instagram being one of their platforms. Students utilize Instagram during 24 hours to generate stories, upload images, or peruse searches in order to discover captivating information or material. In light of the inadequacy of current learning media in incorporating three-dimensional materials and the prevalence of students spending a significant amount of time on social media platform Instagram rather than engaging with books or mathematics lesson modules, there is a pressing need for a more appropriate learning medium.

Featuring interactive three-dimensional content and engaging digital learning, students can conveniently access the material from any location and anytime. Consequently, scientists created a digital educational tool utilizing social media, specifically Instagram and GeoGebra, centred around three-dimensional content. Researchers have created a learning tool appropriate for three-dimensional materials and a platform for engaging digital learning. This learning approach is called Instagram-based learning, and it was developed through conversations with teachers and students and the analysis of questionnaires.

Design Stage (Conceptualization Phase)

Conceptualization Phase: The second phase is the creation of instructional resources, specifically posters, which will, after that, be disseminated via the Instagram platform. Firstly, it is essential to generate a poster template and organize the content based on the findings of the conducted needs analysis. At this stage, the researcher formulates the mathematical content or material they intend to create using the GeoGebra software. Once the teaching materials have been chosen, the next step is to decide on the format for their development. The formats that will be created encompass the file format, dimensions, characteristics, and visual presentation of educational resources utilized in instructional endeavours. This process generates a PDF file format included in the flyer by scanning the QR code or clicking the provided link.

Additionally, it produces a GGB file format that can be accessed with GeoGebra software on a computer device. Meanwhile, Ins-GG offers features and displays that resemble printed training materials. It also includes a menu feature that allows users to access the Geometry Transformation section. Within each submenu, there will be explicit guidelines for operating GeoGebra media. To obtain the Flayer in PDF format, students must scan the provided QR code using a smartphone. They should then identify the learning objectives within the three-dimensional material, generate customized material based on these objectives, capture images of spatial shapes, and describe distances in space using GeoGebra software. Finally, they can select the layout, colour, and typography for the content uploaded to the Instagram feed. The third phase entails the creation of instructional resources, specifically, the composition of flyer content for the Instagram feed.

Developing flyer content involves organizing the material and creating the visual elements and educational media. The components that will be incorporated are textual content and visual representations. The images were generated using the GeoGebra software, while the flyers were designed using the Canva application. After the design of the e-module is completed, the following step is to compile it into a research instrument. The instruments consist of three components. Firstly, the Ins-GG validation questionnaire sheet and Ins-GG validation assessment guidelines exist. Secondly, there are the student response questionnaire sheet, response questionnaire validation sheet, and student questionnaire validation assessment guidelines. Lastly, there are the grid test questions, which include the pretest and post-test, test question sheets and answer keys, test question assessment guidelines, test question validation sheets, and test question validation assessment guidelines. During this phase, a preliminary version of the Ins-GG is created, called Draft I.

Development Stage

Development Stage (Develop): Following the completion of the original product draft, the subsequent phase involves validation. The validation process consisted of three steps, including two stages of validation conducted by language and material experts. The edits and input were made by material and language specialists, who validated the changes. This included replacing non-standard

words with standard words according to the KBBI and revising faults in writing ranks in the home. In addition to being reviewed by material and linguistic specialists, the initial draft will also undergo validation by media experts. Ins-GG validation and testing operations are integral components of the development stage. The document I generated in the preceding phase underwent validation by three validators: two lecturers specializing in Mathematics Education and one teacher specializing in mathematics. The validation process involves Ins-GG validation, validation of student answer questionnaire sheets, and validation of exam questions.

The validation results are subsequently analyzed, and the conclusions of the analysis. The validator's study determined that the average Aiken index (V) was 0.86. The analytical findings suggest that the exam questions are valid (Anggraini et al., 2020). Following validation, the next step is to modify the Ins-GG based on the suggestions provided by the validator and subsequently proceed with testing the Ins-GG, which is designed for student use (Dahliani, 2024; Solehudin & Darmayanti, 2018; Yuniwati, 2024). Based on the media validation results, there are some necessary revisions. Firstly, the size of the writing is too small, causing difficulties for students to read. It is recommended to increase the size by two increments. Secondly, the colour of the flyer is too dim, resulting in dizziness for students. It is suggested to be replaced with a brighter, less shaded theme colour. Following the implementation of enhancements, validation is conducted by professionals specializing in media and materials. The outcome of this validation process is referred to as Draft II, which is published on Google Drive and shared with students in the XII subject class through a hyperlink.

The research activities spanned several weeks, employing Ins-GG in Three Dimension learning. Before utilizing Ins-GG, students commence with a pretest, followed by engaging in learning activities on Ins-GG through their smartphone or computer device. Subsequently, they undertook a posttest and concluded the process by completing the student response questionnaire. The data gathered throughout the research consisted of pretest and posttest assessments and scores from a questionnaire measuring student responses. Analysis results of scores from the student response questionnaire. The mean score for each indication was subsequently examined, and the overall mean score was computed as 3.09, corresponding to a percentage of 86.88%. According to Asnawi (2021), this proportion falls within the range of more than 76.61% and less than or equal to 89.00%, demonstrating appropriate practicality. Ins-GG is a pragmatic solution that can be easily implemented again with slight enhancements initially.

Concurrently, the efficacy of Ins-GG in enhancing students' comprehension of concepts is evaluated by calculating the pretest and posttest scores, which are then analyzed using N-Gain results. The outcomes of the N-Gain analysis are classified into several levels of efficacy (Hake, 1999). The study yielded N-Gain results using formula (2), which indicated that five students fell into the high category, six fell into the middle category, and five fell into the low category.

Concurrently, the mean overall N-Gain is 0.46, indicating a medium level. Ins-GG is highly efficient in enhancing pupils' comprehension of subjects. These findings are corroborated by a prior study conducted by Darmayanti in 2022, which asserted that the outcomes of the data reduction demonstrate that Instagram social media has the potential to facilitate the dissemination of practical and educational information through captivating content that can be implemented, not only for individuals but also for educational resources in formal institutions such as schools and colleges. To be more precise, the data reduction findings indicate a correlation between Instagram and the utilization of visual literacy in instructing three-dimensional content, specifically in comprehending the notion of point-to-point distance through the employment of the Geogebra program.

Moreover, the interview findings demonstrate that Instagram social media assists participants in resolving academic challenges and enhancing their knowledge. According to one of my classmates, it aids my learning and comprehension and stimulates me with valuable and innovative ideas. One student, identified as I1, described his learning endeavours on Instagram and detailed how he utilized the platform to overcome the challenges he encountered in his studies. "I repeatedly viewed videos on the Instagram app to comprehend a three-dimensional subject, particularly when utilizing the Geogebra app, which I struggled to grasp from the textbook or class notes." The utilization of videos and infographics on Instagram, presented in a visually appealing manner with detailed explanations, really facilitated my learning process.

As a result, I have surpassed my classmates regarding personal growth and development. Instagram serves as a platform not just for educational purposes among students but also to address non-academic issues. The subsequent findings are derived from interviews with female students serving as informant 2 (I2): "I utilize Instagram as a tool to address various homework challenges. Specifically, I seek out mathematics-

focused Instagram accounts that offer accessible discussions and tutorials, providing clear, sequential instructions on approaching specific tasks and solving problems." I2 asserts that acquiring knowledge through Instagram is effortless and enjoyable; also, the use of visual aids facilitates comprehension of the imparted material. I find Instagram intriguing since videos and graphical graphics captivate me more than written paragraphs. When informants encounter unfamiliar information, they rely on Instagram to quickly comprehend visual representations over one minute. These visuals effectively demonstrate the precise methods for calculating, adding, subtracting, and problem-solving. The text showcases the utilization of Geogebra to illustrate mathematical literacy content in three-dimensional learning, specifically in point-to-point distance material. The visual representation may be observed in Figure 2.

Figure 2. Content Ins-GG

4 Conclusion

The development of GeoGebra Instagram content in three-dimensional material follows the Thiagarajan model or 4-D model. The findings indicate that Ins-GG in the third-dimension material is highly valid, as evidenced by a correlation coefficient of 0.89. The practicality of this approach is also very high, with an average score percentage of 76.61% on student response questionnaires. Furthermore, the effectiveness of Ins-GG in improving students' understanding of concepts in third-dimensional material is currently increasing, as demonstrated by a pretest and posttest analysis with an N-Gain result of 0.46.

The enhancements provided by Ins-GG encompass the selection of compatible colours, suitable typefaces, and the inclusion of necessary elements. The outcome of this study is Ins-GG, which consists of a compilation of materials, videos, and practice questions accompanied by a QR code and an Ins-GG handbook accessible through a link shared on the Instagram social media platform. The ongoing technological advancement of Ins-GG necessitates further enhancement. It is anticipated that a comparable study utilizing the identical program will be extended to additional pertinent resources, particularly those necessitating visualization. Furthermore, future investigations are anticipated to enhance Ins-GG by incorporating diverse metrics, enabling alternative perspectives, conducting large-scale trials, and addressing the limitations of this study. Therefore, comprehending the subject under investigation or other related skills is an updated development.

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