UNESA 5 Math Gallery: Math Interactive Digital Learning Media Curative for Students Across 9-14 Years Old

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Abstract

Indonesia's socio-economic status (SES) makes it difficult for fourth- to eighth-graders to learn multiplication, geometric forms, and basic mathematics due to insufficient resources and outdated teaching methods. Math topics are abstract and complex, thus engaging virtual learning resources that match with the curriculum are needed to bridge the gap between passive instruction and active, student-centered learning. To meet this need, the UNESA 5 Math Gallery is an interactive virtual gallery that leverages Artsteps to teach basic math through 3D models, films, and quizzes. This medium uses ADDIE-based 'curative' involvement to improve understanding. Active inquiry, formative evaluation, and feedback help students overcome past misconceptions through constructive refinement, using audio-visual elements. The gallery improves motivation, spatial thinking, independent guided learning, self-assessment, and mastery for advanced math skills. This study also examines its usability, learner participation, and academic performance in Indonesian classrooms. Results show that the UNESA 5 Math Gallery's virtual learning tools reduce regional math instruction discrepancies, motivate students, and ensure equitable access to quality materials.

Keywords: *Artsteps; Currative Interactive Learning Media; Mathematics Education; UNESA 5 Math Gallery; Virtual Gallery.*

Abstrak

Status sosial-ekonomi Indonesia (SES) membuat sulit bagi siswa kelas empat hingga delapan untuk belajar perkalian, bentuk geometri, dan matematika dasar karena inovasi pembelajaran terbatas. Topik matematika bersifat abstrak dan kompleks, sehingga diperlukan sumber belajar virtual yang menarik dan sesuai dengan kurikulum untuk menjembatani kesenjangan antara pengajaran pasif dan pembelajaran aktif yang berpusat pada siswa. Untuk memenuhi kebutuhan ini, Galeri Matematika UNESA 5 adalah galeri virtual interaktif yang memanfaatkan Artsteps untuk mengajarkan matematika dasar melalui model 3D, film, dan kuis. Media ini menggunakan keterlibatan 'kuratif' berbasis ADDIE untuk meningkatkan pemahaman. Galeri ini meningkatkan motivasi, pemikiran spasial, pembelajaran mandiri yang dipandu, penilaian diri, dan penguasaan keterampilan matematika tingkat lanjut. Hasil penelitian menunjukkan bahwa alat pembelajaran virtual Galeri Matematika UNESA 5 mengurangi perbedaan instruksi matematika regional, memotivasi siswa, dan memastikan akses yang setara terhadap materi berkualitas.

Kata Kunci: Artsteps; Media Pembelajaran Interaktif Kuratif; Matematika Pendidikan; Galeri Matematika UNESA 5; Galeri Virtual.

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INTRODUCTION

Mathematics is universally regarded as one of the foundations of education because it impacts nearly all aspects of a person's life, including learning, living, and career opportunities in the future. It develops for learners the requisite skills of analysis, logical reasoning, and problem solving that are vital in all disciplines and in practical situations (Li & Schoenfeld, 2019). In view of this importance, the primary and lower secondary mathematics education should be delivered with the best possible quality and effectiveness to facilitate proper academic development and lifelong learning. Over the last few decades, the use of modern teaching methodologies has greatly focused on the use of interactive learning media for the teaching of mathematics (Suprapto et al., 2024). Interactive learning media are physically or digitally available tools of instruction that require active participation of learners on their own through manipulation and exploration of the materials, as well as immediate feedback (Chaidir et al., 2024). Textbook-based instruction is often dominated by a "sit and listen" culture, thus, information is often presented or pushed to students without engaging them actively. Instructional media has and continues to utilize technologies to move away from static learning environments toward dynamic, engaging learning environments (Baradaran Rahimi et al., 2024).

For pupils in grades 4 to 8 in Indonesia, learning more advanced mathematics poses several notable challenges. As an archipelagic country, Indonesia has a diverse range of socio-economic structures owing to the vast gaps in the availability of robust infrastructure, educational resources, qualified teaching personnel, and advanced technology, even within the same country (Churiyah et al., 2020). Therefore, many students struggle with critical arithmetic concepts essential to their geometric progression, such as multiplication and basic shape recognition (Jupri & Drijvers, 2016). The lack of adequate resources is exacerbated by the outdated pedagogical techniques that dominantly rely on rote learning (Tobias et al., 2014). This leads to a vicious cycle of low motivation, disengagement, and poor educational outcomes.

A significant gap in the current educational landscape is the insufficient integration of interactive and immersive digital media in mathematics education in Indonesia.Many teachers still lean on chalk-and-talk routines, so the learning feels flat and one-way. Churiyah et al. (2020) note that currents platforms rarely target students in grades 4 through 8, especially when they are grappling with spatial reasoning or geometry. When a stronger toolset does appear, it often vanishes behind economic barriers, leaving learners in remote districts cut off from decent hardware and bandwidth.

This study explores a novel avenue by pairing the immersive environment of Artsteps with mathematics instruction for middle-grade Indonesian learners, a combination not previously reported in the literature. By curating interactive virtual galleries that students navigate on their own, the project invites them to encounter mathematical ideas in a setting that visually resembles a museum rather than a classroom. The experiment also sits at the intersection of emerging educational technology and established pedagogical theory, aiming to demonstrate that enjoyment and rigor can coexist in a single lesson. A step beyond pilot enthusiasm, the research will systematically assess whether the platform can run reliably in schools where bandwidth and hardware are anything but flawless, thus offering lessons for policymakers who must scale promising prototypes across the archipelago.

This gallery aims to house fundamental mathematics topics from the curriculum enabling learners to navigate through in a virtual space on Artsteps. The project aims to combine theories of instructional design with technological applications in order to construct a ‘math cure’ learning resource, alleviating students’ persistent challenges with the subject by making it easier, more relevant, and enjoyable. To achieve this research objective, the UNESA 5 Math Gallery will be developed as an emerging interactive learning media to ‘curatively’ address the needs of 4th to 8th grade learners of mathematics in Indonesia. The use of the “curative” concept emphasizes that there is an attempt to provide a corrective tool to counter challenges posed in the math learning experience.

This interactive gallery serves to enrich not only to enhance the traditional instructional methods employed in the classroom but also enrich the learner's exposure to diverse and multi-modal learning experiences. With this study, the aim is to improve comprehension of core mathematical concepts among students by increasing their active participation through engaging interactive, immersive, and out-of-the-classroom learning activities. Through engaging with the UNESA 5 Math Gallery, students are encouraged to undertake learning activities such as 3D geometric exploration, virtual arithmetic exercises, and solving embedded quizzes TEEs. These activities are intended to help promote self-directed mastery drills/performance, reinforce instructional objectives, contribute to the understanding of concepts through guided discovery, and provide access to timely feedback critical for effective acquisition and retention of knowledge.

Furthermore, the project seeks to evaluate the effect of such media on students' motivation and engagement because these elements are closely linked to achievement. Engaging and enjoyable learning experiences may not only stimulate curiosity, but they also promote active participation in the learning process. This is especially critical in the context of mathematics instruction, where anxiety and negative attitudes predominate. Another equally important goal is to assess the practicality of the UNESA 5 Math Gallery concerning its potential use in actual school classrooms in Indonesia. This involves assessing the availability of the Artsteps platform in different school settings, its usability for teachers and students, and the instructional guidance that is needed to ensure optimal use of the program. This research seeks to analyze user feedback in order to inform educators and education planners who are interested in enhancing mathematics instruction with digital interactive media.

RESEARCH METHODS

Research Design

The current study employs a research and development (R&D) approach to create UNESA 5 Math Gallery as a curative of math interactive learning media

(Branch, 2009). UNESA 5 Math Gallery could be accessed form this link https://www.artsteps.com/view/67702428fa03b9f06793107f. The ADDIE was implemented in the process of creating UNESA 5 Math Gallery. It was done because the iterative process of ADDIE is flexible and could aid in making the virtual gallery to be more expandable. The research is carried out in the actual classrooms to obtain real-world insight regarding the use of the interactive media in the context of Indonesian education.

Data Collection

To evaluate the educational impact of the UNESA 5 Math Gallery along with its usability in classroom settings which was done in SDN Mranggen 1, Magetan. A comprehensive multi-instrument approach was used. Observation served as the collection instruments. During classroom observations, students' interactive engagements with the media were monitored in relation to participation, interaction, teamwork, and any associated difficulties. Observers documented detailed field notes on student attention, navigation challenges, and teacher scaffolding. These observations enriched other data sources by providing context and immediacy.

Analysis of Data

Responses to open-ended questions, interview texts, and observation notes were used to derive qualitative data that were analyzed qualitatively using thematic analysis. It involved assigning certain concepts to the collected data, which in this case, pertained to student engagement, instructional difficulties, media usability, and media enhancement suggestions. This quantitative analysis was important as it helped explain the quantitative findings. The study supplied users' impressions and observations from the classes, which, alongside the users' impressions and classroom observations, provided qualitative narrative evidence to UNESA 5 Math Gallery's highlighted value as a teaching and learning resource positioned within the teaching and learning.

RESULTS AND DISCUSSION

This part explains the results of the first steps of the UNESA 5 Math Gallery project which are the Analysis and the Design phases. These phases were important in ensuring the interactive learning media was developed properly to address the authentic instructional challenges among Indonesian middle school students from grade 4 to 8. The project's objectives along with standards fulfilled the design gaps by addressing learning gaps which created a sound contextual media for the project.

Analysis Phase

The Analysis Phase was an extensive study focused on the condition of mathematics education for the specific students as well as the external factors that are likely to affect the learning environment. The research team, which included educators, attended classes, and conducted student and teacher interviews to assess their understanding of particular problems, motivation, and overall technological milieu. The needs assessment highlighted essential foundational problems students grapple with in several elementary mathematics topics. Many students frequently struggled with recalling the multiplication tables along with applying the recall in word problems and multi-step calculations. This often impedes their working memory in division and fraction concepts.

The study of geometry pertaining to two-dimensional and three-dimensional shapes posed significant difficulties. Students exhibited poor ability to visualize, construct, and interact with various shapes and spatial reasoning abilities. These challenges were more apparent with three-dimentional shapes, where abstract properties like volume and surface area are not easily accessible when teaching through pictures and text. In the case of quantification, arithmetic operations more advanced than addition and subtraction posed a challenge for learners (Li & Schoenfeld, 2019). Applying arithmetic operations to real life contexts such as measurement, money, or data interpretation was beyond students' competencies. This suggests a gap between intuitive understanding of a topic and the skills required to execute it.

Educators drew attention to the gaps caused by inadequate instructional material that lacked interactive, hands-on, or gamified activities. Educators reported that students disengaged during the predominantly lecture-based lessons and repetitive, rote-worksheet exercises. Furthermore, the assessment showed that students had distinct interests, learning preferences and require tailored approaches to learning, but the materials offered were mostly homogeneous and inflexible to varying paces and modalities (Rianasari et al., 2020). The assessment also looked into motivational factors and attitudes toward mathematics among students. A considerable number of students reported experiencing anxiety and low confidence associated with mathematics, particularly because of prior failures or grasping abstract concepts (Leong, 2013). This psychological wall reinforced the avoidance behavior and learning stagnation. Readiness regarding technology differed by school and area.

The extensive website data allowed the research team to identify specific learning gaps that the interactive media needed to address. In the first place, students' achievement of multiplication had to be enhanced through repetitive, enjoyable practice as well as through explanation of relevant concepts. The media would also need to facilitate rich visual and interactive manipulation of 2D and 3D shapes to foster spatial reasoning and geometric understanding. There are two significant things media attempted to achieve in motivating students, one being the mediational curiosity gap, fostering motivation to attempt a real-world application of their knowledge. The media sought to solve this problem by incorporating contextualized problem-solving exercises. Also, to resolve motivational issues, media utilized features geared towards capturing curiosity, providing constructive feedback, offering rewards that indicate a sense of achievement, or even through tracking achievements.

Design Phase

The Design phase Integrated the analysis findings in form of particular learning outcomes, instructional methods, and a comprehensive content and interaction framework for UNESA 5 Math Gallery, even including strategies for

content delivery. The design process followed a spiral path owing to the collaboration with identified experts in the field, teachers, and even some pilot participants to check for practicality and adoption. In the interest of sustaining relevance to the curriculum, the design team undertook a thorough review of the Indonesian national mathematics curriculum for grades four to eight. This analysis helped to carve out precise learning objectives directed at crucial competencies defined upon critical analysis which included: multiplication fluency, geometric understanding of two and three-dimensional shapes, arithmetic skills, and quantification.

Every single learning objective was constructed using criteria that can be unambiguously evaluated and measured. Examples of these objectives are: “Students will recall times tables up to, and including, 12 x 12, together with associated word problems, and will solve relevant word problems, ” as well as “Students will recognize and name the basic 3 D shapes and be able to compute their volume and surface area.” The articulation helped in ensuring that clarity all media elements such as interactive exhibits, quizzes and explanatory content provided were focused on the stated goals (Eddles-Hirsch et al., 2019). The storyboard showed how the media was organized. It arranged the virtual gallery into thematic rooms for each topic area, progressing from simpler to more complex ideas in a logical order. For instance, the multiplication room first displayed visual aids and drills and then progressed to applied problem-solving. In the geometry room, students interacted with 3D models, dynamically rotating and dissecting shapes to explore their properties.

Teachers who attended the early review session appreciated the learning pathways along with the accompanying visuals and texts because of their clarity. They stressed that minimal, streamlined pathways would be particularly vital for younger age groups or those with limited technological prowess lest they suffer from overwhelming cognitive stress. Because of this feedback, clear labels, consistent layout, and guided navigation cues were incorporated into the design. Feedback from student focus groups was also positive. Students expressed their enthusiasm regarding the virtual gallery walkthrough, particularly the shape

manipulation feature that allowed them to interactively test their knowledge. They appreciated the instant feedback within the systems and reported overall confidence increases with gentle corrections accompanied by explanations when they made errors.

The design team integrated all expert, teacher, and student feedback within the learning media design to finalize it. Added revisions included more constructive feedback, additional clarified instructions, more scaffolded hints during the activity, and scaling back on saying math concepts in real life. The interface design was simplified to remove redundant actions so concentrate on the learning content without diversion. The remaining design plan balanced curriculum alignment with an engaging learning experience to ensure that the UNESA 5 Math Gallery offered both enjoyment and educational effectiveness.

Development Phase

The development phase focused on building the UNESA 5 Math Gallery within the Artsteps Platform. This Work Integrated Learning (WIL) project required all of the mathematics gallery's architectural and instructional design visions to be completed as working models in a fully virtual environment. This phase was challenging and required the work of an entire team including a project manager, graphic artists, video editors, and primary users. To meet these educational objectives, the development team first produced rich three-dimensional (3D) geometric representations of shapes from the Indonesian-specified Curriculum for Years 4 to 8 (C4). Considerable effort was put towards making the geometric models rotatable and zoomable, alongside other degrees of free manipulation, enabling students to deconstruct shapes and explore their various properties, including faces, edges, vertices, volume, and surface area. The editors also prepared video lessons presenting essential arithmetic operations, multiplication, and quantification processes in a fun and age-appropriate style tailored for students.

In creating exercises, the curriculum concepts were broken down into bite-sized parts that were polished for mastery. Simple recall questions were

blended with problem-solving exercises requiring application of learned concepts into real-life scenarios. Immediately after, users were able to receive feedback on their performance through recount quizzes, fostering self-guided correction, diving deep engaging exploration of the content. A prototype of the gallery was implemented and tested with a small group of students and teachers before widespread implementation. This initial testing proved to be beneficial. The students had a positive reaction, enjoying the experience and wishing to explore math through immersion and interaction. Numerous students described how 3D shape manipulation clarified many confusing subjects, and quizzes bolstered engagement and motivation

Figure 1. UNESA 5 Math Gallery Interface

Students' positive feedback regarding the gallery allowed for clear functionality evaluation, but critical gaps needing refinement emerged as well during prototyping. In figure 1, it could be seen that the interface is similar to the real-life gallery. However, navigation controls were too complicated for younger students, especially those in grade 4. Also, the internet connection required smoother interaction for some users, and low-end device users experienced lag as well, severely hindering user experience. Using these observations, compressing media files, enhancing navigation, and streamlining loading times were methods which greatly enhanced the gallery's overall performance. During this stage, the needs voiced by the users emphasized the necessity of incorporating user-design methods into education.

Usability testing was performed in parallel with prototype testing towards the evaluation of UNESA 5 Math Gallery as a learning environment. As part of the system usability assessment, the following aspects were evaluated: ease of navigation, instruction clarity, responsiveness to interactions, and overall satisfaction. Through the usability feedback surveys, the students reported high levels of both participation and engagement, as more than 80% of respondents stated that interacting with the Gallery was simple and enjoyable. The platform was also appreciated by the teachers, who described its museum-like organization as visually appealing and helpful in aiding the students to mentally structure topics. Despite the positive reception, some aspects of usability were lacking. Students with little experience in digital environments had difficulty performing basic tasks, such as moving from one room of the virtual gallery to another or interacting with 3D models. To overcome this issue with step-by-step guided interaction, the initial navigation and interaction tasks received guidance in the form of preemptive help bubbles.

Implementation Phase

During this period, "the UNESA 5 Math Gallery" moved from being a developed prototype to an educational resource that was actively utilized within classroom activities. The teachers used the gallery during the math lessons for a couple of weeks to see how the media would serve as a teaching resource. Instructionally, the teachers felt the gallery was a valuable addition to the lesson as it was an interactive tool that complemented standard instruction and provided additional support to deepen students' understanding. Interacting with 3D shapes and completing quizzes enabled learners to understand abstract concepts far more than using textbooks.

Figure 2. UNESA 5 Math Gallery Introduction in a Local Primary School

Figure 2 showed one of the interactive learning media in UNESA 5 Math Gallery. This digital learning media could be accessed through the math gallery. The media's modular structure facilitated different pedagogical approaches depending on the lesson objectives and the pace of the class. While some instructors used the gallery as a whole-class presentation, leading students through exhibits via projector, others preferred to let students, or small groups, explore on their own devices. This flexibility was greatly appreciated since it allowed more room for various classroom circumstances and the available technology. The focus of the observations during this phase was on the active engagement of the students with the content. Numerous students voiced their excitement in not only exploring the gallery but also in describing concepts, discussing them with peers, and mentally challenging themselves with quizzes. This media interactivity seemed to alleviate the math anxiety and the reluctance to participate, especially within the more traditionally disengaged lessons.

Among the many notable successes of the implementation phase are the motivation and engagement of the students. The inviting atmosphere that encouraged students to try their best was due to interactive format, real-time feedback, and motivation through gamified elements such as badges and progress tracking. Students said that they appreciated having an exploration component and stated that the gallery was "more fun" and "more interesting" than regular

math classes. This increased engagement was often associated with longer attention spans and improved time-on-task, which is a strong predictor of positive learning outcomes (Kushariyadi et al., 2024). Students were prompted to collaborate as they walked around the gallery, solved tasks, and discussed problems together. This informal learning component helped improve attitude and understanding towards math.

As with any intervention, the degree of engagement was influenced by varying levels of motivation, digital competencies, and prior knowledge of mathematics. Many teachers observed that students with stronger competencies were able to adapt more quickly and benefitted greatly while others required guidance to move around the virtual space with confidence. Teachers greatly appreciated the gallery because it met most of their curriculum requirements and facilitated many learning preferences. A number of them expressed the need to focus on more active teaching and met the instructional media requirements beyond basic levels of need diagnosis.

The respondents underscored the importance of visual and interactive materials for better understanding of advanced mathematics. They noted that features like hints for questions and videos explaining various components assisted to decrease frustration and promoted independent learning. The concerns mentioned included occasional technical issues and the need for further teacher training to utilize the media's full potential. Some teachers proposed more inclusive content considering a deeper topical breadth as well as functionalities tailored to the special educational needs of some students.

Evaluation Stage

Students expressed greater confidence with math and reported an improved emotional connection to the subject. Many characterized the gallery as more inviting and less daunting than traditional math lessons, as they appreciated the immersive nature of the material. Teachers noticed enhanced engagement and active participation within the classroom. Furthermore, they reported that the gallery aided in differentiated instruction by permitting students to learn at their

own pace and allowing them to overcome challenging concepts through repetition. The media also acted as a diagnostic, illuminating misconceptions through answer quizzes and strategically enabling targeted aid. Some students and teachers noted that although the gallery was excellent for high visually- and interactively-oriented learners, primary level learners who struggle with reading or basic digital skills may need supplementary materials tailored to these skills.

The most notable strengths were highlighted in the evaluation. The media's alignment with the curriculum was accurate which made relevance easier to achieve. Its interactive, multimodal structure motivated students and aided their understanding of concepts. Moreover, the web-based structure offered access flexibility on numerous devices in different settings. Circumscribed limitations included issues with accessibility, more specifically with internet-reliant infrastructures which were problematic for certain schools. Younger and less tech-savvy students required ongoing support, and some educators voiced the desire for more thorough training and additional materials to enhance impact. Expanding math and including examples relevant to Indonesian culture were recommended. Suggested enhancements also included adaptive challenge levels, multilingualism, and integration into existing learner management systems.

CONCLUSION

The construction and use of UNESA 5 Math Gallery exhibits address an educational concern on how to facilitate effectively grade 4 through 8 level Indonesian students learning mathematics. Using the Artsteps virtual gallery as a platform for this project has helped to implement immersion into the world of mathematics which has often been regarded as a very abstract discipline. Incorporation of 3D models, multimedia resources, as well as formative quizzes aligned with the curriculum has shown positive effects on students' motivation, spatial reasoning, and mastery of the prerequisite skills of multiplication, arithmetic, and geometry. This study shows underlined the promise of using virtual galleries to mitigate the static nature of teaching in many developing contexts where there is a lack of infrastructure and resources. More so, UNESA 5

Math Gallery provides students with self-pacing, instant formative evaluation, real-time assessment, and better control over the learning of core mathematical concepts which are very important for learners' long-term success.As the media demonstrates potential improvements in learning outcomes and engagement, its efficacy is constrained by factors such as internet availability, access to devices, and teacher preparedness to use technology in their teaching. These challenges need to be resolved to achieve widespread, fair utilization.

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