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Transformation Of High School Geography Learning: 3d Hydrological Cycle Media Training For MGMP Teachers

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ABSTRACT
The training on developing 3D media of the hydrological cycle was conducted for geography teachers in the MGMP of SMA/MA in Pariaman City and Padang Pariaman Regency to enhance pedagogical skills and diversify instructional media. The program consisted of administrative preparation, delivery of hydrology materials, and practical sessions using a semi-prepared model strategy for efficiency. Evaluation employed Likert-scale questionnaires, observation, and group discussions. Results indicated an average satisfaction score of 4.4 out of 5, with the highest for student benefit (4.7) and the lowest for model complexity (3.8). Furthermore, 90% of teachers expressed readiness to implement the media in their classrooms. Discussions also highlighted local issues, such as the reliance on rainwater consumption, which enriched teachers' perspectives on water quality and safety. The program was concluded to be effective in strengthening teachers' capacities and recommended enhancing model complexity and expanding innovative media development.

Keywords: 3D media, hydrological cycle, geography teachers, teacher training, community service

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INTRODUCTION

Climate change and environmental degradation have increased the urgency of understanding the hydrological cycle as a foundation for water literacy. Teachers play a crucial role in equipping students with hydrological cycle concepts that are not only academically relevant but also practically relevant to addressing issues of clean water availability. Therefore, strengthening teacher capacity through practice-based training is a strategic step to support improving the quality of geography learning (Müller et al., 2021; Walshe, 2021).

The hydrological cycle is a crucial topic in geography and science curricula, yet students often perceive it as abstract. Concepts such as evaporation, condensation, precipitation, infiltration, and runoff require a visual approach for easy comprehension. Research shows that using visual models and project-based experiments can significantly increase student engagement and conceptual understanding (Aksit et al., 2016; Sari et al., 2020).

The use of three-dimensional (3D) media in learning offers opportunities to transform abstract material into more concrete representations. Physical models allow students to explore the interrelationships between processes in the hydrological cycle, making learning more interactive. Recent studies confirm that both physical and digital model-based learning media can improve student motivation and learning outcomes in science (Teo et al., 2021; Wijnen et al., 2021).

On the other hand, teachers' ability to design innovative learning media still faces challenges, both in terms of technical skills and the availability of facilities. Teachers often rely on lecture methods and conventional media, resulting in passive learning. Training focused on creating 3D media based on the hydrological cycle is expected to bridge this gap. This aligns with findings that teacher professional development through hands-on practice contributes to significant changes in learning strategies (Jang & Tsai, 2013; Kafyulilo, 2020).

The local context also demonstrates the urgency of improving water literacy. In some coastal and island regions, such as Pariaman and Padang Pariaman, communities still rely on rainwater as their primary drinking water source. This requires teachers to have a comprehensive understanding of water quality and availability, enabling them to instill environmental awareness from an early age. Recent research highlights the importance of integrating local issues into geography learning to build students' ecological competencies (Filho et al., 2022; Mukherjee et al., 2020).

Furthermore, collaborative-based training involving teachers in working groups has been shown to enhance pedagogical skills and creativity in media development effectively. Participatory training models provide a space for teachers to share experiences, discuss challenges, and design innovative solutions relevant to their respective school contexts. Educational literature emphasizes that teacher collaboration is a key factor in the success of learning innovations (Vangrieken et al., 2017; Warwick et al., 2019).

Therefore, the training on creating 3D media for the hydrological cycle not only aims to improve the quality of geography learning but also equips teachers with practical skills that can be directly applied in the classroom. This community service program is expected to empower teachers to create more meaningful learning experiences, while supporting the achievement of the Sustainable Development Goals (SDGs) related to quality education and clean water management. Previous findings confirm that learning innovation-based interventions have long-term impacts on the quality of education and environmental literacy (Azeiteiro et al., 2015; UNESCO, 2020).

METHOD

This Community Service activity was conducted in collaboration with the Geography MGMP of Senior High Schools (SMA/MA) in Pariaman City and Padang Pariaman Regency, with SMAN 3 in Pariaman City as the central location. Participants were all 31 geography teachers who are members of the MGMP. To facilitate interaction, participants were divided into two groups of 15–16 people each.

The activity involved three main stages. First, the preparation stage, which included initial observations at SMAN 3 in Pariaman City, administrative arrangements (invitation letters, attendance lists, permits), and the formation of an implementing committee comprising a facilitator, field coordinator, and documentation team. This stage also determined the implementation schedule, taking into account participant availability and school facilities. Second, the material delivery stage, in which the presenter explained the hydrological cycle in a practical, relevant manner. Third, the practical stage of creating 3D media, using a half-finished strategy: the community service team prepared approximately 50% of two hydrological cycle models, and participants then completed the work by labeling each process.

The program evaluation used a simple quantitative survey and field observations. The evaluation instrument was a Likert-scale questionnaire (1–5) that assessed several aspects: material clarity, teacher confidence, ease of media creation, affordability and availability of materials, durability, complexity, and the media's benefits for students. Additionally, yes/no questions related to implementation intentions and one open-ended question were added to elicit development suggestions. The collected data were analyzed by calculating the average score for each aspect, frequency distribution, and percentage of responses. Observations during the training were used as triangulation to assess participant engagement, the smoothness of the process, and the effectiveness of the mentoring method. Thus, the evaluation not only assessed satisfaction but also provided an overview of the potential for implementing 3D media in the classroom.

FINDING AND DISCUSSION

Preparation

The preparation phase consisted of initial observations and coordination activities conducted at SMAN 3 Pariaman City. Administrative requirements, including invitation letters, attendance lists, and permission documents, were completed prior to implementation. An organizing committee was established consisting of a facilitator, field coordinator, and documentation team. In addition, two semi-finished hydrological cycle models (±50%) were prepared to ensure time efficiency during the training and to provide participants with a clear preliminary structure of the learning media.

Implementation of 3D Hydrological Cycle Media Creation Training

a. Presentation

The training was held on 2 August 2025 and involved 31 MGMP geography teachers from Pariaman City and Padang Pariaman Regency. The material was delivered by Dr. Helfia Edial, MT, who explained the short, medium, and long hydrological cycles, the distribution of water on Earth, and rainfall characteristics in the western coastal region of West Sumatra. The presenter emphasized that rainwater is not always suitable for direct consumption due to possible contamination by aerosols, particulates, and heavy metals.



Fig 1. Delivery of hydrological cycle material.

b. Discussion Session

The discussion session revealed teachers' concerns regarding community practices, particularly the reliance on rainwater as a primary drinking source in several areas, such as Mentawai. Questions were also raised about the low quality of groundwater in some regions. These inquiries indicate that participants recognized the relevance of hydrological concepts to local water-resource challenges.

c. Practical Session

Teachers were divided into two groups and guided to complete the remaining components of the semi-prepared 3D hydrological cycle model. Activities included forming topographical features, labeling hydrological processes (evaporation, condensation, precipitation, infiltration, runoff), and refining the visual presentation of the model. Throughout the session, the PKM

team provided technical assistance to ensure conceptual accuracy.



Fig 2. Participants, along with the community service team, compile a 3D model of the hydrological cycle.

Through this hands-on activity, teachers not only deepen their theoretical understanding of the hydrological cycle but also gain hands-on experience developing three-dimensional media. This way, participants gain practical skills that can be directly applied in the classroom, making learning more interactive, concrete, and accessible to students.

Evaluation Result

Evaluation using a Likert-scale questionnaire (1–5) yielded an overall satisfaction mean score of 4.4. The highest mean score was recorded for *student usefulness* (4.7), while *model complexity* received the lowest score (3.8).

Furthermore, 90% of participants indicated readiness to adopt the 3D media in their respective classrooms. Participants suggested enriching the model with more detailed representations of surface runoff, river channels, and human activities to increase contextual relevance.

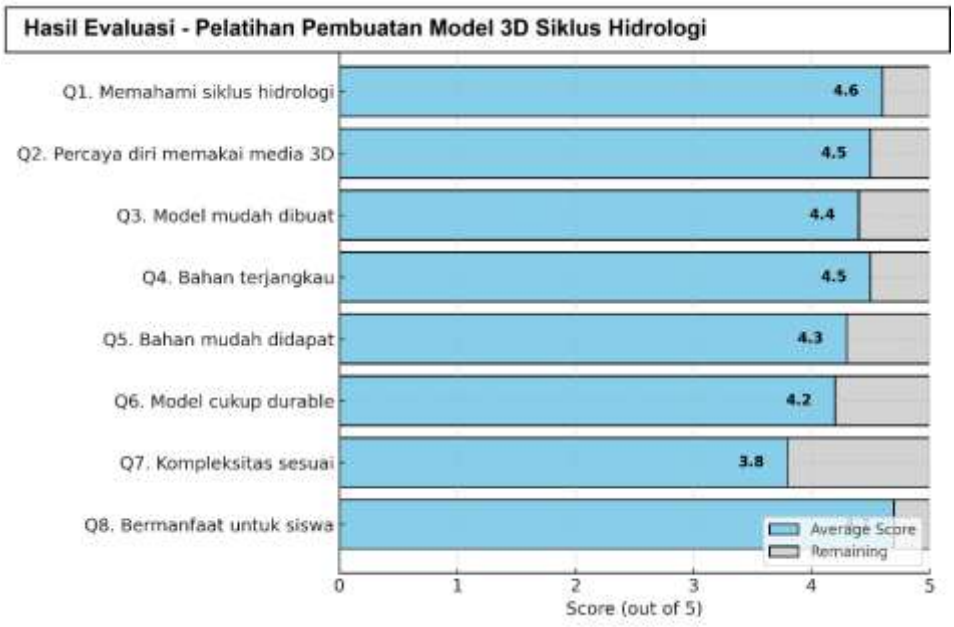


Fig 3. Participant evaluation results (N=31).

Challenges

The main challenge identified during implementation was the limited time allocation, which made it impractical to construct the media entirely from raw materials. The semi-prepared model strategy was therefore essential for ensuring activity completion without reducing participant engagement.

Discussion

Preparation Stage

The structured preparation described in the results was essential in ensuring the smooth implementation of the training. The decision to prepare two semi-finished models (±50%) proved effective in addressing the limited time available. This strategy is consistent with findings by Warwick et al. (2019), who emphasize that clear organization and prior structuring of learning materials improve the quality of professional development sessions. Furthermore, the preparation aligns with Vangrieken et al. (2017), who argue that collaborative and well-planned environments support teacher engagement and readiness.

Presentation Session

The presentation session strengthened teachers' conceptual understanding of the hydrological cycle, which is crucial before engaging in practical model construction. As shown in the results, this session provided clarity regarding rainfall mechanisms, distribution of water, and issues related to water quality. Such conceptual grounding is supported by Müller et al. (2021), who stress that strong content knowledge enhances teachers' confidence and instructional quality. The discussion regarding unsuitable rainwater consumption also reflects the relevance of integrating environmental health issues into geography education, consistent with Aksit et al. (2016) and Walshe (2021).

Discussion Session

The evaluation results (Fig. 3) show high participant satisfaction (mean 4.4), with perceived The questions raised by participants—particularly concerning the community's reliance on rainwater and issues of groundwater quality—indicate that teachers are aware of local environmental challenges. This aligns with Mukherjee et al. (2020), who highlight the importance of integrating local knowledge and contextual issues into environmental learning. The session helped clarify misconceptions and contributed to enhancing teachers' water literacy, supporting the view that contextual engagement enriches pedagogical insight (Filho et al., 2022).

Practical Session

The practical session demonstrated active involvement and collaboration among participants, which aligns with the literature on effective teacher professional development. Hands-on model construction has been shown to improve conceptual understanding in science and geography education (Wijnen et al., 2021; Georgakakos, 2024). The collaborative nature of the practical work also reflects findings from Kafyulilo (2020), who asserts that teacher design teams enhance creativity and skill development. Therefore, the results confirm that practical, model-based learning can significantly improve pedagogical competence.

Evaluation Results

The high satisfaction scores, particularly the usefulness score of 4.7—indicate that participants perceive the 3D model as effective learning media. This aligns with findings by Valeeva et al. (2023),

who note that modeling activities positively influence science learning outcomes. The lower score for complexity (3.8) suggests areas for improvement, consistent with Márquez García et al. (2024), who argue that instructional media must include adequate detail and realism to support deeper understanding. The high implementation readiness (90%) corresponds with the "reaction" and "learning" levels described in Quinton et al. (2022), confirming the training's effectiveness.

Challenges

The main challenge identified, time limitations, highlights structural constraints commonly faced in professional development programs. The semi-prepared model technique effectively addressed this issue, which aligns with Ragsdale et al. (2020), who emphasize adapting instructional strategies to time limitations while maintaining quality. The need for more durable materials and more detailed representations suggests that future training should adopt iterative development models, consistent with UNESCO (2020), which recommends continuous innovation in education for sustainable development.

CONCLUSIONS

Training on creating 3D media on the hydrological cycle for high school (SMA/MA) Geography MGMP teachers in Pariaman City and Padang Pariaman Regency proved effective in improving teachers' understanding and skills. Evaluations showed an average satisfaction score of 4.4 out of 5 (≈ 8.8/10), with the highest score for student benefits (4.7) and the lowest for complexity (3.8). Ninety percent of teachers stated their readiness to implement the media in the classroom, demonstrating the link between discussion, monitoring, and evaluation results and teacher readiness to adopt project-based learning (PBL). The question-and-answer session also strengthened teachers' understanding of water quality issues, particularly the practice of consuming rainwater in coastal areas, which is still considered normal by the community. The presenter emphasized that rainwater is low in minerals and may contain pollutants, making it inadvisable to consume directly. He also emphasized the importance of groundwater quality testing.

These findings demonstrate that the activity not only develops practical skills in creating learning media but also provides space for critical reflection on the local context of water resources. Thus, the sustainability of the program needs to be directed at further training to enrich the complexity of 3D models (for example, adding aspects of runoff, river flow, and human activity), implementation assistance so that the media is used consistently in schools, as well as the development of other innovative media, including digital-based ones.

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