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Strategies to Improve Geospatial Literacy through an Interactive Approach and Survey Instrument Demonstrations at MA Pondok Pesantren Cipari, Garut Regency

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ABSTRACT

High school students' understanding of geospatial science, particularly Geodetic Engineering, remains relatively low. In fact, geospatial technology is closely connected to everyday life, especially in digital mapping and navigation. This community service activity aimed to introduce the Geodetic Engineering Study Program to students of MA Pondok Pesantren Cipari, Garut, through interactive outreach activities. The program included presentations on core subjects such as Geographic Information Systems (GIS), Remote Sensing, and Terrestrial Surveying, as well as demonstrations of survey instruments such as total stations and geodetic GNSS. Evaluation was conducted using pre-tests, post-tests, and partner satisfaction questionnaires. The results indicate a significant increase in students' understanding. Average pre-test scores were below 30% for most parameters and increased to more than 80% in the post-test. The highest improvements were observed in understanding of Remote Sensing (+69.3 points) and interest in Geodetic Engineering (+59.5 points). Students also identified hands-on practice with survey instruments as the most engaging aspect of the activity. From the partner's perspective, more than 77% of teachers rated the activity as very good and recommended its continuation. This activity proved effective in improving geospatial literacy among MA students and can serve as a model for similar community service programs in Islamic boarding school environments.

Keywords: *Geodetic Engineering, geospatial literacy, Islamic boarding school, Cipari Garut Regency, survey instruments*

1. INTRODUCTION

Geodesy is an Earth science discipline that studies the measurement and representation of the Earth and its gravity field. According to the International Association of Geodesy (IAG), geodesy is the science concerned with the shape, size, and gravity of the Earth. Since ancient

times, geodetic principles have been utilized for navigation and orientation purposes. Mapping activities date back to ancient Egyptian civilization (around 2000 BC) to support maritime navigation. In the modern era, maps—especially in digital form—have become an inseparable part of daily life. Digital maps facilitate navigation to destinations, provide distance information and optimal routes, and enable real-time searches for various objects such as restaurants, hotels, and tourist destinations **(Alamsyah et al., 2021; Rimadhani et al., 2015).** This demonstrates that geospatial technology is not only essential for traditional mapping but also plays a major role in everyday activities.

Producing accurate and informative maps requires various surveying and sensing technologies. In Geodetic Engineering, students study terrestrial surveying (land measurement), hydrographic surveying (waterbody measurement), photogrammetry (surface modeling from aerial imagery), remote sensing, and geographic information systems (GIS). These fields demand a comprehensive understanding of field data acquisition, data processing, map visualization, spatial analysis, and geospatial-based decision-making (Amri & Wijayanti, 2019). In other words, modern mapping techniques involve a combination of advanced measurement instruments and data processing software, all of which are taught in Geodetic Engineering programs.

Despite the importance of geodesy and Earth sciences, public knowledge of these fields remains limited, including among high school teachers and students **(Rombe, 2024).** Many senior high school and Islamic senior high school (SMA/MA) students lack a comprehensive understanding of geodesy and its applications. For example, MA Pondok Pesantren Cipari, Garut (the partner of this activity), has limited access to geospatial technology information. Geography learning at the school largely relies on online resources such as YouTube videos, without hands-on field experience or direct use of GIS applications. This condition results in limited student understanding of how digital maps are produced and applied.

In response to these issues, Institut Teknologi Nasional Bandung (Itenas) conducted a community service activity to introduce the Geodetic Engineering Study Program to students of MA Pondok Pesantren Cipari, Garut. The outreach activity included an overview of the Geodetic Engineering curriculum, demonstrations of survey instruments (such as total stations and geodetic GPS), and introductions to GIS, photogrammetry (aerial photo mapping), and terrestrial surveying. The primary objective was to provide students with a direct overview of the geodetic profession and the technologies used in modern mapping. Through a combination of presentations and practical demonstrations, it was expected that students' interest and understanding of Earth science technologies would increase.

Similar outreach and educational introduction efforts have been conducted in various other community service programs. Students at SMAN 3 Mataram experienced a 34.5% increase in knowledge of Arduino applications after participating in a community service program **(Sasongko et al., 2022).** Lecturers from the Faculty of Engineering at Universitas Wijaya Putra also conducted training on industrial testing and measuring instruments for high school and vocational school students, receiving positive responses from 126 students from various schools **(Abdullah et al., 2024).** Another community service activity increased students' understanding of artificial intelligence at Sultan Agung Private High School from 18% to 99% **(Chandra et al., 2023).** Experiential and hands-on learning approaches have been shown to significantly improve conceptual understanding and student engagement in science and technology education **(Kete et al., 2025).** These examples demonstrate that face-to-face engagement and direct introduction are effective in improving students' understanding of new scientific fields.

Based on this background, the community service activity conducted by the Geodetic Engineering Department of Itenas is expected to enrich the learning experiences of MA Pondok Pesantren Cipari students through exposure to geospatial technology. Through presentations on geodesy and demonstrations of field survey instruments, students gained new insights into map production and its applications. This approach aims to support more contextual and practical geography learning while inspiring young generations to engage with Earth science fields that are highly relevant to everyday life.

2. METHODOLOGY

This community service program was designed to improve students' geospatial literacy and interest in Geodetic Engineering through interactive lectures and hands-on demonstrations of survey instruments.

The indicators of success included:

1. increased student understanding of Geodetic Engineering concepts,
2. improved knowledge of GIS, Remote Sensing, and Terrestrial Surveying, and
3. increased student interest in the field of Geodetic Engineering.

Program effectiveness was evaluated using pre-test and post-test questionnaires administered to students, as well as satisfaction questionnaires completed by teachers. The use of pre-test and post-test design is widely applied in educational intervention studies to measure learning improvement and program effectiveness **(Suhartati, 2022).** The comparison between pre-test and post-test results was used to measure learning improvement, while teacher feedback was used to assess the relevance, delivery quality, and overall implementation of the program.

2.1 Program Implementation

The outreach activity was conducted on Monday, May 5, 2025, at the Al-Syuro Mosque Hall in Cipari, Garut, which is designated as a Regency-level Cultural Heritage building. The location is approximately 75.2 km from Itenas and can be reached by private vehicle or by local train from Kiaracondong Station to Cibatu Station. A total of 73 students from grades 10 and 11, specializing in science (MIPA) and social sciences (IPS), participated in the activity. The sequence of activities is summarized in Table 1.

The activity began with the distribution of a questionnaire to assess students' prior knowledge of Geodetic Engineering (pre-test). This was followed by a general introduction to Geodetic Engineering and an overview of core courses such as Terrestrial Surveying, Geographic Information Systems, and Remote Sensing. In addition to theoretical explanations, students were given the opportunity to directly try survey instruments commonly used by Geodetic Engineering students, including Electronic Total Stations and geodetic GNSS receivers. Two days prior to the outreach activity, students had also observed university students conducting data acquisition for final projects using these instruments.

Table 1. Schedule of the Community Service (PKM) Activities.

No.	Time	Activities
1	09.00-09.30	Introduction to Itenas Bandung and the Geodetic Engineering Study Program by the Head of the Geodetic Engineering Program, M. A. Basyid, Ir., M.T., and Dr. Gusti Ayu Jessy Kartini, S.T., M.T. (Lecturers).
2	09.30-10.10	Introduction to core courses: Geographic Information Systems (GIS), Remote Sensing, and Terrestrial

No.	Time	Activities
		Surveying by Sumarno, Ir., M.T., Thonas Indra M., S.Kel., M.T., and Indrianawati, S.T., M.T. (Lecturers).
3	10.10-11.00	Survey instrument demonstration by Ade Ma'mun Nurussalam, S.Pd. (Laboratory Technician) and Itenas Geodetic Engineering students.
4	11.00-11.30	Discussion and question-and-answer session.
5	11.30-11.40	Completion of questionnaires or evaluation forms.

At the end of the session, students participated in a discussion, question-and-answer session, and completed a post-test questionnaire to evaluate their understanding after the activity. Teachers also completed satisfaction questionnaires to assess their perspectives on the implementation of the program. The main stages of the activity, including pre-test administration, introductory lectures, and survey instrument demonstrations, are shown in Figure 1.

(a) (b) (c)

Figure 1. (a) Students completing the pre-test questionnaire,(b) introduction to Geodetic Engineering, and (c) introduction to total station survey instruments by Geodetic Engineering students.

3. RESULTS AND DISCUSSION

During the initial session, 73 students completed the pre-test questionnaire to assess their prior knowledge of Geodetic Engineering. Table 2 show that most students had never heard of or were unfamiliar with courses taught in the Geodetic Engineering program. However, when provided with multiple-choice options regarding the definition of Geodetic Engineering, 71.2% correctly identified it as a field related to mapping and Earth measurement. When asked whether they were interested in learning more about Geodetic Engineering, 69.9% of students responded that they were very interested.

Table 2. Closed-ended Questions in the Pre-Test Questionnaire.

No.	Questions	Yes (%)	No (%)
1	Have you ever heard of Geodetic Engineering?	24,7	75,3
2	Do you know what GIS is?	8,2	91,8

No.	Questions	Yes (%)	No (%)
3	Do you know what Remote Sensing is?	17,8	82,2
4	Do you know what Terrestrial Surveying is?	1,4	98,6

In the final session, 70 students completed the post-test questionnaire. Compared to the pre-test results, there was a 63.9% increase in understanding of Geodetic Engineering. A total of 98.6% of students stated that Geodetic Engineering is a discipline that studies mapping and Earth measurement techniques, representing an increase of 27.4% compared to the pre-test.

To assess students' attention to the material presented, the post-test asked students to mention two courses introduced during the outreach. Most students were able to recall one or two core courses, with Terrestrial Surveying, Remote Sensing, and Geographic Information Systems being the most frequently mentioned (Figure 2). This indicates that the material was delivered effectively, although there remains room for improving terminology clarity and visual presentation to enhance retention.

(a) (b) (c)

Figure 2. (a) Presentation on Terrestrial Surveying, (b) Geographic Information Systems, and (c) Remote Sensing.

In open-ended responses, students identified hands-on practice with survey instruments as the most memorable experience (Figure 3a and 3b). This suggests that future Geodetic Engineering outreach activities should prioritize practical sessions. Previous studies also highlight that hands-on demonstrations and interactive engagement significantly enhance student motivation and retention of technical concepts **(Laid & Adlaon, 2025).** For theoretical sessions, students recommended incorporating interactive elements such as quizzes with prizes (Figure 3c) and more dynamic delivery styles to maintain engagement throughout the program.

(a) (b) (c)

Figure 3. (a) Introduction to survey instruments by the laboratory technician, (b) explanation of geodetic GPS instruments by students, and (c) prize distribution to participants who asked questions.

Based on the pre-test and post-test questionnaires, a significant improvement was observed across all aspects, including understanding and definition of Geodetic Engineering, comprehension of GIS, Remote Sensing, and Terrestrial Surveying, as well as student interest in the field (Figure 4). Table 3 shows teachers satisfaction questionnaires also indicated very high satisfaction levels. More than 77% of teachers rated the activity as "Good" or "Very Good" across all aspects, although 11.1% suggested that the pace and depth of material presentation could be improved. Teachers also recommended extending this activity to other schools, highlighting the potential for sustainable collaboration.

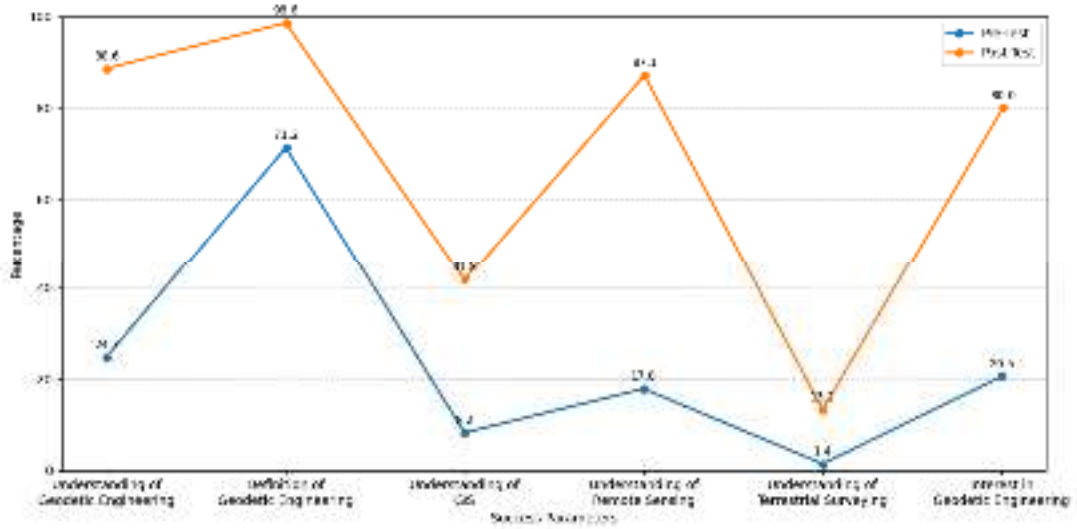

Figure 4. Results of the questionnaires administered to students at the beginning and at the end of the Geodetic Engineering outreach activity.

Table 3. Partner Satisfaction Questionnaire

No.	Questions	Very Good (%)	Good (%)	Fair (%)	Poor (%)
1	Did this activity meet your expectations?	88,9	11,1	0	0
2	What is your opinion regarding the materials presented?	77,8	22,2	0	0
3	How do you assess the delivery method used by the Itenas team?	77,8	11,1	11,1	0
4	Did the survey instruments introduced provide new insights for the students?	77,8	11,1	11,1	0
5	Was the duration of the activity appropriate?	77,8	22,2	0	0
6	How do you evaluate the collaboration between Itenas and MA Pondok Pesantren Cipari during the activity?	77,8	22,2	0	0
7	How likely are you to recommend this activity to other schools?	77,8	22,2	0	0

Recommendations derived from student and teacher feedback include refining delivery methods (speech pace, intonation variation, and concise slides), providing clearer technical explanations of instruments before hands-on practice, and optimizing time allocation by extending practical and discussion sessions.

As a follow-up plan, future activities are proposed in the form of periodic outreach programs and the provision of introductory learning materials related to geospatial technology for teachers and students. Collaboration with MA Pondok Pesantren Cipari may also be extended through student visits to the Itenas Geodetic Engineering laboratories or short practical workshops. These follow-up actions are intended to ensure sustainability and long-term impact of the program.

4. CONCLUSIONS

Based on the evaluation of pre-test and post-test results, the outreach activity of the Geodetic Engineering Study Program at MA Pondok Pesantren Cipari successfully increased students' understanding and enthusiasm significantly. Average pre-test scores across six success parameters ranged from 1.4% to 71.2%, while post-test scores increased to between 13.2% and 98.6%. The highest gains were observed in understanding of Remote Sensing (+69.3 points) and interest in pursuing Geodetic Engineering (+59.5 points), confirming the effectiveness of interactive approaches and instrument demonstrations.

Teacher responses were also highly positive, with more than 77% rating all aspects—including activity relevance, material quality, and collaboration—as "Good" or "Very Good." The highest score was recorded for alignment of the activity with expectations (88.9% "Very Good"). Nevertheless, suggestions were made to deepen theoretical explanations and extend discussion sessions.

Students' open-ended responses emphasized hands-on instrument practice as the most impactful component, followed by increased understanding of geodetic concepts and digital mapping. Suggestions highlighted the need for longer practical sessions, deeper exploration

of GIS and Terrestrial Surveying, and varied delivery methods such as quizzes and light humor to sustain engagement.

By extending hands-on sessions, strengthening interactive visual materials for GIS and Terrestrial Surveying, and enhancing presentation dynamics, future outreach activities can further optimize student interest and readiness for advanced studies in the geospatial field.

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