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Introduction to Digital Practicum to Enhance Numeracy Literacy of Teachers

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Abstract: The characteristics of physics learning, which discuss natural phenomena and present them in a scientific context, are often supported today by digital practicum activities. However, field facts indicate that some teachers still need help analyzing data in tables and graphs, which are part of numeracy literacy. Therefore, activities are needed to introduce digital practicum to improve teachers' numeracy literacy skills. This effort is realized through community service activities using the Participatory Action Research (PAR) method in the Physics Teachers Professional Association (MGMP) of senior high schools in Batang Regency, Central Java. The activities include training related to introducing digital practicum using the Arduino Science Journal application, reading, processing, and interpreting data. Overall, 100% of teachers reported gaining new knowledge related to the digital practicum supporting mastery of numeracy literacy.
Keywords: arduino science journal; digital practicum; numeracy literacy

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INTRODUCTION

The Merdeka Curriculum was created to solve the low results of Indonesian students in the Programme for International Student Assessment (PISA). Therefore, literacy skills must be connected to the Merdeka Curriculum. The Ministry of Education and Culture has intensified the National Literacy Movement (GLN). This movement has been well received by the education sector, as evidenced by numerous studies in the literacy field (Darwanto et al., 2021; Feriyanto, 2022; Mukharomah et al., 2021). Research shows that students' literacy skills generally need to be improved, including scientific literacy in physics learning. One factor contributing to the low scientific literacy skills in physics is the need for more practical activities in online learning (Marwah & Pertiwi, 2024; Mukharomah et al., 2021; Nurlaili et al., 2023; Zulaiha & Kusuma, 2021). One effort that can be made to improve scientific literacy skills in physics is through literacy-based practical activities.

Numeracy literacy is broadly understood as the knowledge and ability to use various numbers and symbols related to basic mathematics to solve real-life problems (Ministry of Education and Culture, 2017). In classroom learning and daily life, it is common to encounter information analysis presented in various forms, such as tables and graphs, which are then interpreted and used as needed. Someone with mathematical ability does not necessarily have numeracy skills, thus requiring appropriate development. Numeracy is not the same as mathematical competence. Both are based on the same knowledge and skills, but the difference lies in the empowerment of these knowledge and skills. Mathematical knowledge alone does not make someone numerate.

In addition to teaching skills, which are an important and prominent part of learning, the physical environment and teaching aids also significantly influence learning (Benseman et al., 2005). The current digital technology era offers many conveniences in obtaining and disseminating information, including its use in education. Digital technology can stimulate creativity, thereby facilitating the learning process. The Ministry of Education and Culture has provided expanded access to information and online learning resources regarding numeracy literacy through Pustekkom (Ministry of Education and Culture, 2017).

However, some other programs and applications are easily accessible and free to use, such as Scratch, Liveware, Visual Analyser, and Phyphox. Scratch simulations can be used to develop computational thinking skills in their construction and numeracy literacy in data analysis processes. Liveware is an electronics simulation program used to design and analyze circuits, presented in animation form to demonstrate electronics' basic functions or principles. Visual Analyser is often used to explain wave concepts. Phyphox is a smartphone-based sensor application used as a measuring tool in practical activities, thus overcoming the limitations of practical equipment in schools while promoting students' numeracy literacy skills.

The above applications are just examples that can enhance numeracy literacy skills by displaying data in graphical form. Then, the numeric data can be downloaded in various formats such as .csv or Excel. This data can then be processed according to needs. Digital technology like this in education has been widely implemented (Geiger et al., 2015; Harjono, 2021; Widhiyanto, 2010; Yasmini et al., 2021). Research results indicate that applying digital technology can improve students' conceptual understanding, making it effective in learning. Another application that can be utilized in the digital physics practicum is the Arduino Science Journal. This application can be downloaded for free from the Google Play Store. It operates using sensors, one of the built-in facilities of Android phones.

It is clear that numeracy literacy needs to be mastered not only by students but also by teachers and educators. Numeracy literacy is a crucial element in the Merdeka Curriculum, so teachers need to implement literacy and numeracy-based learning to achieve educational goals. Regarding learning, numeracy literacy is essential for physics teachers. The characteristics of physics learning, which discuss natural phenomena and present them in a scientific context, require good numeracy literacy skills, especially when presenting quantitative data in tables and graphs, which must also include analysis to derive meaningful physical information.

A digital practicum is crucial because it can enhance literacy and numeracy skills besides presenting learning suitable for current developments and involving technology. Therefore, teachers need training in digital practicum. Hardyanto et al. (2021) and Wahyuni et al. (2022) introduced digital practicum in community service activities, and both activities used Scratch as their chosen medium.

This community service activity continues Hardyanto et al. (2021) with the same audience, the Physics Teachers Professional Association (MGMP) of Senior High Schools in Batang Regency, but uses a different application. The application chosen this time is the Arduino Science Journal. In addition to focusing on introducing the application for digital practicum, this activity also aims to assist some teachers who still face difficulties in analyzing numeric data presented in tables and graphs along with their physical meanings. Therefore, this activity aims to enhance teachers' numeracy literacy by introducing the Arduino Science Journal application in the digital physics practicum.

METHOD

The method used in this community service activity is Participatory Action Research (PAR) (Afandi et al., 2022). The activity begins with identifying the community's problems, in this case, the Physics Teachers Professional Association (MGMP) of senior high schools in Batang Regency, and then mapping out solutions. The activity implementation involves training, with the procedure presented in Figure 1.

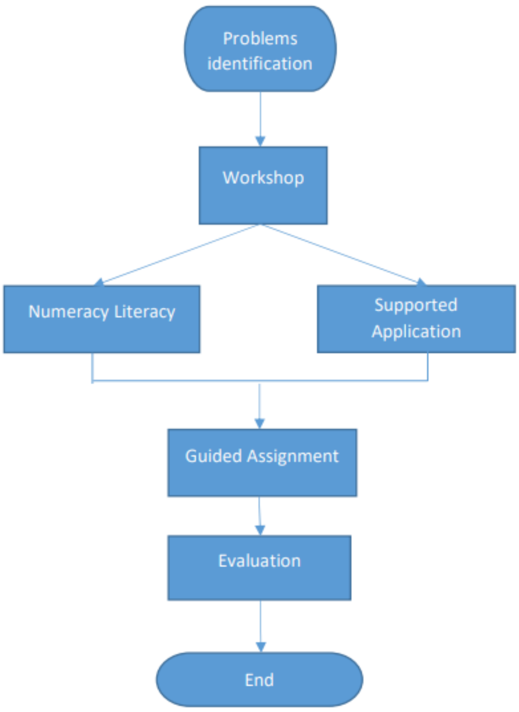


Figure 1 Community service flow

The application chosen for this digital practicum is the Arduino Science Journal. Experiments conducted include calculating the acceleration of free-falling objects, the motion of objects on inclined planes, and physical quantities in circular motion. All these practicums require smartphones equipped with the Arduino Science Journal application.

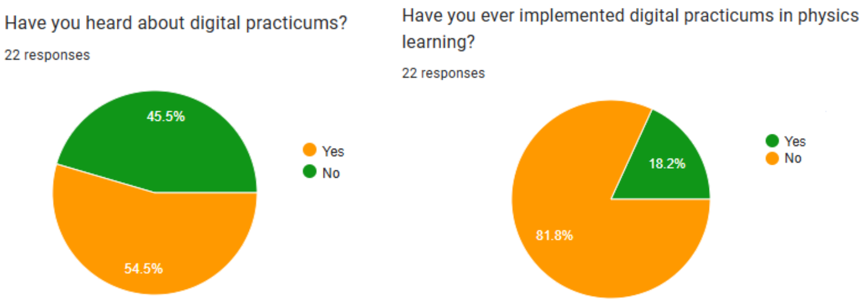
RESULTS AND DISCUSSION

The community service activity was conducted on Thursday, August 3, 2023. The activity was attended by high school physics teachers from Batang Regency who are members of the Physics Teachers Professional Association (MGMP). The activity took place offline at the auditorium of SMA N 1 Batang. The topic covered during the meeting was numeracy literacy, which introduced a digital practicum using the Arduino Science Journal application, which can be freely downloaded on Android smartphones. This application utilizes sensors available on Android smartphones. This application is crucial as it can enhance numeracy literacy skills by downloading experiment data into Excel format, processing it into analyzable data with physical meaning, and then depicting it in graphical form. Experimental results can be compared with theoretical predictions.

For instance, in the experiment on the motion of objects on an inclined plane, as shown in Figure 2, a series of inclined planes were set up on a table. Smartphones were attached to toy cars moving along these inclined planes, with the acceleration calculation menu on the Arduino application activated. Sensor readings on the smartphone appear as graphs on the screen. Numerical data can then be downloaded in Excel format and processed as needed to determine the acceleration, velocity, and position at any given time. Furthermore, the data in the Excel file can also be plotted directly into graphs. Comprehensive motion analysis can be determined based on numerical and graphical representations.

Figure 2 Experiment on motion on an inclined plane

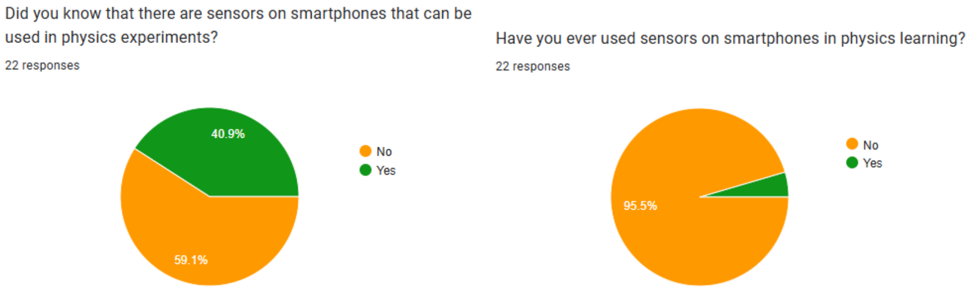
The first session was attended by 22 teachers from public and private schools. More than half of the attending teachers indicated familiarity with digital practicum, yet only 18.2% have implemented it in their teaching. This data aligns with the teachers' survey results, as depicted in Figure 3.



(a) (b)

Figure 3 (a) Initial data on knowledge of the digital practicum and (b) Initial data on the implementation of digital practicum

Although many are aware of digital practicums, a significant portion still need to be made aware that smartphones commonly used for communication also feature sensors suitable for physics experiments, thus their utilization in teaching remains minimal. This data can be seen in Figure 4.

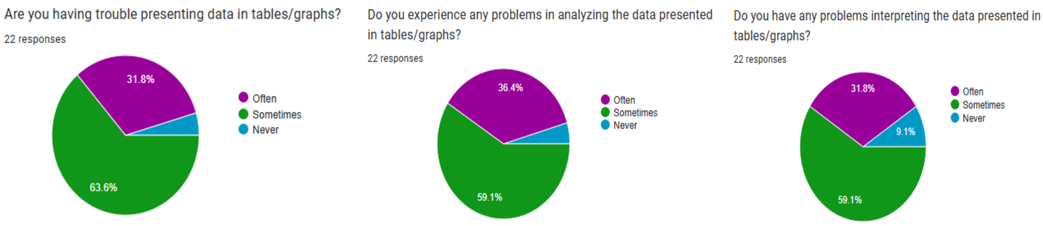


(a) (b)

Figure 4 (a) Initial data on knowledge of smartphone sensors and (b) Data on the utilization of smartphone sensors in teaching

Regarding numeracy literacy, a focal point of the national literacy movement, smartphone sensors can be utilized effectively. Sensors available on smartphones can aid in measurements during physics experiments. The Arduino Science Journal application is one such option. This application provides several sensor utilization menus, including ambient light (flux), sound intensity (dB), pitch (Hz), linear accelerometer (m/s²), accelerometer X (m/s²), accelerometer Y (m/s²), accelerometer Z (m/s²), compass (degrees), and magnetometer (µT). These menus can be used according to specific needs. For example, an ambient light sensor can measure light intensity, while a sound intensity sensor can measure sound intensity.

Numeracy literacy is inseparable from the ability to present data in tables and graphs. After data presentation, the next capabilities involve data analysis and interpretation. As indicated in Figure 5, some teachers still face challenges in these three areas.



(a) (b) (c)

Figure 5 (a) Data on teachers' difficulties in data presentation, (b) Data on teachers' difficulties in data analysis, and (c) Data on teachers' difficulties in data interpretation

In addition to introducing sensor-based digital practicums on smartphones, the Arduino Science Journal application can enhance numeracy literacy skills. After the smartphone records, raw practicum data can be downloaded in Excel format and processed according to needs. For example, in an experiment on linear motion using an accelerometer sensor, the acceleration data obtained can be processed to derive velocity and position data at every moment along its path. This experiment no longer requires a stopwatch or length measurement tools because Arduino Science Journal provides the data with a precision of three decimal places.

Teachers were enthusiastic about participating in the activities, especially when allowed to conduct practicums using their smartphones, as shown in Figure 6.

(a) (b)

Figure 6 (a) Teachers conducting independent practicums and (b) Enthusiastic teachers conducting guided practicums

Overall, this activity benefitted teachers, as evidenced by questionnaire results indicating that 100% of teachers gained new knowledge related to digital practicums to enhance numeracy and literacy skills. These results are presented in Figure 7.

Figure 7 Questionnaire results

These questionnaire results align with Hardyanto et al. (2022) and Wahyuni et al. (2022) findings. Overall, teachers stated that community service activities in schools were beneficial, but due to limitations in mentoring and support, only a few teachers ultimately developed skills to apply in physics teaching. However, if teachers can master digital practicum applications, they can provide simulation projects to students, thereby fostering creativity and critical thinking skills. This supports the goals of the independent curriculum.

CONCLUSION

Community service activities equipped teachers with knowledge about digital practicums and numeracy literacy. Teachers conducted digital practicums using smartphone sensors integrated with the Arduino Science Journal application.

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