Development of practical tools faraday effects on magnetic materials

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Abstract. This research aims to develop practical tools faraday effects that can be used as a medium for learning physics subjects in magnetic materials. The development method used is the Research and Development (R&D) method with the ADDIE model approach. The stages of this research are to Analyze, Design, Development, Implementation, and Evaluation. The tools and materials used are magnetic field sensors, 400 winding solenoids as induction sensors for test materials, Power Supply, 500x magnification USB microscope, CSV as data storage from sensors, Delphi 2007 as a hysteresis curve viewer. Product evaluation in the form of validation was carried out using an instrument in the form of a questionnaire filled by media experts with an average score of 93.94% so that it was in the excellent category and material experts with an average score of 86.05% so that it was in the very good category. The expected results of this study are. The results of the assessment of the effectiveness of the Faraday effect practicum tool, an N-gain of 0.67 was obtained that the average pretest was 48.0 and posttest 83.0. Based on the data above, this research shows that the development of the Faraday effect practicum tool is suitable for use as a learning medium.

1. Introduction

Physics is a scientific discipline that is part of the most fundamental science and technology. Physics examines the interaction of matter and energy. Almost all principles in physics are taught through experimental activities. One of the fields of study in physics that underlies the development of advanced technology today is electricity and magnetism. Implementation of magnetism in the use of magnetic materials following certain characteristics is determined by observation and research. In physics experiment activities, the three characteristics of this material can be analyzed through hysteresis curves obtained from observational data [1]. Previous studies have shown that demagnetizing field effects can find layers of weak magnetic material (paramagnetic) and obtained temperature dependence on demagnetizing fields [2]. The study conducted a study related to the influence of the magnetic field to determine the magnetism of the material. However, the research has not revealed the effect of magnetic material on the weakening and strengthening of the magnetic field and how much the permeability value of the tested magnetic...
In other previous studies, the results of levitation configuration can be stabilized with hollow cylinders of diamagnetic material [3]. The above research provides an overview of tool design and implementation of the types of magnetic materials in the field of life, where the utilization of magnetic materials is input in this study, so it is important in advance to determine the types of magnetic materials. Based on the results of the needs analysis of the learning media carried out from several universities in Indonesia with 27 respondents. The analysis data revealed that 100% of respondents had learned about magnetic material, there were 85.18% had difficulty in learning it, while the difficulty was understanding concepts, visualizing characteristics and mathematical calculations.

From some of these difficulties, 96.29% of respondents wanted the existence of learning media that can help the learning process, amounting to 92.59% of respondents need a practical tool Faraday effect as a tool that can determine the characteristics of a material. Thus, by placing the rods of this material in strong magnetic fields, it is possible to know the application of Faraday’s Law in measuring instruments, for example, the Faraday effect has been used to measure optical rotating forces, for modulation of the amplitude of light, and for remote sensing of magnetic fields. The magnetic material can be affected if placed in a magnetic field. Based on this magnetic material is divided into 3 groups, namely ferromagnetic, paramagnetic, and diamagnetic [4]. One way to determine the magnetic properties of magnetic material is by magnetizing the material which is then shown through a hysteresis curve [5].

Based on the description above, one of the efforts that can be done to improve the quality of learning of magnetic material which is material is to be assisted by the media, so that in this study a Faraday effect practicum tool will be developed to study the characteristics of magnetic phenomena as a learning medium so as to facilitate students to understand learning which is given.

2. Methodology

The method used is research and development that refers to the ADDIE model. The stages are based on the ADDIE model [6]. The instrument used in this study was the material expert validation sheet, the media expert validation sheet.

Data analysis was performed using a Likert scale to measure people's opinions and perceptions [7].

In determining the percentage of success the following equation is used.

\[ P = \frac{S}{N} \times 100\% \]

Information:
P: Percentage of success (%)
S: The amount of acquisition value
N: The maximum number of values

The data obtained is written in the interpretation of the score in the table (1) below[7].

| Average Score | Interpretation |
|---------------|----------------|
| 0%-20%        | Bad            |
| 21%-40%       | Not Good       |
| 41%-60%       | Enough         |
| 61%-80%       | Good           |
| 81%-100%      | Very Good      |

Analysis of the effectiveness of the practicum using N-gain calculated using equation as follows[8].

\[ N - \text{Gain} = \frac{\text{Post test score} - \text{pretest score}}{\text{Maximum score} - \text{pretest score}} \]
The results of the N-gain calculation are categorized into 3 (three) categories[9]:
High: N-gain ≥ 0.7
Medium: 0.3 ≤ N-gain ≤ 0.7
Low: N-gain < 0.3

3. Results and Discussion
The media developed is the Faraday Effect practicum tool consisting of hardware and software to determine the hysteresis curve simply from a solid material and the dipole moment of powder material. In this study used a magnetic field sensor, a solenoid with 400 turns as an induction sensor for test materials, Power Supply, 500x magnification USB microscope, CSV as data storage from the sensor, Delphi 2007 as a hysteresis curve viewer. The photo of the practicum faraday effect that has been developed is as follows.

![Figure 1. Practical tools for faraday effects](image1)

![Figure 2. Display of the magnetic dipole moment of the current powder material B = 0 using digital microscope software](image2)

![Figure 3. Display the magnetic dipole moment of powder material when B > 0 using digital microscope software](image3)
Furthermore, a tool trial was carried out with powdered Fe2O3 and NaCl samples placed in the middle of a 400-winding selenoid coil and observed using a digital USB microscope with a magnification of 500 times. The results can be seen in the following curve.

**Figure 4.** Display of hysteresis curves in the material magnetization process.

**Figure 5.** The results of experiments with Fe2O3 powder

**Figure 6.** Results of experiments with NaCl
In measuring magnetic field induction and viewing the magnetic domain using a digital microscope 500 times magnification on the Fe$_2$O$_3$ test material (iron sand), and NaCl (table salt), there is a similarity in the pattern of magnetization that occurs without test material, where the magnetic field induction increases with increasing strength electric current. However, if observed, at the same electric current strength value of B generated in the measurement of the magnetic field induction with a sample that is larger than without the test material. This can occur because the sample Fe$_2$O$_3$ (iron sand), Fe Powder has been magnetized by the induction coil so that the magnetic field sensor detects B which is a contribution from the value of the external magnetic field and magnetization. Based on this, in measurements with samples of Fe$_2$O$_3$ (iron sand), Fe powder, induction of the magnetic field is directly proportional to the resultant H and B. This is what happened in figure 5 shows that the sample Fe$_2$O$_3$ (iron sand), Fe powder has the same characteristics, namely easily magnetized and not easily lose its magnetic properties even though there is no inducing magnetic field. The magnetization pattern shows the characteristics of the ferromagnetic material. Based on figure 6 it can be seen that the powder of nonmagnetic material NaCl powder direction of the magnetic moment of the atom of nonmagnetic material results in being zero so that the magnetic domain does not change.

The results of the validation of material experts and media experts can be considered in the table below.

| Table 2. Results of material expert validation |
|-----------------------------------------------|
| No   | Rated aspect         | Average score (%) | Interpretation |
|------|----------------------|--------------------|----------------|
| 1    | Content conformity   | 84.37              | Very good      |
| 2    | Media objectives     | 91                 | Very good      |
| 3    | Learning quality     | 90                 | Very good      |
| Average |                     | 86.05              | Very good      |

Data validation results by material experts in terms of the suitability of the content, media objectives, quality of learning obtained an overall average score of 86.05% which means very good [7]. The results of the validation are then analyzed and used as a basis for revision.

The results of the validation of teaching aids by material experts showed that the product developed was suitable for use with editorial revisions.

| Table 3 Results of media expert validation |
|-------------------------------------------|
| No       | Rated aspect         | Average score (%) | Interpretation |
|----------|----------------------|--------------------|----------------|
| 1        | Quality of media     | 98.21              | Very good      |
|          | contents             |                    |                |
| 2        | Media design         | 93                 | Very good      |
| 3        | Learning Interaction | 90.62              | Very good      |
| Average  |                      | 93.94              | Very good      |

Data validation results by media experts reviewed the quality of media content, media design, and learning interactions obtained an average score of overall aspects of 90.62% which means very good [7]. The results of the validation are then analyzed and used as a basis for revision.

The results of the validation of teaching aids by media experts indicate that the product developed is suitable for use with editorial revisions. Testing the effectiveness of the media using a one-group pretest-posttest design. The instrument used was a multiple-choice objective test for the pretest and posttest. From the results of the study, it was found that the average pretest was 48.0 and posttest 83.0. The results of the study obtained a calculation of a normalized gain of 0.67 so that it falls into the medium category [9]. This research recommends that improvements need to be made in the graphic viewer software that is connected with the hardware to facilitate students in obtaining the results of each material tested.
4. Conclusion
Based on the results of data analysis and discussion, it can be concluded that the development of Faraday effect practicum tools for magnetic materials as learning media is divided into hardware and software. The software consists of a digital USB microscope application that is used to display images of magnetic dipole moments and hyper terminals used to monitor data from sensors. The hardware consists of solenoid coils, power supply, sensors, digital USB microscopes, and laptops. The Faraday effect practicum tool developed had the results of the material expert validation showing 86.05% (very good), the results of the media expert validation showed 93.94% (very good) so that it could be used as a learning medium. The results of the assessment of the effectiveness of the Faraday effect practicum tool obtained that the average pretest was 48.0 and 83.0 posttest. N-gain obtained a score of 0.67 with the medium category.

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