Constructivism-Based Magnetic KIT Design as a Science Learning Media

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Abstract. Some students still feel foreign to hear about electrical material because the material that is passed by some considers it to be still abstract. So that the concept of electric magnetism is still a lot of misconceptions. Based on the research, there are also some teachers who make assignments to students for experiment at their respective homes which makes students not do experiment but imitate the existing theory. The research aims to design a magnetic KIT that can be used for practicum at school. This study uses a 4D development model which is limited to the media development stage. The development of KIT magnets designed with four experiments with precision values in each of experiment have a very high range from 0.93 to 0.99 which it can be categorized high and the highest precision. So that from very high precision the error percentage of the magnetic KIT experiments are the lowest ranging a the lowest percentage 1.8%-9.7% which is categorized as a very low percentage of the magnetic KIT device. So the accuracy of the magnetic KIT device can be said to be very high. For the first and second experiments the results obtained are not much different from the existing theory. The percentage of errors for the first and second experiments ranged from 1.8%-8.6% while the third and fourth experiments were carried out repeatedly but the results were not much different or almost the same.

1. Introduction
Like science learning in general, science learning in junior high schools should always be oriented to laboratory activities related to laboratory activities [1] observation and experimentation are activities that must be carried out. By conducting experiments, students will more easily observe physical symptoms. For example, learning the concept of testing the nature of magnetism will be easy to understand if students conduct experiments. Without experimentation, this concept will be difficult for students to understand. Therefore, learning science without laboratory activities is useless, because this is contrary to the nature of science [2]. Science learning is not enough just to be based on books, but also equipped with practical tools for students to experiment. Students will be more motivated to learn so that learning activities become better. Through the use of learning media, planting science concepts, principles, and laws will result in more effective learning [3][4].

The creation of interactive learning activities is influenced by one of them by media and learning resources as useful tools in teaching and learning activities [5]. The media used can represent something that cannot be conveyed by the teacher through words. The effectiveness of students’ absorption of difficult and complicated learning materials can be achieved with the help of media as a...
Even aids are recognized to be able to give birth to good feedback from students. By utilizing complete and simple tactics of assistive devices, teachers can increase students' enthusiasm for learning.

Among the Physics Science materials that require the help of teaching aids in clarifying the concept are magnetic electricity materials. Based on the results of Indriani's research [10], it is known that the physics material at the junior high school level that has not been mastered by students is magnetic electricity [11][12]. The teacher's explanation of magnetic electricity such as the transformer principle without using teaching aids or experiments makes it difficult for students to understand it [13][14].

Science material that requires the help of KIT tools in clarifying the concept is electric-magnetic material so that if there is no KIT, the school will not never did a real experiment [15] magnetic field material is also a difficult material and you have to do experiments using a magnetic KIT because the level of complexity is high and full of abstraction. The teacher's explanation of the magnetic field around a current-carrying wire without using visual aids makes it difficult for students to understand it [16].

Experiments do not have to be done with KIT, but can also be done with surrounding materials so that a KIT device can be developed from local materials. Therefore, science learning should be changed to student-centered learning where students are actively engaged in learning or constructivism-based [17][18] so that in this study the development of a Magnet KIT for junior high school students consisted of four experiments, namely determining the direction of the magnetic field, straight wire, the effect of distance on the magnitude of the magnetic field, the Lorentz force and the phenomenon of Electromagnetic Induction. The development of this KIT uses the simplest method to understand the material of electric magnets and produces the best measurements [17]. The development of a magnetic KIT is designed using experimental tools that have been structured and systematic so that it can produce a calculation that is the same or almost the same as the existing theory.

2. Methodology

This research procedure refers to the steps of the 4-D (four D) development model, consists of 4 stages, namely defining, designing, developing and disseminating. Based on the results of these definitions, it is necessary to develop a KIT in order to be able to carry out practical work in schools so that there is no misunderstanding of the concept of electric magnetic material. The design of the KIT device consists of the mechanical design shown in Figure 1.

![Figure 1. KIT design of the first and second experiments](image)

Figure 1 is a mechanical design for an experiment to determine the direction of the magnetic field of a straight wire with current and the effect of distance on the magnitude of the magnetic field. This tool is equipped with a power supply and a small compass and straight wire which aims to make it...
easier to see the influence of the magnetic field on the straight wire. The design of experimental tool 3 namely the Lorentz force can be seen in Figure 2

![Figure 2. KIT design of the third experiments](image)

This experiment aims to identify and identify the quantities that affect the size of Lorentz-style funds. Based on Figure 3, this tool is also equipped with 3 magnets and 3 batteries to see how far the deviation occurs. The last experimental mechanical design on KIT magnets is the phenomenon of electromagnetic induction which can be seen in Figure 3

![Figure 3. KIT design of the fourth experiment](image)

Based on the KIT design in Figure 4, it can be seen that this tool only consists of a coil, a magnet keeping and a galvanometer. This experiment aims to prove that if the magnet is moved toward or away from the coil, an electric current will appear

3. Results and Discussion
The experimental set is built based on a pre-made design. Figure 4 is a display of the magnetic KIT tool
Experiments 1 and 2 use the same KIT tool in Figure 4 (a) equipped with a power supply on the table. There are six scales to place the compass so that it can be seen on the magnitude of the compass deviation that occurs. Figure 4 (b) is for the third experiment where the Lorentz force is equipped with ON and OFF buttons to turn on the current and the battery can be replaced. Furthermore, the last experiment can be seen in Figure 4 (c) consisting of coils of 100 and 200 turns equipped also with a battery to see the deviation of the galvanometer.

KIT magnetic device has been developed so as to produce a product that can be seen as it should. Furthermore, a functional test was carried out in order to see the extent to which it was able to find the concept of electric magnetism in accordance with the theory. This functionality test aims to calculate the level of accuracy, precision and percentage of errors of the magnetic KIT tool. There are 4 types of experiments designed in the magnetic KIT, namely the first experiment aimed at finding the effect of
current polarity on the direction of the magnetic field. Table 1 is the value of precision and error percentage for the first experiment

**Table 1. value of precision and error percentage for the first experiment**

| Experiment Name | Current Direction | Average Deviation Direction Result (°) | Precision Of Deviation Direction Result (Experiment) | Error percentage (%) |
|-----------------|-------------------|----------------------------------------|-----------------------------------------------------|----------------------|
| The direction of the magnetic field of a straight wire carrying current | To the top | 88,4° | 90° | 0.99 | 1.8 |
| | Down | 87,4° | 90° | 0.97 | 2.9 |

Based on the data, it can be seen like for that the calculation results obtained through the practicum are not much different from the existing theory, this can be seen from the high precision so that the percentage of errors is very small. Further results for the second experiment are can be seen Table 2

**Table 2. value of precision and error percentage for the first experiment**

| Name Experiment | Table Scale | Average Compass Deviation Value (°) | Precision | Error Percentage (%) |
|-----------------|-------------|-------------------------------------|-----------|----------------------|
| The Effect of Distance on the Magnitude of the Magnetic Field | 1 | 79 | 80 | 0.94 | 8.6 |
| | 2 | 68.25 | 70 | 0.97 | 9.0 |
| | 3 | 57.5 | 60 | 0.95 | 2.7 |
| | 4 | 45 | 50 | 0.96 | 8.8 |
| | 5 | 35 | 40 | 0.93 | 7.7 |
| | 6 | 27.75 | 30 | 0.94 | 8.6 |

The average accuracy of compass deviation measurements is shown in Table 2 by placing objects at certain distances. For distances on a scale of 1, the calculation results are 70° while according to the theory it is 80°. It can be concluded that the experimental results are not much different or almost the same as the theory. Where the calculation that has the largest error is when the object is placed on a scale of 2 which is 9% which in the calculation results are 68,25° while the theory of n should be 70°. However, the percentage of error is lowest when the object is placed on a scale 3. Overall the error percentage ranges from 2.7%-9 %. For experiment 3 can be seen in Table 3

**Table 3. Measurement results and calculations of the Third experiment.**

| Name Experiment | Current Value (A) | Magnetic Value | Average Deviation Value (cm) | Precision | Average Accuracy |
|-----------------|-------------------|----------------|-----------------------------|-----------|------------------|
| Lorentz Force   | 1                 | 1              | 1.1                         | 0.93      | 95%              |
|                 | 2                 | 1              | 1.4                         | 0.96      |                  |
|                 | 3                 | 1              | 1.7                         | 0.97      |                  |
|                 | 1                 | 0.96           |                             | 0.95      |                  |
|                 | 1                 | 2              | 1.3                         | 0.96      |                  |
|                 | 1                 | 3              | 1.6                         | 0.94      |                  |

The Lorentz force experiment uses a current of 1 to 3 A and the required number of magnets ranges from 1 to 3 magnets. In Table 3, it can be seen that even though the measurements were carried out repeatedly, the results were almost the same or not much different. Overall, it can be seen that the accuracy of this experimental tool reached 98%. The calculation results for the last experiment in the KIT magnet can be seen in Table 4.
Table 4. Measurement results and calculations of the Fourth experiment

| Experiment Name          | Number of Coils | Number Of Magnet | Movement | Average Deviation (G) | Precision |
|--------------------------|-----------------|------------------|----------|-----------------------|-----------|
| Electromagnetic Induction| 100             | 1                | Slow     | 4.9                   | 0.99      |
| Phenomenon               | 100             | 1                | Fast     | 5.9                   | 0.99      |
|                          | 100             | 2                | Slow     | 5.9                   | 0.99      |
|                          | 200             | 1                | Slow     | 9.6                   | 0.93      |
|                          | 200             | 1                | Fast     | 14.6                  | 0.95      |
|                          | 200             | 2                | Slow     | 13.9                  | 0.99      |
|                          | 100             | 1                | Slow     | 4.9                   | 0.99      |

The coils used in the experiment of the electromagnetic induction phenomenon range from 100-200 turns, while the number of magnets used is 1 and 2 only by moving slowly or quickly. Based on Table 3, it is found that even though measurements are carried out repeatedly, they still produce the same or almost the same calculations. In this experiment, the lowest precision was when using a coil of 200 turns with a magnet number of 1 and moving slowly, namely 0.93. So the precision for this experiment ranges from 0.93-0.99. The overall level of accuracy of the tool is 97%. Based on the analysis of the results of the precision value and the level of accuracy of the tool, the magnetic KIT tool can be categorized as feasible to use. Other researchers [19] [20] in another subject of learning also shown that the use of media is also can make another positive filling to the student. Finally, by using of learning media in the physics subject, it hopefully can increase the ability of student in thinking critically [21].

4. Conclusion
The magnetic KIT device succeeded in measuring the quantities contained in the magnetic electric material, one of which in the first experiment was found that the farther away from the current-carrying wire, the smaller the magnetic field (compass deviation) and vice versa about magnetism can be seen clearly and easy to understand.

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