Developing temperature and wind speed monitoring devices as a way to introduce IoT to students

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Abstract. Although the Internet of Things (IoT) application is already widely used by students, understanding the working principle of the device is not easy. This paper aims to describe the way to introduce IoT to students through the development of learning media based on Arduino Uno built-in Wifi on temperature and wind speed monitoring devices. The method used is Research and Development. The results showed a flow chart and design of tool development. After the product is made, an expert's view of the visibility and function of the device as a physics learning medium is needed before the invention is applied for its effectiveness to be known.

1. Introduction
In the era of the industrial revolution 4.0, all digital devices can be connected people with short time intervals. The phenomena causes various e-commerce in various parts of the world to overgrow, especially in Indonesia. Some people feel a variety of conveniences from integrated service products. The key to integrating multiple products and services is the internet. The internet connects one device to another. Connected devices were popularized with the term Internet of Things (IoT) [1].

IoT has gradually brought about changes in people's lives and helped make their lives simpler and more comfortable. Through the integration of technology and applications, IoT has penetrated into all domains, including the medical world, manufacturing, industry, transportation, education, governance, mining, etc. [2]. Simply stated, IoT has three main bases in its operations, namely censorship, programming, and the internet. The sensor can be connected to other devices when given a program to connect with other devices via the internet [3].

Many people have felt the benefits of IoT in their lives, including students in middle school. In their daily life, they are very close to smartphones ranging from playing social media to shopping online. Unconsciously, they already use IoT-based applications. Even though they are active users, they don't necessarily understand IoT and its working principles. There needs to be an effort to bring IoT closer to them both in terms of concepts and applications. One of them is through learning physics.

IoT knowledge transfer through physics learning can be presented through the creation of simple, practical tools. This paper wants to describe the design of IoT-based simple, useful tools at the secondary school level. The device is a wind speed and temperature monitoring tool that is integrated with the
website. The device base used to connect sensors with the site is Arduino Uno R3, which already has Wi-fi in [4].

2. Methods
This research is a series of Research and Development (R&D) using the Analysis, Design, Development, Implementation and Evaluation (ADDIE) model [5]. ADDIE shows that there are four main stages in the making of wind speed and temperature monitoring devices, namely Analysis, Design, Development, and Implementation. At the end of each process, each stage is evaluated. The complete research procedure can be described as follows.

2.1. Analysis
At this stage, determine the purpose of making tools, user characteristics (students), and needs analysis [6]. The use of making tools is to explain the working principle of IoT simply. This tool is designed as a simple practicum tool for the secondary school level. The development of this device is driven by the need to provide an in-depth understanding of students as users of IoT-based technologies and applications.

2.2. Design
This stage begins by making a flowchart for making tools. Visual programming using flowcharts is the best way for programming at the beginner level [7]. Through a flowchart, we can see the process steps in detail, complete with the activities that occur. Flowcharts function as a communication and documentation tool. In addition to flow chat, at this stage, a tool scheme is also designed.

2.3. Development
At this stage, the initial drawing of the device that will be developed for later production becomes a prototype. Furthermore, experts will test the feasibility of this prototype for further implementation.

2.4. Implementation
Prototype tools that have been tested and assessed by experts will be implemented in the physics learning process. At this stage, the effectiveness of learning media will be assessed in increasing students' understanding of the IoT application.

3. Results and discussion

3.1. Tool design
The design of a tool system consists of a flowchart and a tool scheme. Making flowchart aims to determine the logic that will be processed on wind speed and air temperature monitoring tool. Figure 1 below shows a flowchart for monitoring wind speed and air temperature.

When the device starts working, Arduino will configure the sensor and Wi-Fi module. The Wi-fi module connects Arduino to the internet network either from a router or a smartphone hotspot. Arduino will forward the signal received from the sensor to the website so that the sensor and the website become connected. That will allow sensor output data to be read on the website [8]. Furthermore, the sensor takes measurements of wind speed and air temperature. The output of the sensor will be processed by Arduino into the data you want to be displayed on the website. The technique of taking sensor data by the website uses the GET method in javascript. The GET method is one of the four methods that exist in HTTP that is used by the REST API in javascript for data retrieval [9]. This will help in the appearance of sensor data on the website in realtime.

The sensor output data processing requires an algorithm to process the data. In this tool, an algorithm according to equation (1) is used to get the value of the wind speed. Meanwhile, the temperature output value is automatically generated directly from the sensor.
\[ v = \frac{2\pi r}{T} \]  \hspace{1cm} (1)

Where \( T \) is the rotation period of the disc detected by the sensor, \( r \) is the radius of the disc, and \( v \) is the wind speed.

**Figure 1.** Flowchart wind speed and temperature monitoring tool.

In addition to the flowchart, a tool scheme and its components are also made. Figure 2 below shows the scheme of the monitoring tool for wind speed and air temperature.

**Figure 2.** Schematic of wind speed and temperature monitoring equipment.
3.2. Prototype
Figure 3 below shows the design of the shape of a wind speed and temperature monitoring device. This design is used as a reference when producing tools. With the reference design, tool making is effective and avoids buying unnecessary tools and materials.

Figure 3. Design of wind speed and temperature monitoring equipment.

Wind speed and temperature monitoring tools consist of several parts, namely:

3.2.1. Windmill. Windmills are useful for turning the disc underneath which has a rotating sensor installed to measure wind speed. This section is intentionally made open so students can see firsthand how these windmills work to produce output in the form of wind speed data.

3.2.2. Temperature sensor. Temperature sensor mounted on the left side of the tool body. Temperature sensor is used to measure the temperature of the air around the appliance. The shape protrudes to the outside so that it can be clearly seen by students.

3.2.3. Body of device
This section is the mainstay for windmills. There are bearings so that the axis of the windmill rotates smoothly. Two main sensors on this device are also installed in this section. After the device is produced in the form of a prototype, an expert's view of the feasibility of the prototype to be used as a physics learning medium is very much needed. If it has been declared feasible, the product begins to be implemented in schools.

Wind Speed and Temperature Monitoring Tool is expected to be a media to introduce IoT work principles to students. There is no denying that going forward, the waves in the computing era will be outside the realm of traditional desktops. In the IoT paradigm, many objects that surround us will be on the network in one form or another. Radio Frequency Identification (RFID) and sensor network technology will increase to meet this new challenge, where information and communication systems are implicitly embedded in the environment around us [10]. With the continued development of emerging IoT technology, the concept of IoT will soon develop on a very large scale [11].

4. Conclusion
Research and Development (R&D) stages to make the physics learning device based on IoT look more systematic. Through the stages of analysis can be obtained information needs, user characteristics, and purpose of making tools. Through the design phase, information is obtained about the flowchart of the working principle of the tool and the design of the tool. The next stage is the development of tools that
are ready to be tested and their feasibility assessed before they are implemented. The effectiveness of
the use of the tool will be obtained through the evaluation phase after implementation in the field.

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