The Development of Thermodynamics Law Experiment Media Based on IoT: Laboratory Activities Through Science Problem Solving for Gifted Young Scientists

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The Development of Thermodynamics Law Experiment Media Based on IoT: Laboratory Activities Through Science Problem Solving for Gifted Young Scientists

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Abstract

In this research, thermodynamics law experiment media based on IoT (Internet of Things) was developed and tested. The purpose was to assess the effectiveness of the IoT-based thermodynamic law experiment media through a problem-based learning approach and laboratory activities using science problem solving for talented young scientists. This research was conducted at SMA 2 Batang. This study using the ADDIE approach model. The development steps are: (1) analyzing curriculum requirements and demands in 2013, (2) designing and manufacturing, (3) developing media, (4) limited through small-scale tests, expert testing, tested on professional physics teachers and student grade XI sciences, (5) evaluated to get feedback in the form of comments and suggestions. This media is equipped with an LCD display to read of temperature, electric current, and electrical voltage in real-time, which is integrated with the Thingspeak application on every student's android phone. This media is easily assembled, based on digital, equipped with manuals and student worksheets. The validation results from the media experts 90.20% (Very Good), the results of the validation from the material experts 91.50% (Very Good), and the results of the physics teacher's responses covering all aspects of the material and multimedia 93.00% (Very Good). The results of the validation show that thermodynamics law experiment media based on IoT is appropriate to be used as a media for learning activities in the thermodynamics law material laboratory.

Keywords: experiment media, IoT based, thermodynamics law, problem-solving

INTRODUCTION

Physics is one of the compulsory subjects Math and Natural Sciences interest group at the 2013 curriculum in Indonesia. Physics Learning applies learning based on conceptual understanding through the construction of science with active and fun learning through experiments or activities in the laboratory (Alfiyah et al. 2016). Learning physics is not only transferring information, but learning physics must provide a direct learning experience for students (Ariyana et al. 2019). The direct learning experience can be provided through experiment activities in the laboratory with a problem-solving approach using learning media (Rusydi 2017). Referring to the cone of Edgar Dale's experience, direct experience, which has been thaught, could give more effectivity of understanding and makes meaningful learning (Docktor et al. 2015). According to Argaw et al. (2017), learning achievement and problem-solving ability of students can be improved using problem-based learning models, even though physics learning motivation is not yet high. Based on this explanation, to achieve meaningful learning, there needs to be learning media innovation that is collaborated with models and learning methods that support students' problem-solving abilities.

Learning media innovation become an integral part of the school learning process (Goovaerts et al. 2019). Learning media as an experimental tool can be used as an alternative to present physics learning to be more interesting (Religia & Achmadi 2017). Experimentation is a learning method where students are invited to conduct a series of experiments by experiencing and proving the subject that is taught in theory. Experiments in the laboratory are expected to increase scientific and social behavior also develop student's curiosity in solving problems (Dostál 2015). The model Problem-Solving Laboratory (PSL) facilitates students to carry out practical activities that enable them to practice becoming gifted young scientists in making decisions based on the physics problems presented (Argaw et al. 2017). The solve physics problems are done in the laboratory, so that requires students to make decisions based on their physics knowledge (Malik et al. 2019).

The education in the industrial revolution era 4.0 was marked by the emergence of new literacy, namely data literacy, technological literacy, and human literacy (Zimmermann & Torsten 2018). The purpose of global education states that 21st-century learning needs to integrate aspects of learning and innovation skills (Eveline et al. 2019). Information and Technology development in the era of globalization has entered the age of the Internet of Things (IoT) (Muchlis et al. 2015). IoT is a data transfer technology via the internet that connects various objects ('things') and does not require public IP on the client-side that can be accessed anytime and anywhere using a ThingSpeak server (He et al. 2016). ThingSpeak is a server dedicated to the Internet of Things devices that connect microcontrollers to the internet (Al Rikabi, Nasser, & Alaidi 2020; Saputra & Hertanto 2018). Thingspeak can be used to create IoT projects and can be downloaded for free (Prihatmoko 2016). The presence of IoT provides a new color in the development of instructional media innovation (Artono & Putra 2017). The potential of ubiquitous learning is reflected in increasing access to learning content and collaborative learning environments supported by computers anytime, and anywhere. It also allows the right combination of virtual and physical spaces. The purpose of ubiquitous computing technology is basically improving learning processes (He et al. 2016). The presence of IoT has a positive influence on the world of education. Limitations such as the lack of experimental learning media or visual media can be handled by IoT facility. The use of IoT requires objects which exchange information must be in the wireless fidelity (wifi) range (Prihatmoko 2016). IoT provides a new color in the development of learning media innovation.

Based on the report on the results of the Computer-Based National Examination (UNBK) in 2019, the most difficult physics material nationally is thermodynamics with the number of students who answered correctly only 42.51% (Puspendik, 2019). Furthermore, based on the results of observations and interviews with XII grade students of senior high school in Batang Regency, the most difficult physics material in UNBK is thermodynamics. The thermodynamics is a branch of physics that studies the relationship between energy and work of a system (Serway & Jewett 2012). Thermodynamics has various concepts, and some of them are very abstract, such as the concepts of heat and entropy (Hakim et al. 2017). Christensen & Thompson (2010) states that most students have difficulty understanding the concept of entropy (the second law of thermodynamics). It causes problems in the learning process. The application of android-based technology in collaboration with experimental learning can help teachers overcome difficulties in visualizing abstract concepts (Gunawan et al. 2019).

Observations at several secondary schools in Batang indicate the unavailability of thermodynamic law experiment media and learning media that utilize IoT. One foundational technology of IoT is the Radio-Frequency IDentification (RFID) technology, which allows microchips to transmit the identification number of the objects to a reader through wireless communication. Through RFID technology, physical objects can be identified, tracked, and monitored automatically (Dasilva et al. 2019). Students say that the law of thermodynamics is a theory that is difficult to learn and requires the media to understand it (Azizah, Saputro & Zulaikah 2017). Most physics teachers in secondary schools only use informative learning methods that emphasize cognitive skills.

In contrast, the 2013 curriculum requires students to play an active role in the learning process through a scientific approach (Cahyo, Saputro & Admoko 2019). The obstacle that is often encountered by teachers is the problem of teaching time, lack of time to do practical work is the main obstacle for teachers because the time most used is to pursue teaching materials. Judging from the conditions or facts on the ground, it does not fulfill the expected competencies and learning objectives. Besides, the lack of opportunities for students to have experienced real and active learning through experiment activities, especially thermodynamic law (Layali & Kartika 2015).

The facts of the above research indicate that it is necessary to develop learning media in accordance with technological developments in the industrial revolution era 4.0 as a means to attract students' learning interest. Thermodynamics law experiment media based on IoT to provide real learning experiences for students according to the phenomena of everyday life and can civilize scientific and technological literacy. The application of problem-solving in experiment activities is expected to improve the ability of students to solve physics problems. This study aims to analyze the feasibility and effectiveness of the IoT-based experiment media as a learning medium on the material of the zero law of thermodynamics, the first law of thermodynamics, and the second law of thermodynamics.

METHODS

Developing Process of Instructional Design

This study uses Research and Development with ADDIE models can be seen in FIGURE 1. describes the design stages of the development of ADDIE as follows. The product being developed is an IoT-based thermodynamic experimental media that is equipped with manual books and student worksheets (LKPD).

Before a limited trial was conducted, the experiment media of thermodynamic law were validated by two supervisors lecturer, including the newness of the media, the durability of the experimental instrument components, practicality, precision measurement results, safety for students, the efficiency of media and aesthetics utilization. After the revision, limited trials and extensive trials were carried out.

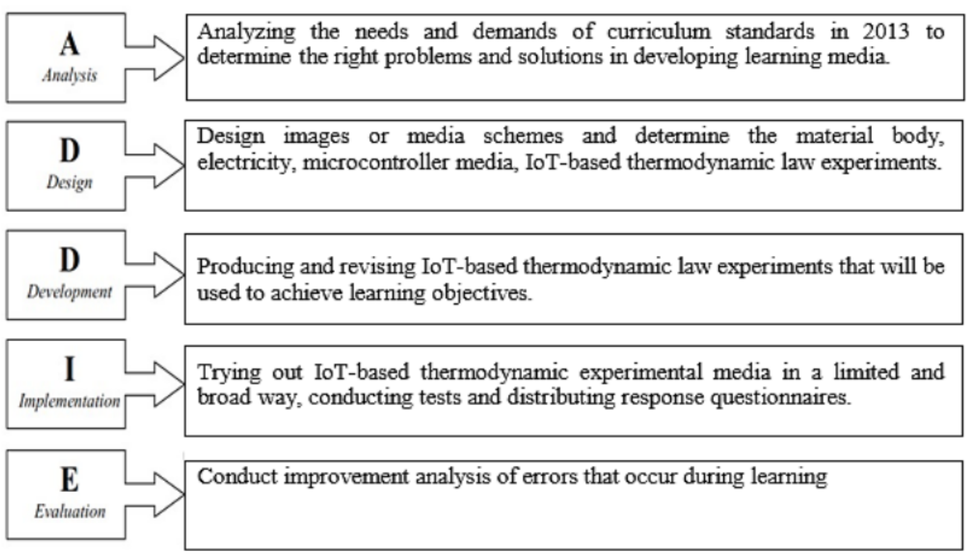


FIGURE 1. Development Stages of the ADDIE Model.

Participants

The subjects of this study were students, experts, physics teachers, and peer-reviewers. The testing of the learning tools involved XI grade students in Senior High School 2 Batang in the even semester of the school year 2019/2020. Whereas two experts, three physics teachers, and four peer-reviewers were involved in content validation.

Stage of Analysis

The analysis stage is a stage that identifies what teachers and students need in learning physics, knowing problems were directly complained by teachers and high school students. This stage consists of three aspects, needs analysis, curriculum analysis, and the subject of theory analysis (Yono et al. 2016). Based on the results of a needs analysis for 20 senior high school physics teachers in the Batang Regency, we know that learning methods that are often applied in schools still use the discussion model and question and answer models. Besides, there are no teaching model or experiment media of thermodynamic law, so physics learning in high school on thermodynamic law theory still have not applied scientific learning approach (Observing, Asking, Trying, Reasoning, Communicating).

The 2013 curriculum demands teachers must be able to become facilitators, motivators, and inspirators for students in the process of finding their knowledge, including the transfer process, level of understanding, ability to predict, problem-solving, and translating process 3Holme et al. 2015). Implementation of the 2013 curriculum uses three learning models which expected to advance scien8ic and social behavior also develop a sense of curiosity (Subali et al. 2019). The three models are: (1) Discovery/Inquiry Learning model, (2) Problem-Based Learning model (3) Project-Based Learning model.

Based on the high school physics curriculum analysis, the Basic Competence 4.7 in thermodynamic law theory supposed to make a work/model of the first and second law of thermodynamics application and their physical meaning. It requires teachers to be creative and innovative in creating learning media so they can guide students in observing the phenomenon of thermodynamic law through real experiments. The results of high school physics subject analysis based on the UNBK average score in 2019. Nationally, student's ability to answer thermodynamic subjects was 42.51% (Puspendik 2019). The percentage of indicators related to thermodynamic law material is the lowest among other physic s subject achievements. Therefore there is required for learning media, which provides real experiments for students can observe thermodynamic laws directly (Tatar and Oktay, 2011).

Stage of Design

The initial design was made in the form of three-dimensional drawings that were developed using the SketchUp application. These hot and cold water reservoirs are made of acrylic with dimensions of 30 cm × 15 cm × 20 cm, which is equipped with a water circulation pipe in the cold water reservoir. The two reservoirs are separated by a thermal wall made of Aluminum Composite Panel (ACP) with 8 Peltier TEG SP1848. Electrical boxes and microcontrollers made of multiplex boards with dimensions of 30 cm × 15 cm × 10 cm are placed under the water reservoir, which is equipped with an LCD display and lamp holder. The data displayed on the LCD display are temperature, electric current strength, and electrical voltage. The product developed is an IoT-based thermodynamic legal experiment media using ATmega328 microcontroller, so that the data generated can be communicated wirelessly using radio to the receiver, by connecting it to the internet via wifi and sending data to open source sites (Thingspeak.com) as shown in FIGURE 2.

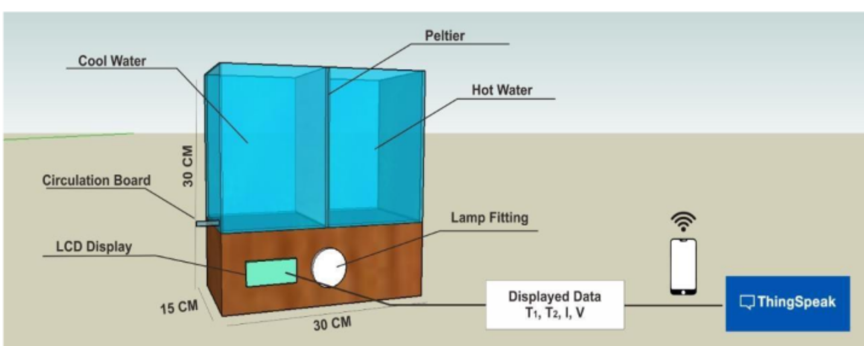


FIGURE 2. The IoT-based Thermodynamic Law Experiment Media Design

The advantages of IoT-based thermodynamic law experiment media are the results of automatic time measurement and high-temperature measurement data (T_1), low temperature (T_2), electric voltage (V) and electric current (I) can be observed directly in real-time through the Thingspeak website.com on android-based mobile phones by typing https://thingspeak.com/channels/channel ID following the experimental group, shown in FIGURE 3.

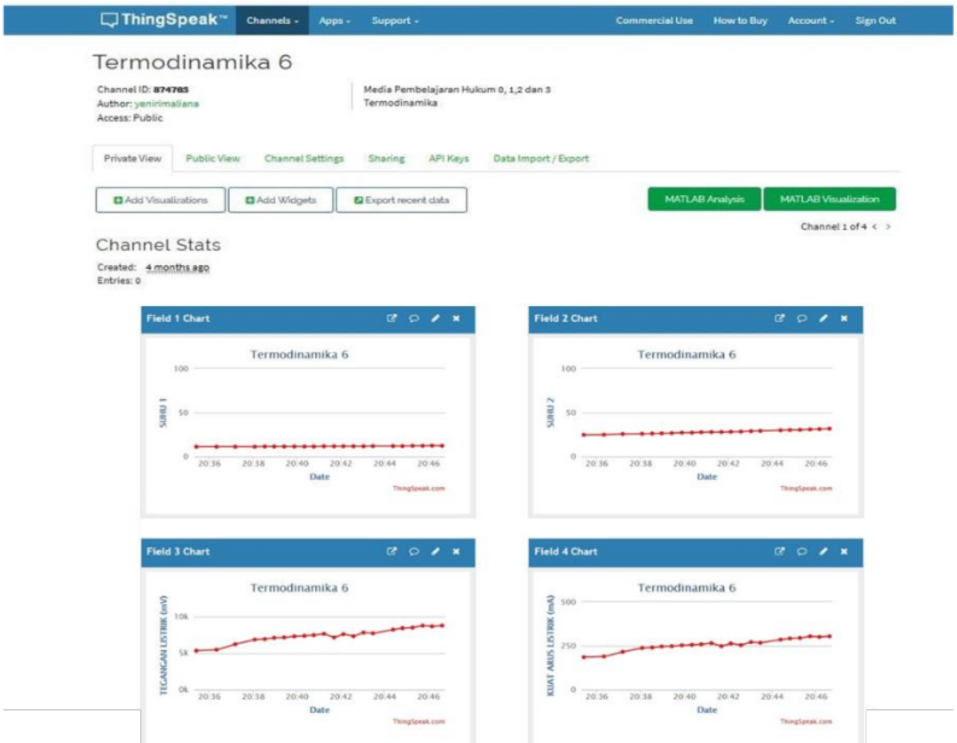


FIGURE 3. Thinkspeak.com site data display on android phone.

Stage of Development

a. Hot and Cold Body Reservoir Components (Top)

Hot and cold reservoir components are made of acrylic with a thickness of 5 mm. In the boundary plane between the hot and cold reservoirs given a diathermal seal of ACP with dimensions of 20 cm long, 15 cm wide, and 2.5 mm thickness connected in series with eight TEG SP1848 Peltier. The function of the TEG SP1848 Peltier is converting heat energy into electrical energy due to the temperature difference between the two reservoirs. The top of both reservoirs is closed with ACP, which is equipped with a hole to put the heater and insert two temperature sensors DS18B20.

(a) (b)

FIGURE 4. The IoT-based thermodynamic law experiment media (a) front view and (b) top view.

b. Electrical Body Components (Bottom)

The electrical components of the front consist of LCDs, TEG sockets, lamp sockets, and 12 VDC LED lamp fittings. Whereas the rear electrical component consists of 220 VAC sockets, on/off buttons, temperature control buttons, temperature sensor sockets that are colored yellow, red and black, water heater sockets, TEG sockets, and 5 VDC output terminals for circulating water pumps as shown in FIGURE 5.

(a) (b)

FIGURE 5. The components of electricity bodies in the IoT-based thermodynamic law experiment media (a) front view and (b) rearview.

At this stage, the electrical body component is revised, which was originally used multiplex material replaced with acrylic material based on input from media experts and material experts. The goal is that the internal components of the body in the form of a microcontroller and sensor can be seen clearly and add aesthetic factors. Besides, the electronic components inside can be seen and facilitate identification in the event of a failure to read the thermodynamic law experiment data. The electricity body is also added to the information label so that students are more familiar with the names of each component in the IoT-based thermodynamics experimental media such as FIGURE 6.

(a) (b)

FIGURE 6. The components of the electricity body of the IoT-based thermodynamic law experiment media (a) before the revision and (b) after the revision.

c. Microcontroller Components

The microcontroller components consist of: (1) 830-point breadboard, (2) Arduino Nano version 3.0, (3) ESP8266-01 wifi module, (4) 3.3 Volt AMS, (5) voltage sensor, (6) 5V adapter; 3A, (7) USB cable, (8) NYAF 2.5 mm cable, male to female jumper cable, resistor such as FIGURE 7.

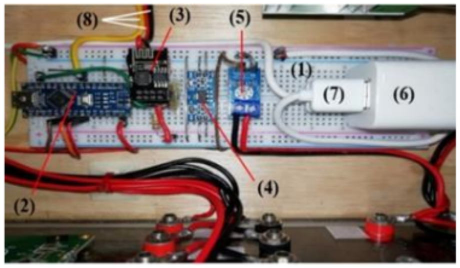
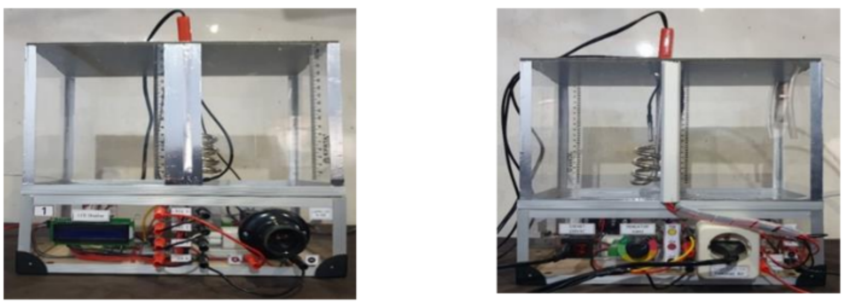


FIGURE 7. Microcontroller Components

The process of developing thermodynamics law experiment media based on IoT is based on the characteristics of the feasibility of instructional media, made of a material that is strong enough, interest shapes and colors, simple and easy to use, can explain concepts thermodynamics law, according to learning objectives, and can be the basis of problem-solving. Then the product design is realized, namely the development of thermodynamics law experiment media based on IoT for laboratory activities through problem-solving, as shown in FIGURE 8.



(a) (b)

FIGURE 8. thermodynamics law experiment media based on IoT (a) front view and (b) rearview.

d. Experiments Guide Section

This media is equipped with an IoT-based thermodynamic law experiment guide and a Student Worksheet (LKPD), which contains instructions for use, procedures, and practicum for the zero law, law I, and law II thermodynamics such as FIGURE 9.

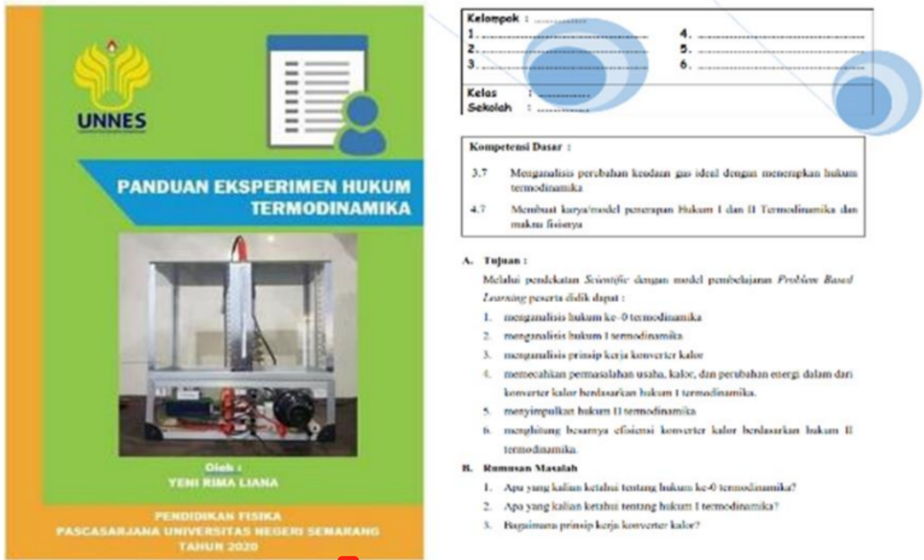


FIGURE 9. Guide to thermodynamics law experiment media based on IoT.

Stage of Implementation

Early media testing of students

The initial trial or limited test of media to students is carried out into two stages. The first stage is One to one Trying Out conducted to student grade XI sciences in Senior High School 1 Pekalongan as many as three students, while the second stage is Small Group Tryout conducted to students student grade XI sciences in Senior High School 2 Batang. In the first stage, the trial was conducted by demonstrating the media by students individually with the guidance of researchers, then conducted interviews with students regarding the thermodynamics law experiment media that are being developed. In the second stage, the trial was carried out by carrying out experimental activities by six students who were divided into two groups with the guidance of researchers, then students processed the data obtained, conducted interviews, and filled out the questionnaire given.

Experiments by experts

Thermodynamics law experiment media based on IoT that have been created and revised from the results of the initial media trials to students, then tested by material expert and media expert. The trial was conducted by four people consisting of two material experts (lecturers) and two media experts (lectures). Each expert was given a questionnaire sheet containing statements relating to the suitability of the media with the intended aspects.

Broad field trials of media to physics teachers and students

The implementation of field trials was carried out at Senior High School 2 in Batang Regency with a population of 72 students grade XI sciences. Trials to physics teachers are done by demonstrating the media. Then the teacher fills out the questionnaire provided. Trials to students are carried out by carrying out thermodynamic legal experiment activities in the learning process. Students are divided into six groups with the names thermodynamics group 1 to thermodynamics 6. Each group consists of six students. Implementation of experimental activities under the guidance of researchers, then students process data obtained, conducted interviews, and filled out the questionnaire given.

Analysis of media Feasibility Assessment, student and teacher responses

Data from the results of the media feasibility assessment, student and teacher responses were analyzed by converting the results of the validator's assessment and categorizing these values. Then, the value is compared with the categories that have been made. Convert values into categories using the five-scale grading criteria technique, as seen in TABLE 1.

TABLE 1. Evaluation of Likert Scale

Alternative Answer	Score
Very Agree	4
Agree	3
Disagree	2
Very Disagree	1

The validation was calculated using EQUATION (1).

$$\text{score percentage} = \frac{\sum \text{score}}{\sum \text{max score}} \times 100\% \qquad (1)$$

The percentage score obtained is then measured using the interpretation of scores for the Likert scale, as TABLE 2.

TABLE 2. Likert Scale Interpretation

Percentage	Interpretation
0%-25%	Very Bad
26%-50%	Bad
51%-75%	Good
76%-100%	Very Good

Stage of Evaluation

The fifth stage is the evaluation. At this stage, thermodynamics law experiment media based on IoT that have been implemented to students get feedback in the form of comments and suggestions from students and professional physics teachers regarding the advantages and disadvantages of this media. The next step is to refine or final revise the experimental media so that the media becomes feasible and better. From the research stage, the development that has been carried out will result in thermodynamics law experiment media based on IoT product with all its equipment.

RESULTS AND DISCUSSION

Preliminary Analysis Results

Analysis of the 2013 curriculum syllabus, namely: (1) analyzing the Core Competencies (KI) and Basic Competencies (KD) that students must achieve in thermodynamic legal material, (2) setting learning objectives that are appropriate for KI and KD, and (3) preparing an Implementation Plan Learning (RPP) is following the syntax of the Problem Based Learning model. The school needs analysis is based on the results of interviews with physics teachers and surveys of experimental equipment available in the physics laboratory of Senior High School 2 Batang that there are no experimental media to explain the material of thermodynamic law. Based on curriculum analysis and the need for learning media in schools, the researchers developed thermodynamics law experiment media based on IoT to support learning and civilize science and technology literacy in students.

Results of a Limited Media Trial to Students

Based on the results of a limited trial of one to one media trying out to students, it is found that it is very easy to use thermodynamics law experiment media based on IoT because it is equipped with guidelines for using thermodynamics law experiment media based on IoT and Student Worksheets (LKPD) which contain instructions for the zero law thermodynamics, the 1st law of thermodynamics and the 2nd law of thermodynamics are clear so that students do not experience difficulties in conducting experiments. While based on the results of the initial small group tryout media test to students, the interpretation of the concept conformity score was 88.32%, the media 92.05%, and the design 93.00%. From the interviews, it was found that to remove water from the heat reservoir. It is necessary to have a water pump equipped with a switch so that students do not need to lift the reservoir from the electrical body holder.

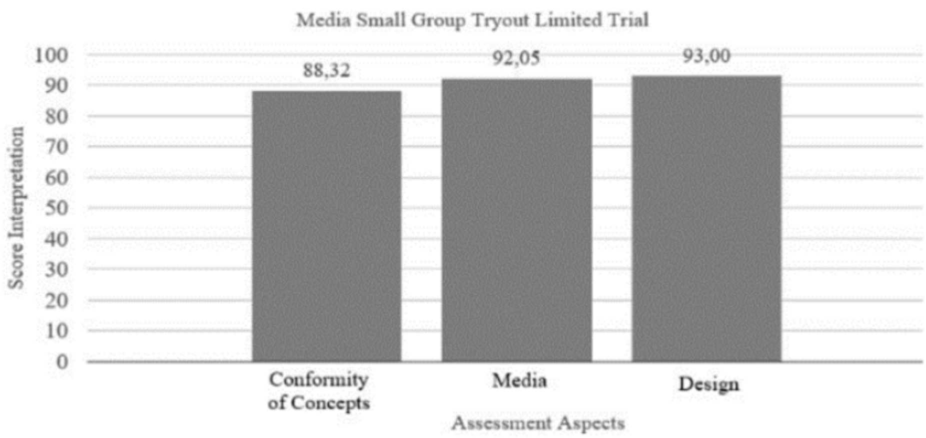
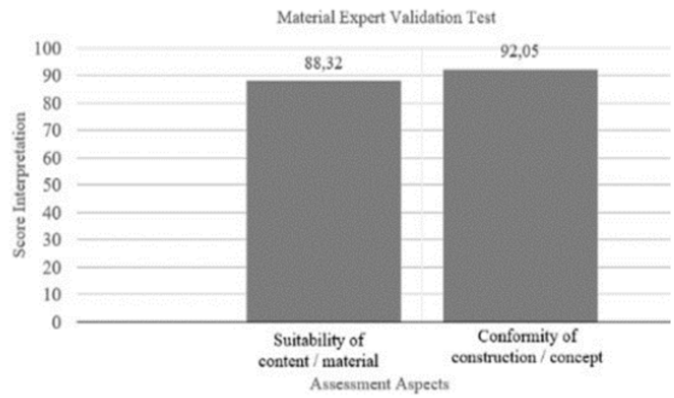


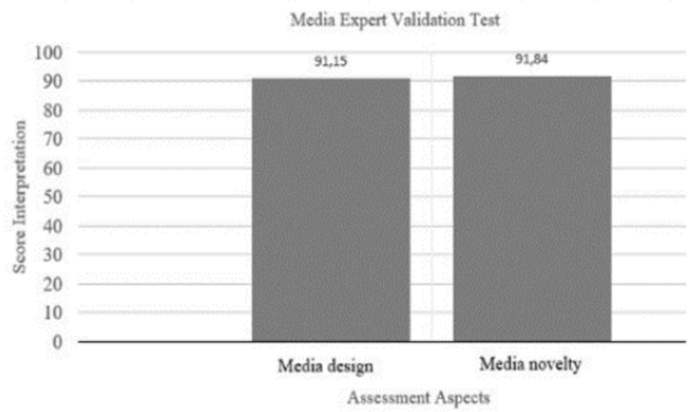
FIGURE 10. Media Small Group Tryout Limited Trial

Expert Validation Test Results

Based on the results of the validation test of the four aspects of media evaluation based on IoT thermodynamic legal experiments, namely the suitability of the content/material and the suitability of the construct/concept by the material experts showed an average percentage of achievements of 90.20% with a very good interpretation of all aspects of the material. The results of the design validation and novelty of the media by media experts showed an average percentage of 91.50% with a very good interpretation of all aspects of the media.



(a)



(b)

FIGURE 11. Expert Validation Test

Broad Field Media Trial Results to Teachers and Students

Steps in field trials of thermodynamics law experiment media based on IoT: (1) preparing Learning Implementation Plans (RPP) according to the syntax of the Problem Based Learning model, (2) dividing students into 6 experimental groups with the names of thermodynamic groups 1 through thermodynamics 6, (3) guiding each experimental group into the thingspeak.com website using channel ID, namely: https://thingspeak.com/channels/924020, 924021, 924024, 944777, 944778, dan 874763, (4) monitoring graphs of the results of each group's experiments through the website thingspeak.com, channel settings, and public view (heat vs. time, cold vs. time, electric voltage vs. time, and strong electric current vs. time), (5) students process the data to calculate the heat released by the heat reservoir, heat received by cold reservoirs, electrical effort generated from lights, changes internal energy in the system, and converter efficiency, (6) students analyze and evaluate problem solving process, (7) student conclude the results of experiments on on the zero law thermodynamics, the first and the second law of thermodynamics, the principle of heat converter work, and the efficiency of the converter.

RENCANA PELAKSANAAN PEMBELAJARAN
(RPP)

Satuan Pendidikan : SMA Negeri 2 Batang
Mata Pelajaran : Fisika
Kelas / Semester : XI / Genap
Materi Pokok : Hukum Termodinamika
Alokasi Waktu : 2 Pertemuan (4 x @45 menit)

A. Tujuan Pembelajaran

Kompetensi Dasar		Tujuan Pembelajaran
3.7	Menganalisis perubahan keadaan gas ideal dengan menerapkan Hukum Termodinamika	Setelah mengikuti kegiatan pembelajaran menggunakan model pembelajaran *problem based learning*, dengan metode literasi, eksperimen, praktikum, dan presentasi dengan menumbuhkan sikap menyadari kebesaran Tuhan, sikap gotong royong, jujur, dan berani mengemukakan pendapat, peserta didik dapat menganalisis hukum termodinamika, menganalisis besarnya usaha, kalor dan perubahan energi dalam berdasarkan hukum I termodinamika, menganalisis efisiensi konverter panas berdasarkan hukum II termodinamika, mengambil data, menganalisis data, menyimpulkan hasil eksperimen, dan menyusun laporan hasil eksperimen hukum ke – nol, hukum I, dan hukum II termodinamika.
4.7	Membuat karya/model penerapan Hukum ke – nol, hukum I dan II termodinamika dan makna fisisnya	

B. Kegiatan Pembelajaran

Pendahuluan	Kegiatan Inti	Penutup
• Guru Melakukan pembukaan dengan salam pembuka dan berdoa untuk memulai pembelajaran, memeriksa kehadiran peserta didik sebagai sikap disiplin, menyiapkan fisik dan psikis peserta didik dalam mengawali kegiatan pembelajaran dan literasi. • Menginformasikan tujuan pembelajaran, kegiatan eksperimen hukum termodinamika yang dilaksanakan peserta didik dan memotivasi peserta didik terkait dengan manfaat mempelajari termodinamika dalam kehidupan sehari-hari.	• **Orientasi peserta didik pada masalah** Peserta didik dengan difasilitasi guru berdiskusi tentang hukum yang mendasari termodinamika • **Mengorganisasikan peserta didik untuk belajar**. Guru membagi kelas dalam 6 kelompok untuk melaksanakan kegiatan eksperimen hukum ke- nol, I dan II termodinamika. • **Membimbing penyelidikan individu maupun kelompok**. Peserta didik difasilitasi oleh guru melakukan kegiatan eksperimen hukum ke – nol, hukum I dan hukum II termodinamika. • **Mengembangkan dan menyajikan hasil karya**. Peserta didik menuliskan hasil eksperimen dan mempresentasikan hasil kerja dan diskusi berkaitan tentang hukum ke- nol, I dan II termodinamika. • **Menganalisis dan mengevaluasi proses pemecahan masalah**. Setiap kelompok melakukan presentasi, kelompok yang lain memberikan apresiasi. Membuat kesimpulan sesuai dengan masukan yang diperoleh dari kelompok lain.	• Peserta didik dibantu oleh guru membuat kesimpulan secara umum kegiatan pembelajaran. • Guru bersama peserta didik mereview proses pembelajaran, meng - informasikan kegiatan pembelajaran yang akan datang dan memberikan penugasan.

C. Penilaian
Penilaian sikap diambil dari Jurnal sikap ; penilaian pengetahuan dilakukan dengan penugasan dan penilaian harian, penilaian keterampilan berupa penilaian kinerja dan observasi dari kegiatan eksperimen yang telah dilakukan

Batang, 20 Januari 2020
Kepala Sekolah Guru Mata Pelajaran

Drs. Suraji, M.Si Yeni Rima Liana, S.Pd
NIP. 19600530 198603 1 011 NIP. 19780621 200312 2 010

FIGURE 12. Learning Implementation Plans

Based on the results of extensive field trials of the thermodynamic legal experiment media on professional physics teachers, the interpretation of KD suitability scores and concepts, design, media, and learning were obtained with an average percentage of achievements of 93.0% (very good). The results of trials on class XI students' responses obtained interpretation of the suitability of the concept, design, and media with an average percentage of achievements of 91.07% (very good), shown in FIGURE 13.

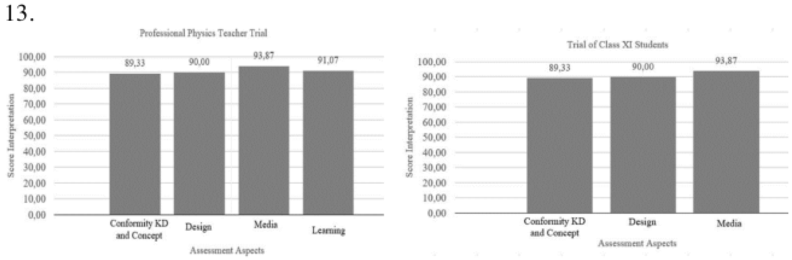


FIGURE 13. The Field Trial of Professional Physics Teachers and Class XI Student

SUMMARY

The development of thermodynamics law experiment media based on IoT for science XI grade students of Senior High School has met the criteria and is suitable for use as a learning medium for 21st-century physics based on the assessment of material experts, media experts, professional physics teachers, and student responses. The advantages of this thermodynamics law experiment media based on IoT are the results of measurements of temperature, electric current, and electrical voltage digitally and experimental data can be observed directly and in real-time through the ThingSpeak application on Android phones owned by students. Thermodynamics law experiment media based on IoT provide opportunities for students to be directly involved in the learning process through real authentic experiences and are expected to improve the competence of 4Cs (critical thinking, communication, collaboration, and creativity) skills in problem-solving.

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