Application of Performance Assessment and Technology-Applied Approach of Thermodynamics Learning on High School Students

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Abstract:- This research was conducted due to the lack of availability of practical tools of thermodynamic learning in SMA Kristen Tumou Tou Bitung, Indonesia. This research's aims were to: 1) develop learning tools and media for performance appraisal and technological application approaches to learn the laws of Thermodynamics; 2) test the feasibility of product development tools and instructional media by evaluating performance and technological application approaches to the Laws of Thermodynamics Learning. This research used the "Research and Development" method following the stages of development research according to Brog and Gall. Retrieval of data in this development research used small and large groups test and student questionnaire responses. The average percentage of the assessment process in the small group and large group test was obtained 90.38% and 84.01%, and the results of the small group and large group responses test were 96.6% and 99%. The result of product development was at 81% -100% feasibility level, therefore the thermodynamic learning tools and media are very feasible to use.

Keywords:- *Performance Assessment; Technology Application; Thermodynamics.*

I. INTRODUCTION

Advances in science and technology today require each individual to have skills in science so they can compete in globalization era. One way to improve individual quality is through the education system. A quality education system will produce individuals who have high quality human resources who are able to contribute in the development of science and technology. Education is the biggest investment of a nation and it has a major role in realizing the quality of human resources in order to be able to master and develop science and technology [1]

Physics is the study of the answers to the questions why and how this nature occurs [2]. Besides physics is also a field of science that plays an important role in the development of science and technology. Physics is a part of natural science that studies about natural phenomena, changes in material that can be written into mathematical equations. Physics is a part of natural science which is abstract in nature so in the delivery of concepts must use media so that the concepts of physics that are conveyed can be easily understood. Physics is one branch of natural science that explains various natural phenomena in daily life [3]. This natural phenomenon can be explained through a concept, theory and physical laws so that it can be accepted by human thought. Learning physics means studying nature and the concepts in it. These concepts could be concrete or abstract.

The use of instructional media in the activity of learning physics has special benefits that can become a consideration as research subjects, including: (1) delivery of material can be uniformed, (2) the learning process becomes more interesting, (3) student learning processes, students are more interactive, (4) the amount of teaching and learning time can be reduced, (5) the quality of student learning can be improved, (6) teaching and learning process can occur anywhere and anytime, (7) the role teacher, lecturer can change to a more positive and productive direction [4]. The use of instructional media in teaching and learning activities will influence the improvement of student learning outcomes. The use of the Advance Organizer Model assisted with computer animation was effectively used in seeing the physics learning outcomes of student [5]. There were differences in learning outcomes between experimental classes that were treated using audio-visual media with a problem-based metacognitive approach and control classes that were conventionally studied [6]. One of the roles of visual aids is to make abstract concepts more concrete [7]. Teaching aids are useful to make learning effective and successful [8]. There was an influence of generative learning models using simple teaching aids on understanding the concept, shown in the similarity test of two averages using t-test results obtained, the average value of the final test of the experimental class differed significantly from the average value of the final test of the control class [9].

Besides teaching aids, learning tools also strongly support the implementation of teaching and learning activities. Learning devices are media that are prepared as a reference in carrying out learning activities so that what is expected in learning activities can be achieved. Learning tools are everything or some preparations prepared by the teacher both individually and in groups so that the implementation and evaluation of learning can be done systematically and obtain the expected results [10], while the intended learning device consists of Analysis of Effective Week, Annual Program, Semester Program, Syllabus, Learning Implementation Plan and Minimum

Completeness Criteria. The availability of teacher learning tools will make it easier to assess student performance in the implementation of teaching and learning.

Based on the facts found in the field that the lack of thermodynamic laboratory equipment in Tu Mou Tou Bitung Christian High School so that learning for thermodynamic material is not optimal. The lack of equipment for practicum at the school resulted in the thermodynamic concept that they have is very weak so that it impacts on their learning outcomes. In addition to the availability of practical tools, learning tools are also a problem in learning activities at the school. Learning tools made by teachers in this school were rarely involved students directly in learning activities. Based on the information obtained from the students, it was found that the learning was teacher-centered. The way to overcome the low student interest in learning about thermodynamic material is to create practical tools and thermodynamic learning tools. Practical tools and learning tools can be used when learning activities for the delivery of thermodynamic concepts and assessing student performance so that student activity in participating in learning activities can be assessed. The existence of practicum tools and performance-based thermodynamic learning tools with a technology application is expected to improve the thermodynamic learning in Tu Mou Tou Bitung Christian High School.

II. METHOD

The development model used in this research was the Reseach & Development (R & D) model which consists of planning, exploratory studies, initial product development, validation, product trials, revisions based on field tests and product dissemination [11]. The flow of development using the Brog and Gall model can be seen in Figure 1. Data collection method in this research was by validating material experts and media experts, small group test and large group test and student questionnaire responses to the product being developed.

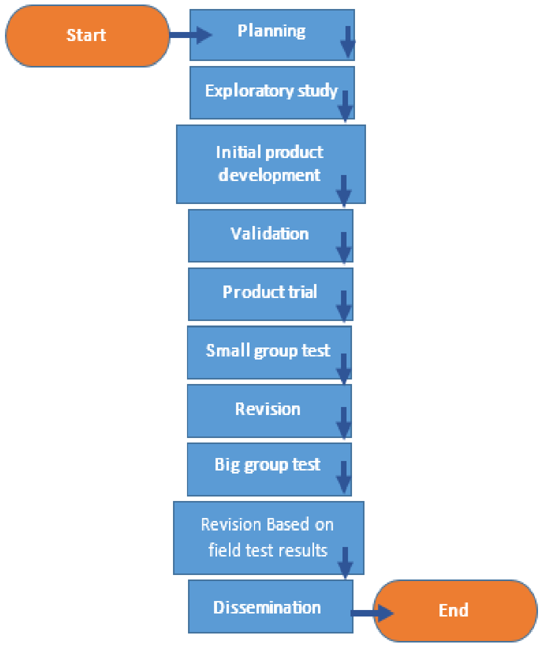

Fig 1:- Development Flow with the Reseach and Development R & D Model

A. *Research Instrument*

The research instruments used in this study were: validation sheet material experts and media experts, performance appraisal and student response sheets.

No	Aspects Observed	Score		
		KB 1	B 2	SB 3
1	The degree of innovativeness			
2	Level of creativity			
3	Originality			
4	The level of effectiveness of use			
5	Usage Efficiency			
6	Aesthetics			
7	Benefits for the Department (participating in providing solutions to problems faced by the Department/ Study program			

Table 1:- General Format Validation Sheet Material Experts and Media Experts.

B. *Data Analysis Technique*

Data analysis techniques for questionnaire data using the percentage eligibility formula as in equation 1.

$$PP = \frac{\Sigma XX}{\Sigma XX_{ii}} \times 100\% \qquad (1)$$

Information.
PP : Percentage
$\sum XX$: Total number of respondents
$\sum XXii$: ideal number of scores in an item
100% : constant

The eligibility categories based on criteria can be seen in Table 2.

Category	Percentage	Equivalent
1	81 % - 100 %	Very Feasible
2	66 % - 80 %	Feasible
3	56 % - 65 %	Feasible Enough
4	41 % - 55 %	Less Feasible
5	0 % - 40 %	Not Feasible

Table 2:- Eligibility Level Criteria

III. RESULTS AND DISCUSSION

A. Planning

➢ *The Formulation to be Achieved*

Researchers develop practicum tools and thermodynamic learning tools with the aims: a) developing practicum tools and learning appraisals of performance appraisal with the application of technological approaches to learning the laws of thermodynamics. b) test the feasibility of the product development of practicum tools and learning tools with performance appraisal and technological application approaches to learning thermodynamic law.

➢ *Establishing Success Criteria*

The success criteria will be achieved in development research: a) the practicum tools and thermodynamic learning tools developed have been said to be feasible or valid by material experts and media experts using validation sheets, b) practicum tools and learning tools are said to be feasible by conducting the assessment process and student questionnaire responses on small group and large group tests.Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

B. Exploration Study

Activities carried out by researchers in exploratory studies: a) analysis of the need for practicum tools and thermodynamic learning tools as learning media, b) 2013 curriculum analysis of Physics studies thermodynamic laws material, c) analysis of the suitability of practicum tools with the material used in development research.

C. Initial Product Form Development

At this stage the researchers conducted a validation test on the initial form of the product to be developed. This initial validation uses four lecturers consisting of two material expert lecturers and two media expert lecturers. The results of the validation of the two expert lecturers on the material are presented in Table 3.

	Validator Name	Total Score (ΣXX)	Ideal Score (ΣXX_{ii})	% Feasibility
1	Validator A	17	24	70.83
2	Validator B	18	24	75

Table 3:- Data on Validation Results For Initial Forms of Products by Material Experts

The initial validation results from 2 media expert lecturers are presented in Table 4.

	Validator Name	Total Score (ΣXX)	Ideal Score (ΣXX_{ii})	% Feasibility
1	Validator A	17	24	70.83
2	Validator B	18	24	75

Table 4:- Data on Validation Results For Initial Forms of Products by Material Experts

Based on Tables 3 and 4 it can be seen that the results of the validation of 2 material expert lecturers and 2 media expert lecturers are at the 66% - 80% eligibility criteria so that the initial form of the product is feasible to be developed.

D. Validation

After the initial form of the product to be developed has been revised based on notes from material expert lecturers and media experts on product validation, the product developed is revalidated before being tested on a small group. The results of product validation by 2 material expert lecturers are presented in Table 5.

	Validator Name	Total Score (ΣXX)	Ideal Score (ΣXX_{ii})	% Feasibility
1	Validator A	42	48	87.50
2	Validator B	44	48	91.67

Table 5:- Data on Product Validation Results by Material Experts

The results of product validation from two media expert lecturers are presented in Table 6.

	Validator Name	Total Score (ΣXX)	Ideal Score (ΣXX_{ii})	% Feasibility
1	Validator C	42	48	87.50
2	Validator D	44	48	91.67

Table 6:- Data on Product Validation Results by Media Experts

Based on Tables 5 and 6, it can be seen that the results of the validation of 2 material expert lecturers and 2 media expert lecturers are at the 81% - 100% eligibility criteria so that the products developed are eligible to be tested on small groups.

E. Product Trial

At this stage, researchers conduct trials of products developed through small group testing and large group testing to see the feasibility of the product being developed.

➢ *Small Group Trials*

At this stage the researchers used 5 students as a small group trial. A small group trial was conducted by giving an assessment of the process to 5 students and asking students for responses through a questionnaire about the product being developed. The results of the process assessment conducted by researchers on students obtained an average percentage of process assessment of 90.38%. While the results of student responses to the product developed obtained 63.3% of the responses of students gave the choice of the category of "Strongly Agree" (SS), 33.3% of the responses of students gave a choice of the category of "Agree" (S), from these results it appears that the development of practical tools and this thermodynamic learning device has a good value of students on student response indicators of 96.6%. Then 3.3% of students chose the category "Disagree" (TS) and no students chose the category "Strongly disagree" (STS). Rating results process performance and student responses to the product being developed are at the criteria of the level of eligibility of 81% - 100% so that the product developed is eligible to be tested on large groups.

➢ *Revision*

Before practicum tools and thermodynamic learning tools are tested on large groups, the product is first revised to revise deficiencies in the product developed based on notes from material lecturers and media experts.

➢ *Large Group Trial*

At this stage the researchers conducted a product trial that was developed to class XI Binsus as a large group or real class trial. The results of the performance appraisal in the large group test obtained an average percentage of process performance assessments of 84.0%. While the results of student responses to the product developed were obtained 58.67 % of student responses gave the choice of the category of "Strongly Agree" (SS), 40.33% of the responses of students gave a choice of the category "Agree" (S), from these results stated that the development of this teaching material had a good value for students towards the stated response indicators by 99%. Then there are 1% of students who choose the category "Disagree" (TS) and no students who choose the category "Strongly disagree" (STS). The results of the assessment of process performance and student responses to products developed in large group trials are at the eligibility level criteria of 81% - 100% so the products developed are said to be very valid or very feasible to use.

F. Revision Based on Field Trials

Products that have been tested in the field are then revised based on deficiencies encountered during product trials in big groups or real class. At this stage the researcher perfects the product that is developed so it is suitable for use by both teachers and students.

G. Product Dissemination

At this stage, the researcher spreads the products of practicum tools and thermodynamic learning tools that are feasible to use to schools that do not have practicum tools and thermodynamic learning tools with the aim of supporting learning activities in schools. In addition to products distributed to schools, researchers also report the results of development research in scientific meetings or scientific journals.

H. Discussion

Development research conducted at Tumou Tou Bitung Christian High School consists of several stages starting from the planning stage. At the planning stage the researcher found a problem in Tumou Tou Bitung Christian High School. The problem encountered at the school is the lack of availability of practical tools and thermodynamic learning tools, which causes the students' thermodynamic concepts to be weak. Departing from these problems, the researchers then compiled a research plan on the development of tools and devices based on performance appraisal using a technology application approach to the material of thermodynamic laws.

To compile research development scaffolding researchers conduct exploratory study activities where researchers analyze the things needed in development activities such as practical tools and learning tools to be developed, Curriculum 2013 analysis, and suitability of tools to be developed with the material to be used. After these things are considered, the researcher makes the initial form of the product in the form of practical tools and devices thermodynamic learning. The initial form of the finished product is then conducted an initial validation test. The initial validation test was conducted using 4 lecturers consisting of 2 material expert lecturers and 2 media expert lecturers. The results of the initial validation of the product form 2 material expert lecturers get a percentage value of 70.83% and 75% and the results of the initial validation of the product form 2 media expert lecturers get a percentage value of 66.67% and 70.83%. So that the initial form of the product is said to be feasible to develop. The low validation value of the material experts is because the thermodynamic practicum tools developed have not been able to show physical phenomena according to the theory so that there is still a need for further improvements from the practicum tools to the physics concepts and the data obtained from the practicum tools in accordance with the theory. In addition, the results of validation from media experts also get a low percentage value. That is because the effectiveness and efficiency of the use of practicum tools and thermodynamic learning tools in learning activities is not yet known, causing the score from the assessment aspects to be low.

The validated product is then revised again to correct any deficiencies in the product. The revised development product was then validated again by the same material expert lecturer and media expert. The results of product validation from 2 material expert lecturers get a percentage of 87.5% and 91, 67%. While the results of product validation from 2 media expert lecturers scored 89.58% and

93.75%. Practicum tools that have been said to be feasible are then tested on small groups. These results are supported by the results of Sundari's research (2014) that the development of character-based performance assessment models is known to be valid with a total value of 85.7%, in general the development of character-based performance assessment model products is feasible to use [12]. Testing the development product on a small group test using 5 students. The results of the performance appraisal in the small group test were obtained the average percentage of process appraisal is 90.38%.

The high value of the average percentage of small group tests is due to the limited number of students making it easier for researchers to assess student performance in practicing. the limited number of students also causes opportunities for students to play in practical activities to be reduced so that students can remain serious in doing practical activities. The results of student responses in the small group test to the product developed obtained a percentage value of 70.3% of the responses of students giving the choice of the category "Strongly Agree" (SS), 27.6% of the responses of students giving the choice of the category "Agree" (S), from these results it can be seen that the development of practicum tools and thermodynamic learning tools has a good value of students towards 97.9% student response indicators. Then 3.1% of students chose the category "Disagree" (TS) and no students chose the category "Strongly disagree" (STS). After the product is tested on a small group, the product is revised again to correct the deficiencies in the practical tools and thermodynamic learning tools.

The revised product is then tested on a large group or a real class. The results of the performance appraisal in the large group test obtained an average percentage of performance appraisal of 84.0%. While the results of student responses to products developed obtained 67.67% of student responses gave the choice of the category "Strongly Agree" (SS), 31.33% of the responses of students gave a choice of the category "Agree" (S), from the results stated that the development of materials This teaching has a good value for students of the response indicators expressed by 99%. Then there are 1% of students who choose the category "Disagree" (TS) and no students who choose the category "Strongly disagree" (STS). These results are supported by the results of the study of Usman et al (2014) from the analysis results obtained that 93.3 percent of students gave a positive response to practical guide [13]. Based on the small group test and large group test, the average percentage of student performance appraisal is 90.38% and 84.0%. These results prove that the use of practicum tools and thermodynamic learning tools improves student process performance. These results are supported by the results of research Riswanto and Dewi (2017) said that laboratory-based learning is able to improve science process skills and be able to encourage the realization of the character of student activity in the form of the character of responsibility for preparing reports, tidying tools, and collaboration between groups [14]. With the existence of student performance appraisal, educators can assess the competency of students' skills during practicum in the laboratory, so that activities related to student performance can be measured [15].

The average percentage of performance appraisal in the large group test is lower than the average percentage in the small group test. This is due to the large number of students on large group tests making the performance evaluation process difficult. In addition there are some students who are not serious in practicing practicum so that their performance scores are lower than their peers. Practicum tools and thermodynamic learning tools that have been said to be feasible through small group tests and large group tests are then revised again according to the deficiencies encountered in the field test so that it becomes a product that is suitable for use by high school physics teachers.

IV. CONCLUSION AND SUGGESTION

A. Conclusion

- Development of learning tools and media with performance appraisal and technological application approaches to learning Thermodynamics is very helpful in involving students in the learning process of observing phenomena of Thermodynamic law, understanding concepts and being able to find the physical principles of Thermodynamic law.
- Based on the average percentage of performance appraisal and student responses to products developed, practicum tools and learning tools can be said to be very feasible because they are at the 81% -100% level of eligibility criteria.

B. Suggestion

- Physics teachers at Tu Mou Tou Bitung Christian High School to be more active and creative in making practical tools and thermodynamic learning tools so that the process of teaching and learning activities becomes more effective.
- Physics teachers need to do an assessment of the process during the learning activities so that students' activities in participating in the learning activities can be assessed.
- Practicum tools and thermodynamic learning tools developed by researchers there are still many shortcomings so the need for further research from high school physics teachers

REFERENCES

[1]. Marisda, D. H. (2014). Pengembangan Modul Fisika Kesehatan Materi Getaran, Gelombang dan Bunyi Melalui Model Pembelajaran Langsung di SMK Kesehatan Terpadu Mega Rezky Makassar. Jurnal Pendidikan Fisika. 4(3): 268-275.

[2]. Anaperta, M. (2015). Praktikalitas Handout Fisika SMA Berbasis Pendekatan Science Evironment Technologi and Social pada Materi Listrik Dinamis. Jurnal Riset Fisika Edukasi dan Sains. 1(2): 99-106.

[3]. Karniawati, I. (2017). Pengaruh Simulasi Komputer Terhadap Peningkatan Penguasaan Konsep Impuls-Momentum Siswa SMA. Jurnal Pembelajaran Sains. 1(1): 24-26.

[4]. Nasrul R., & Handika, J. (2012) Penggunaan Media Pembelajaran IM3 Ditinjau Dari Kemampuan Berpikir Siswa. Jurnal Penelitian Pembelajaran Fisika. 3(1): 31- 40.

[5]. Hatika, R.G. (2016). Peningkatan Hasil Belajar Fisika Dengan Menerapkan Model Pembelajaran Advance Organizer Berbantu Animasi Komputer. Jurnal Pendidikan Fisika Indonesia. 12(2): 113-117.

[6]. Prayudi, L. M.E., Sahidu, H., & Gunawan 2017. Pengaruh Penggunaan Media Audiovisual dengan Pendekatan Metakognitif Berbasis Masalah Terhadap Hasil Belajar Fisika Siswa Kelas XI IPA di SMA 1 Gerung Tahun Pelajaran 2016/2017. Jurnal Pendidikan Fisika dan Teknologi. 3(1): 55-60.

[7]. Preliana, E. (2015). Pengembangan Alat Peraga Sains Fisika Berbasis Berbasis Lingkungan untuk Materi Listrik Statis pada Siswa kelas IX SMP Negeri 3 Pleret. JRKPF UAD.2(1): 6-11.

[8]. Nasution. (2005). Psikologi Pengajaran Nasional. Bandung : Remaja Rosda Karya.

[9]. Hamdani, D., Kurniawati., & Sakti, I. (2012). Pengaruh Model Pembelajaran Generatif dengan Menggunakan Alat Peraga Terhadap Pemahaman Konsep Cahaya kelas VIII di SMP Negeri 7 Kota Bengkulu. Jurnal Exacta. X (1): 79-88.

[10]. Nazarudin. (2007). Manajemen Pembelajaran Implementasi Konsep, Karakteristik dan Metodelogi Pendidikan Agama Islam di Sekolah Umum. Yogyakarta: Teras.

[11]. Gall, M. D., Borg, W. R., Gall, J. P. (1996). Educational Research: An Introduction. White Plains, N.Y.: Longman Publishers USA.

[12]. Sundari. 2014. Model Pengembangan Asesmen Kinerja (Performance Assesment) Mata Pelajaran IPA Berbasis Nilai Karakter di SMP Kota Ternate Maluku Utara. Jurnal EduBio Tropika. 2(1): 121-186.

[13]. Usman, A., Herman & Yusuf, M. (2014). Pengembangan Perangkat Penilaian Kinerja Praktikum Fisika Pada Peserta Didik SMP Unismuh Makassar. Jurnal Sains dan Pendidikan Fisika. 10(3): (274-284)

[14]. Riswanto & Dewi, N. A. K. (2017). Pembelajaran Berbasis Labolatorium untuk Meningkatkan Keterampilan Proses Sains dalam Membangun Karakter. JRKPF UAD. 3(1): 60-65.

[15]. Ihzani, Z., & Margono, G. (2017). Pengembangan Instrumen Penilaian Kinerja Praktikum Suhu dan Kalor. Jurnal Evaluasi Pendidikan. 8(2): 79-87.