PAPER • **OPEN ACCESS**

Validation of Student Project Based Learning Worksheets with a Non-Parametric Statistical Approach on Greenhouse Effect Material

Validation of Student Project Based Learning Worksheets with a Non-Parametric Statistical Approach on Greenhouse Effect Material

H Akhsan[1], M Muslim, M Ariska, CL Sapitri and DK Sari.
Department of Physics Education, Sriwijaya University
Jl. Raya Palembang-Prabumulih, Ogan Ilir 30862, Indonesia
Email : [1]hamdiakhsan@fkip.unsri.ac.id

Abstract So that can to produce a PjBL-based Student Worksheet with a valid and practical statistical approach to the Greenhouse Effect material in the Environmental Physics course, this research was conducted. Through the stages of planning, development procedures and Tessmer's formative evaluation model with expert review stages in order to validate the language, content and design which is the definition of the Rowntree research model used in conducting this research. The use of the Likert scale by questionnaire techniques and walkthroughs is used to design validity data analysis for student worksheet products. As for the data analysis carried out, very valid results were obtained from a maximum score of 5 with a value of 4.3 for validation of the greenhouse effect context using a statistical approach, 4.9 for validation of working width design and 5 for linguistic validation. Tests for practical use are carried out on students. At the one-to-one evaluation stage, test results were obtained which showed the average score and for testing in small groups, it reached 93.7% and 97.5% in the very practical category.

1. Introduction

As is known, currently the topic that is being hotly discussed by the world community is the issue of global warming. The continuous increase in the average temperature of the earth system is the definition of what is meant by global warming [1]. Significant climate changes that occur throughout the world are the impact of global warming [2]. Global warming results in an increase in the average temperature of the earth's surface. This opinion is explained by the Intergvernmental Panel On Climate Change or IPCC [3]. In 2022 the average global surface temperature will be warmer than in 1991-2000 [4].

Greenhouse gas emissions caused by daily human activities are the cause of global warming according to IPCC Results [5]. The gases found in the atmosphere that occur due to daily human activities or naturally are greenhouse gases [6]. There is no problem if greenhouse gas concentrations are constant [7]. The phenomenon of global warming will occur if the concentration of greenhouse gases increases [8]. Carbon dioxide, methane, chlorofluorocarbons, ozone and nitrous oxide are types of greenhouse gases that will cause global warming phenomena [7].

The Kyoto Protocol is a policy implemented to support efforts to reduce greenhouse gas emissions [9]. Global warming will cause world life to be threatened, which is why the Kyoto Protocol emerged [10]. Global warming occurs due to increased emissions of greenhouse gases. To reduce it, an international agreement called the Kyoto Protocol was held [11].

Apart from the Kyoto Protocol, the world's step in preventing global warming is the Paris Agreement. To limit global warming to below 2°C and try to limit it to 1.5°C above pre-industrial levels, the Paris Agreement was entered into [12] [13] [14] [15]. This is done so that the earth is at a temperature of 1.5°C in 2100 [16]. Carbon dioxide is a greenhouse gas that can cause global warming [17]. Therefore, Carbon dioxide mitigation needs to be carried out early to achieve long-term temperature goals [18].

All countries in the world contribute and participate in this policy. Indonesia is one of the countries participating in the Kyoto Protocol and the Paris Agreement. All sectors in Indonesia, one of which is education, are trying to reduce greenhouse gas emissions. Using universities to include environmental physics into the curriculum is a contribution made to the field of education. Environmental physics is a mandatory subject for Physics Education students to improve students' abilities in finding environmental problems and efforts to solve these problems [19].

Learning for students must have high-level critical thinking characteristics in accordance with learning in the 21st century [20]. The Project Based Learning learning model is the right learning model to use [21] [22]. To guide students to be more active in developing their skills and abilities, relevant and appropriate teaching materials and courses are needed [23], stimulates critical thinking skills that can help students in problem solving [24]. In physics learning, Student Worksheets based on PjBL using a statistical approach are teaching materials that can be implemented. The application of PjBL-based Student Worksheets with a statistical approach in learning environmental physics can provide experience to students and make students think HOTS through statistical analysis contained in the Student Worksheets.

2. Research methods

Development research or Research and Development (R&D) is a type of research used and the Rowntree development model is used in this research. Going through the planning, development and evaluation stages are the components in this development model [25]. Meanwhile, an evaluation has been carried out using the Tessmer formative evaluation method of products that have been developed, namely (1) self-evaluation, (2) expert review, (3) one-on-one evaluation, (4) small group, and (5) field test [26]. Because this research only aims to see and obtain information regarding the level of practicality and level of validity, this research does not carry out field testing stages.

During planning, an analysis of student needs is carried out and learning objectives are formulated based on basic competencies and competency achievement [27]. Next, the researcher developed a topic on the material to be selected and compiled a student worksheet based on non-parametric statistics with data collection procedures, data homogeneity tests, non-parametric Mann-Kendall trend tests and future temperature predictions. After preparing the draft student worksheet, prototype 1 was created.

By utilizing Tessmer's formative evaluation, prototype 1 will be evaluated independently through the self-evaluation stage. Next, to validate the product in terms of language, design, product and content, several experts in their respective fields will carry out the expert review stage [28] [29]. Furthermore, in order to find out the level of practicality of the product to be developed, a small group stage is carried out by students and a one to one evaluation. Then several students will be interviewed regarding the PjBL-based greenhouse effect worksheet with a non-parametric statistical approach. Data analysis of the validity of student worksheet products that have been designed using a Likert scale through walkthrough and questionnaire techniques.

3. Results and Discussion

3.1. Planning stage

The needs analysis was the initial one carried out at this stage. The results obtained from the needs analysis showed that 71.4% of students felt the need to develop PjBL-based worksheets with a non-

parametric statistical approach related to the greenhouse effect material. Next, analyze the Environmental Physics Semester Program Plan to determine learning objectives based on Basic Competencies and Competency Results.

3.2. Development Stage

The development stage begins with developing a topic on the selected material, then developing a draft and making a prototype 1. To determine the learning material and project objectives that are in accordance with the learning objectives at the planning stage are the results of the topic development carried out. After developing the topic, the next step is to create an arrangement of the components that will be presented in the student worksheet, this is what is called developing the student worksheet draft. Once everything is ready, the next step will be to develop prototype 1 PjBL-based greenhouse effect worksheet using a non-parametric statistical approach. The cover design on the worksheet can be seen in Figure 1, the initial view of the worksheet can be seen in Figure 2 and the project view on the worksheet can be seen in Figure 3.

Figure 1. Cover of student worksheet

Figure 2. Initial display of student worksheet

Figure 3. Student worksheet project view

3.3. Evaluation stage

The use of the Tessmer formative evaluation model was carried out at this evaluation stage. At this stage, the researcher independently tested prototype-1. Several things that need to be improved include the size of the worksheet, the cover design and the design of the worksheet content. Then several experts who are used to be able to evaluate the validity of the product from aspects of language, design and content are involved in this expert review stage.

Table 1. Recapitulation of Research Results at Expert Review Stage

Validated aspects	Validity score	Category
Contents	4.3	Very valid
Design	4.9	Very valid
Language	5	Very valid

Judging from the results above, it is known that the product produced is very valid for all aspects of validation. Next, a one-to-one evaluation stage was carried out, namely testing the product on three FKIP Physics students at Sriwijaya University class of 2019 who had taken the Environmental Physics course.

Table 2. Recapitulation of Research Results *from One-to-one Evaluation Stage*

The total score of each participant	Percentage
71	93%
70	92%
73	96%
Average	**93.7 % (Very Practical)**

Judging from the results obtained above, the resulting prototype 1 is very practical. From the results of considering comments and suggestions from the three students and experts after going through the revision stage, prototype-2 was obtained which then small groups would test as the final stage of this research to obtain the final student worksheet. Products on the Greenhouse Effect material by testing prototype-2 products on three different level groups with a total of nine student participants.

Table 3. Recapitulation of *Small Group Evaluation* Stage Research Results

The total score of each participant	Percentage
76	100%
72	95%
76	100%
76	100%
70	92%
74	97%
76	100%
72	95%
75	99%

Average	**97.5 % (Very Practical)**

The results obtained like the data above actually produce a very practical category. What is meant by practical is that it is easy to use by anyone who uses the product [30]. Based on the results of positive student comments and the results of questionnaire analysis using this student worksheet. The resulting product is very practical based on the results of questionnaire analysis and positive comments from students who use this worksheet. So there are not too many things that need to be revised to produce prototype-3.

After the evaluation is carried out, several students as representatives will be interviewed regarding the PjBL-based greenhouse effect worksheet with a non-parametric statistical approach that has been provided. From the interviews, it was found that students had difficulty using the Mann-Kendall non-parametric statistical test without training because they had not studied statistics courses. So it needs to be included in the statistics course at the Faculty of Teacher Training and Physics Education regarding homogeneity tests and non-parametric trend tests.

The student worksheet developed has the advantage of being the latest teaching material product for the environmental physics course at the Faculty of Teacher Training and Physics Education, Sriwijaya University, the latest interesting learning innovation that utilizes science and technology, and can be taken anywhere because of the product. can be used as a hard file or soft file. However, there is also a weakness in the student worksheet being developed, namely that when using the student worksheet the device must be in an environment with a good network, because it has to access several websites according to the project steps in the student worksheet. Because it has not been thoroughly tested in the field, the effectiveness of the product that has been produced cannot be confirmed.

4. Conclusion

Judging from the results of the research that has been carried out on the development of student worksheet on Greenhouse Effect Material Based on the PjBL Environmental Physics Course using a non-parametric statistical approach, it can be concluded that a very valid category has been successfully developed for the student worksheet on Greenhouse Effect Material. 4.3 in the content aspect, 4.9 in the media and design aspect, and 5 in the linguistic aspect are the average scores of the assessment results. So the Greenhouse Effect Material student worksheet product was categorized as very practical and was successfully developed. For the one to one evaluation stage, it was 93.7% and for the small group evaluation stage it was 97.5%, which is the average result of the student response questionnaire.

Reference

[1] Mathew M D 2022, *Prog. core. Energy*, **143** 104080, doi: 10.1016/j.pnucene.2021.104080.
[2] Hidayat A 2023 *Univ. Medan Area*, page 1–11, doi: https://doi.org/10.31219/osf.io/mw5ge.
[3] Rosyada K, Trismadi, and Ras A R 2021 *J. Maritime Security*, volume **7**, No 2, page 236–250,
[4] Meila K D, Dianty A, and Veronica L 2024 *Owner*, volome **8**, No. 2, page 1849–1864, doi: 10.33395/owner.v8i2.2001.
[5] Lee H, *et al.* 2022 *IPCC Sixth Assessment Report - Synthesis Report*
[6] Patrianti T, Shabana A, and Tuti R W 2020 *J. Perelit. Commun. And Public Opinion*, volume **24**, no. 2, doi: 10.33299/jpkop.24.2.3416.
[7] Pratama R and Parinduri L 2019 *Bul. Main Tech*. volume **15**, no. 1, page 1410–4520
[8] Nik H, Agus T, and Wiji P M 2022 *J. Din. Econ. Sharia*, volume **9**, no. 2, p. 168–183, doi: https://doi.org/10.53429/jdes.v9i2.386.
[9] Ismail A 2020 *Jukung (Environmental Tech Journal)*, vol. **6**, no. 2, page 195–203, doi: 10.20527/jukung.v6i2.9262.
[10] Susilowati I, Ahmad S T M, Faturrahman T, and Hidayat R F 2022 *J. Leg. Res*, volume **4**, no. 5, p. 1255–1274, doi: 10.15408/jlr.v4i5.28901.

[11] Iqbal F M and Ruhaeni N 2022 *J. Din. Blocky*, volume **7**, no. 02, pp. 223–244, doi: 10.36859/jdg.v7i02.1071.
[12] Leahy S, Clark H, and Reisinger A, 2020 *Front. Maintain. Food Systems*, volume **4**, p. 1–8, doi: 10.3389/fsufs.2020.00069.
[13] Price J, *et al.2022 Clim. Change*, vol. **174**, no. 1–2, p. 1–16, doi: 10.1007/s10584-022-03359-2.
[14] Brecha R J, *et al.* 2022 *Nat. Community*, volume **13**, no. 1, doi: 10.1038/s41467-022-31734-1.
[15] Warren R, *et al.* 2022 *Clim. Change*, vol. **172**, no. 3–4, p. 1–16, doi:10.1007/s10584-021-03277-9.
[16] Wei H E, *et al.* 2020 *Nat. Community*, volume. **11**, no. 1, p. 1–13, doi: 10.1038/s41467-020-15453-z.
[17] MJ Regufe, A. Pereira, AFP Ferreira, AM Ribeiro, and AE Rodrigues 2021 *Energies*, vol. **14**, no. 9, doi: 10.3390/en14092406.
[18] Xiong W, Tanaka K, Ciais P, and Yan L 2022 *Energies*, vol. **15**, no. 16, p. 1–17, doi: 10.3390/en15166002.
[19] Kamilia H N, *et al. 2024 J. Anal*, volume **3**, no. 1, pp. 141–151
[20] Al-Mahrooqi R and Denman C J 2020, *Int. J. Instructions*, volume **13**, no. 1, pp. 783–796, doi: 10.29333/iji.2020.13150a.
[21] Sari D M M and Prasetyo Y 2021 *Stud. English Educate*, volume **8**, no. 2, pp. 442–456, doi: 10.24815/siele.v8i2.18407.
[22] Yunita Y, Juandi D, Kusumah Y S, and Suhendra S 2021 *J. Phys. Conf. Ser.*, volume. **1882**, no. 1, doi: 10.1088/1742-6596/1882/1/012080.
[23] Dwijayanti R, Soesilowati E, and Handayati P 2023 *Stud. Learn. Teach.*, volume **3**, no. 3, pp. 163–169, doi: 10.46627/silet.v3i3.111.
[24] Syawaludin A, Gunarhadi, and Rintayati P 2019 *Int. J. Instructions.*, volume **12**, no. 4, pp. 331–344, doi: 10.29333/iji.2019.12421a.
[25] Dhiu K D and Laksana D N L 2021 *J. Educ. Technology.*, volume **1**, no. 1, p. 1–7, doi: https://doi.org/10.23887/jet.v5i1.30764.
[26] Fahmi, Fajeriadi H, Irhasyuarna Y, Suryajaya, and Abdullah 2021 *J. Phys. Conf. Ser.*, volume **2104**, no. 1, doi:10.1088/1742-6596/2104/1/012025.
[27] Syakur A, Zainuddin H, and Hasan M A 2020 *Budapest Int. Res. Linguist Critic. Educate. J.*, vol. **3**, no. 2, pp. 724–733, doi: 10.33258/birle.v3i2.901.
[28] Nurvita D, Akhsan H, Muslim M, Ariska M 2022 *J. Phys. Conf. Ser.*, volume **2165**, no. 1, doi: 10.1088/1742-6596/2165/1/012010.
[29] Fathurohman A,*et al.2023 Momentum Phys. Educate. J.*, vol. **7**, no. 1, pp. 125–135, doi: 10.21067/mpej.v7i1.7980.
[30] Akhsan H, Muslim M, Ariska M, and Rianti S 2020 *J. Physical Sciences. and Learning, volume* **4**, no. 2, 1689–1699