



# Development of Natural Disaster Mitigation LKPD Based on PJBL-STEM Assisted by Micro: Bit to Increase Self Awareness and Creative Problem Solving

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**Abstract:** This research aims to validate the PJBL-STEM-based natural disaster mitigation worksheet assisted by Micro: bit that has been developed. Validation was carried out by three experts, two of whom were academic experts in the field of education, and the other person was a teacher as a practitioner expert. The validation results show that the worksheet developed is very valid. The content validity of the worksheet obtained an average validity percentage weight of 89.1%, which was categorized as very valid; this shows the vital relevance of the content to learning objectives related to mitigating natural disasters due to global warming. The validity of the language aspect obtained an average weighted percentage of validity of 89.6%, which is categorized as very valid and shows excellent language quality and communication skills. Finally, the media and design's validity consists of cover and content aspects. The cover design received an average validity percentage of 93.5%, and the content design obtained an average validity percentage of 91.7%, so both are categorized as very valid. This confirms that the design of the worksheet, both the cover and the presentation of the contents, is perfect. These findings highlight that these worksheets maintain high-quality content, language, and design standards.

**Keywords:** Creative Problem Solving; Global Warming; Self Awareness; Worksheet.

## Introduction

Competent resources in science, technology, engineering design, and mathematics are urgently needed to face competition in the 21st century. One of the government's efforts to respond to current challenges is implementing an independent curriculum integrating learning with project creation activities. Using the PjBL model in learning, project learning can be integrated with a STEM learning approach (Rahmania, 2021). Applying PJBL-STEM in learning was chosen because STEM combines 21st-century 4-C skills (Triana et al., 2020).

Project-based learning is one of the characteristics of STEM-based learning. (Laboy-Rush, 2010) suggests 5 stages in STEM project-based learning: reflection, research, discovery, application, and communication.

PJBL-STEM is considered capable of improving students' problem-solving skills in a structured and open manner (Baran et al., 2021; Purwaningsih et al., 2020). Solving a problem structured and openly can train students to improve their creative problem-solving abilities (Kardoyo et al., 2020; Szabo et al., 2020). The learning process using PjBL STEM also allows students to increase self-awareness in solving problems in their environment (Baran et al., 2021). Self-awareness towards a good environment will foster a positive attitude towards ways of thinking and ways of solving problems related to the environment.

Creative problem-solving is essential to improve at this time because creative problem-solving combines creativity, critical thinking, and problem-solving, which are 2nd-century skills (Güven & Alpaslan, 2022). Creativity is often described as the ability to think

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differently, be sensitive to a problem, solve problems, and find unusual solutions to these problems (Bacanli, et.al., 2011). Students with creative abilities can produce something new, an idea, or a product in line with (Ekasari, et.al., 2017), which states that creativity is a person's ability to produce a new product or a combination of things that already exist, which are helpful and understandable.

PJBL-STEM learning, apart from having a positive impact on students' creativity in solving problems, also has a positive impact on self-awareness abilities. This is by research results, which state that implementing PJBL-STEM learning has a significant impact on increasing students' self-awareness, understanding of concepts, and creativity (Han, et.al., 2021). Self-awareness itself has a positive impact on students' 21st-century skills (Rusmansyah et al., 2019). Individuals with 21st-century skills can produce quick and practical solutions to problems they face in everyday life, have strong communication skills, are critical and creative, and are expected to be able to keep up with current technological developments.

Concretely, technology can improve learning to be more dynamic and interactive and present more exciting content (Bakri, 2018). One technology that can be used is IoT-based micro: bit. Micro: bit is suitable for use in activities related to Physics (Teiermayer, 2019). Apart from that, the teacher's role is to create teaching materials, such as LKPD, to make it easier for students to work on projects. However, many teachers must use worksheet in learning, especially global warming material (Akhsan, et.al., 2016).

The worksheet contains tasks that can help students understand the material and improve their abilities to carry out learning activities (Rahmawati & Wulandari, 2020). Project-based worksheets can help teachers maximize students' work and creativity with sequential and organized teaching so students will be more focused on searching for valid information for project learning. However, many teachers still need to use educational worksheets, especially global warming material (Akhsan, et.al., 2016).

LKPD is a means to help and facilitate teaching and learning activities so that effective interaction between students and educators is formed so students can increase their activities in improving achievement (Nurahman et al., 2019). Worksheets have various functions in different contexts and support students' thinking abilities if designed correctly (Lee, 2014). The function of making LKPD, according to Hidayati and Zulandri (2021), is as teaching material that can minimize the role of educators but further activate students, as teaching materials that make it easier for students to understand the material provided, as teaching materials that are concise and rich in tasks for

practice, facilitate the implementation of teaching to students.

In Indonesia, many natural phenomena occur due to global warming, which significantly impacts people's survival, such as forest fires, floods, tornadoes, etc. Therefore, tools are needed as markers in disaster mitigation efforts that contribute to reducing the impact of natural phenomena due to global warming. Based on literature analysis regarding difficulties in learning global warming material, it was found that teachers still need help understanding and preparing learning tools, determining models, and lack creativity (Deka, et.al., 2020; Pradita, et.al., 2020). Meanwhile, according to students, there is no learning about global warming material in class; students are only asked to study independently (Deka et al., 2020).

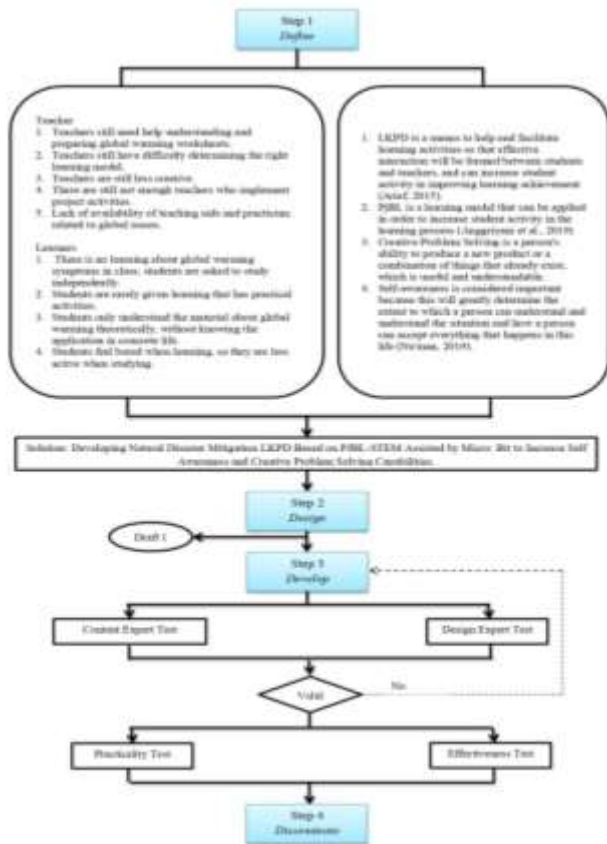
Based on the explanation presented, it is known that there still needs to be worksheet that contains PJBL STEM activities. Most students need help understanding the SDGs, especially the topic of global warming. This is because students tend to be directed towards independent learning, resulting in a need for more information provided by teachers. Apart from that, there is a lack of teaching aids and practical tools regarding global warming. Therefore, it is necessary to develop products like worksheet for mitigating natural disasters due to global warming based on PJBL-STEM with the help of micro: bit to increase students' creative problem-solving and self-awareness.

The problem-solving approach in this research uses STEM-PJBL-based natural disaster mitigation worksheet with the help of micro: bit, which is expected to increase students' self-awareness and creative problem-solving. The worksheet is one of the essential teaching materials in supporting the learning process. In several research studies on global warming material, the worksheet is one of the teaching materials used. However, it is still rare for the worksheet to be developed based on PJBL-STEM, especially on natural disaster mitigation. PJBL-STEM can improve students' problem-solving skills in a structured and open manner (Baran et al., 2021; Purwaningsih et al., 2020) so that it can train students to improve their creative problem-solving abilities (Kardoyo et al., 2020; Szabo et al., 2020). The learning process using PjBL-STEM also allows students to increase self-awareness in solving problems (Beier et al., 2019; Samsudin et al., 2020; Wan, 2021). Many PJBL-STEM learning activities are integrated with technology. However, it is still rare for PJBL-STEM learning to be assisted by micro: bit. Micro: bit is suitable for use in Physics (Teiermayer, 2019) activities and can improve 21st-century skills (Korhonen, et.al., 2019). So, it is essential to develop products like worksheet for mitigating natural disasters due to global warming based on PJBL-STEM with the help of micro: bit to

increase students' creative problem-solving and self-awareness.

**Method**

This development research uses a 4D design. The 4D development research theory is an instructional development model developed by (Thiagarajan, et.al., 1976). The 4D development research design refers to an instructional development model consisting of four stages: Define, Design, Develop, and Disseminate. The development research flow in this research can be seen in Figure 1.



**Figure 1.** Research Flowchart

In the initial stage of the research, the researcher carried out initial analysis in the form of curriculum analysis and analysis of teacher and student needs. So that we can determine the innovative solutions offered by researchers. The second stage is the design stage, so a draft storyboard worksheet design is obtained, which will become the product of this development research. The next stage is development, which contains activities that will produce a worksheet product by what was designed at the design stage. At stage 3, testing was also carried out to see the feasibility of using worksheets in learning. In the results of this published research, the research reached the content, language, media, and

design validation testing stage to see the product's suitability for limited testing and effectiveness trials.

The validity test scale determines the worksheets' validity from content, language, and design. The validity test was carried out by three experts who checked the product's validity by filling in the validity test scale that had been prepared. On this scale, experts are also allowed to provide input on products that have been developed and provide advice on whether the product is suitable for use or not. Table 1 shows the aspects assessed in the validity test.

**Table 1.** Aspects assessed in the validity test

Validity	Aspects	Number of Statement
Content	Worksheet step presentation	13 Items
	Social System	3 Items
	Reaction principle	4 Items
	Support System	2 Items
	Instructional and Nurturant effect	3 Items
	Language	Straightforward
Language	Communicative	3 Items
	Dialogical and Interactive	1 Item
	Suitability to the level of development of learners	2 Items
	Demand ability and cohesiveness of mindsets	2 Items
	Use of terms, symbols, or icons	2 Items
Design	Cover	9 Items
	Content	10 Items

Each statement item on the scale is given a choice of scores of 1-4 with criteria that are not suitable, less suitable, suitable, and very suitable. The data analysis is done by summing the scores of each statement item and calculating the presentation of each dimension of validity. The presentation results are then converted to the criteria available in Table 2.

**Table 2:** Validity Assessment Criteria

Range	Criteria
25% < score < 43.75 %	Not suitable
43.75% < score < 62.50 %	Less suitable
62.50% < score < 81.25 %	Suitable
81.25% < score ≤ 100 %	Very suitable

**Result and Discussion**

This research was carried out to develop teaching materials in the form of worksheets regarding mitigating natural disasters due to global warming, which were created based on Pjbl-STEM with the help of Micro: bit. The define stage is the initial research stage; the researcher carries out initial analysis in the form of curriculum analysis and analysis of teacher and student needs. This is done to find out the latest learning problems in the field that require learning innovation. So

that data containing learning problems juxtaposed with the expected ideal conditions is obtained. Based on the results of this analysis, researchers provide alternative solutions for designing a natural disaster mitigation worksheet that focuses on global warming.

The next stage is to design the worksheet that will be developed. This design stage starts with determining the format, the media, or learning content, creating an initial design, and developing data collection instruments. The researcher also made a storyboard, which became the worksheet design.

The next stage in this research is the development stage; the researcher develops the worksheet to produce a product that matches the storyboard design. Figure 2 shows the cover and several pages contained in the worksheet.



**Figure 1.** (a) Cover; (b) Table of Content; (c) Symbol Explanation; (d) Instructions for use; (e) element learning; and (f) Activity Sheet

After the product has been successfully developed, the product is then tested by three experts using a validity scale. These three experts consist of two academic experts and 1 practitioner expert. The results of the LKS content validity test can be seen in Table 3.

**Table 3:** The validity test result for Worksheet content.

Validity	Aspects	Average Score From 3 Validators	(%)	Criteria
Content	Worksheet step			
	presentation	10.5	87.59	Very suitable
	Social System	10.3	85.83	Very suitable
	Reaction principle	11.3	94.17	Very suitable
	Support System	11.5	95.83	Very suitable
	Instructional and Nurturant effect	11.3	94.17	Suitable
	Average percentage		91.52	Very suitable

Table 3. Shows the results of validating the content aspects of the natural disaster mitigation worksheet that was developed. The average percentage of content validation obtained is very valid. Furthermore, the results of the validation of language aspects can be seen in Table 4.

**Table 4:** The validity test result for Worksheet language.

Validity	Aspects	Average Score From 3 Validators	%	Criteria
Language	Straightforward	9.6	80.00	Suitable
	Communicative	10.5	87.50	Very suitable
	Dialogical and Interactive	10.0	83.33	Very suitable
	Suitability to the level of development of learners	11.8	98.33	Very suitable
	Demand ability and cohesiveness of mindsets	11.5	95.83	Very suitable
	Use of terms, symbols, or icons	11.0	91.67	Very suitable
	Average percentage		88.61	Very suitable

Table 4. Shows the results of language validation on the natural disaster mitigation worksheet. Based on the table, it is known that the average percentage of



language validation for the disaster mitigation worksheet is very valid. Next is media and design validation, as seen in Table 5.

**Table 5.** The validity test result for Worksheet design.

Validity Aspects	Average		Criteria
	Score From 3 Validators	(%)	
Design Cover	11.2	93.33	Very suitable
Content	11.0	91.67	Very suitable
Average percentage		92.50	Very suitable

Table 5 shows that the Natural Disaster Mitigation Worksheet that has been developed is very suitable for both cover design and content media for use in learning. Furthermore, based on the validity test of the content, language, and design aspects, the researchers determined that the Natural Disaster Mitigation Worksheet was appropriate or valid for learning about global warming in class X, stage E, senior high school.

The development of the Global Warming worksheet begins with a process of curriculum analysis and analysis of student and teacher needs. This requires products developed by what are needed in the learning process at school (Dwipayana, et.al., 2020; Mulyatiningsih 2015; Purwoko et al. 2020). For curriculum analysis, researchers found that global warming was part of the learning outcomes at stage E class X. From the learning outcomes provided by the government, the researchers then explained the learning objectives and these achievements. Meanwhile, researchers also conducted a preliminary study by distributing questionnaires to several teachers and students. This preliminary study provides researchers with insight into the need to develop worksheets that help teachers develop self-awareness and creative problem-solving skills. Because so far, these two skills have yet to be developed optimally in learning (Kao, et.al., 2008; Loksia et al. 2016).

Next, the researcher designs the worksheet that will be made. This design includes determining the LKS format, media, activities displayed in the LKS, and the LKS storyboard as a preparation guide. Storyboard worksheets were created to simplify the worksheet development process to be more focused and appropriate to what is needed (Lusiana, et.al., 2021; Wahyuni, et.al., 2019). Apart from that, researchers also developed instruments that will be used to test the validation, practicality, and effectiveness of the worksheet. The validation test validates content, language, media, and design. The practicality test consists of limited trials to validate the worksheet's attractiveness and readability. The effectiveness test will be tested using tests on applying worksheets in future learning.

At the development stage, researchers began to compile worksheets based on the designs that had been created. The worksheets were created using the Canva application and prepared using the PJBL-STEM model. Through learning that integrates PJBL-STEM, students are directed to be able to create projects in the form of natural disaster mitigation sensors with the help of Micro: bit. This activity aims to increase students' self-awareness and creative problem-solving abilities.

The validity of the Worksheet is considered valid in both content and language. As can be seen in Table 3 and Table 4, the average weight percentage is 91.52% and 88.61% with very valid criteria. Content validity is seen from the appropriateness of content and language, both of which are categorized as very good. In terms of content suitability, the validity of the Worksheet can be seen from the presentation steps, social system, reaction principle, support system, and the impact of learning and mentoring.

The appropriateness aspect of language shows that the language used is straightforward, communicative, dialogical and interactive, appropriate to the student's level of development, presents coherent learning stages and is consistent in the use of terms and symbols, and icon. The appropriateness of the content and appropriateness of the language in the Worksheet meet the criteria for good physics teaching materials, namely accurate in quoting and presenting theory, in accordance with competence and content coverage, communicative, complete and systematic, student-oriented, using correct language rules, and having good readability.

Worksheet validation and review regarding media and design in the cover and contents. The cover section of the Worksheet has a center of view, the balance of composition and size of layout elements, harmony of cover design, harmony of title color with background, and font combination in the outstanding category. The illustrations presented in the worksheet can describe the content/material and have shapes, sizes, colors, and illustration objects that are proportional to reality. Furthermore, the content, placement of titles, and layout elements are consistent, the print area and margins are proportional, the shape, color, and size of the layout elements are appropriate, and there are elements of page numbers and illustrations, and image descriptions, using a good combination of fonts, decorative/decorative letters, and letter variations. This is a teacher innovation to attract students' interest and motivate students to learn because the media presented is not just words or text but consists of words or text, images, animations, and videos (Abdulrahman et al., 2020; Mayer, 2003).

The percentage of validity tests shows that the LKS developed received very positive assessments in various aspects. The content aspect received a score of 91.52% in

the Very Valid category, which shows that the worksheet's content is very appropriate and relevant to learning objectives related to climate change. The language aspect obtained a score of 88.61% in the Very Suitable category, which shows that the quality of language and communication skills is excellent. Finally, the Design dimension received the highest score of 92.50% in the Very Appropriate category, which shows that the worksheet design, including the cover and presentation of the contents, is adequate. Overall, these results illustrate that these worksheets have high-quality content, language, and design standards, with little room for improvement in construction. This ensures that this worksheet is ready to be used in the learning process related to climate change.

## Conclusion

Based on the results of research data analysis that has been carried out, the natural disaster mitigation worksheet assisted by Micro: bit is very valid for increasing students' self-awareness and creative problem-solving abilities. This is because content validity shows that the natural disaster mitigation worksheet with the help of Micro: bit can be applied in Physics learning phase E class X with the topic of global warming to increase students' self-awareness and creative problem-solving abilities. Furthermore, the validity of the media and design is very interactive or multimedia-based, so it can be an innovation that attracts interest and motivates students to learn. Based on the validity of the content, language, media, and design, which show valid results, it can also be concluded that this development research can be continued to the next stage, namely practicality testing and effectiveness testing.

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## Author Contributions

The first author, Ayu Nurjanah, contributed to product development, validity instruments, data analysis, and preparation of data and articles. The second author, Kartini Herlina, contributed as a head researcher who coordinated all research activities, was an analyst, and guided students in preparing products, instruments, and articles. The third author, Chandra Ertikanto, contributed to monitoring the

implementation of validity tests, assisted the research team leader, and guided students in preparing products, instruments, and articles.

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## Conflicts of Interest

The authors declare no conflict of interest.

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