Al-Ishlah: Jurnal Pendidikan
Vol.16, 3 (September, 2024), pp. 3832-3842
ISSN: 2087-9490 EISSN: 2597-940X, DOI: 10.35445/alishlah.v16i3.4158

Development of PBL-Based Student Worksheets to Improve Collaborative Skills on the Effect of Environmental Temperature on Body Temperature Material

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ARTICLE INFO

Keywords:

feasibility analysis;
student worksheet;
PBL;
collaborative skills;

Article history:

Received 2023-06-04
Revised 2024-02-26
Accepted 2024-07-25

ABSTRACT

In the context of contemporary education, learning tools are a crucial factor in facilitating adaptive, creative and student-centered learning to meet expected and desired learning outcomes and skills. This study aimed to produce PBL-based student worksheets on the effect of environmental temperature on body temperature that is suitable for in science learning activities and to find out their practicality to improve students' collaborative skills. This research and development (R&D) study used the Four D model (define, design, development, and disseminate). The feasibility and practicality of student worksheets were known to four experts, six teachers, and 17 students. Testing the feasibility and practicality of PBL-based student worksheet to improve students' collaborative skills was carried out using a product feasibility questionnaire analysis with 5 aspects (content, language, presentation, graphics, and PBL components) and a product practicality questionnaire with 3 aspects (ease of use, attractiveness, and efficiency). The research results show that PBL-based student worksheets have an average total score of 138.2 with a 'very good' classification, showing positive results in terms of feasibility and practicality. So, this student worksheet can be used in science learning activities and can be used as a sufficient means to improve collaborative skills. Therefore, science teachers should adopt this PBL-based student worksheet to support their learning activities.

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1. INTRODUCTION

The field of education is continuously evolving, adapting to the demands of the present and the future. Educators strive to shape students into competent individuals who can recognize and develop their potential. Effective learning experiences equip students with essential skills for their future success (Mufidah & Yuwono, 2019). A comprehensive understanding of learning is crucial, as it encompasses more than just absorbing information; it involves adapting to changes and fostering growth. This

perspective emphasizes the importance of creating conditions that enhance student achievement and build a strong foundation of character and resilience for navigating challenges, both now and in the future (Ambrose et al., 2010; Green & Bavelier, 2012). Learning goes beyond memorization; it involves connecting ideas, integrating past and new knowledge, encouraging independent and critical thinking, and applying knowledge in diverse contexts. These elements are fundamental for achieving deep, lasting, and lifelong learning (Csapo et al., 2018).

Learning currently only gets a very small portion of time because educators are only preoccupied with routine tasks to immediately complete the curriculum which is their responsibility, especially to provide critical thinking exercises and social interaction (Muttaqin Arif, Yoesoef & Anwar, 2018). Human interaction in the context of cooperative group work aims to prevent unfavorable circumstances for students, promoting more dynamic, efficient, and innovative learning experiences. (Asmani, 2016; Darimi, 2016). This collaborative ability is also a social advantage that every student must acquire during the learning process, which is also a fundamental domain that must be enjoyed in the twenty-first century as a whole (Sihite, 2022). So, the efforts made to realize learning that is in accordance with the circumstances and environment of students require collaborative interactions in order to deepen knowledge and become more active, effective, and creative.

The Indonesian education system is designed to contribute to producing students who meet the requirements for 21st-century skills, but there are still many Indonesian education systems currently that do not have the criteria for these skills as expected (Ainia, 2020). Not only that, but many of the methods that are used to teach science today do not develop the collaborative skills that are clearly important in educational settings. These issues show that many students still lack this collaboration ability, and it is very much needed in education to increase the standard of student cooperation skills through learning in schools (Tekad & Pebriana, 2022). This was additionally observed in grade 7 students at SMPIT Al-ihsan Boarding School, which students still lack of collaboration skills, which are defined by an individual learning environment even though the activities that have taken place are group learning activities.

Collaborative learning is a learning process that can develop student interaction in building knowledge in groups (Apriono, 2013; Muttaqin Arif, Yoesoef & Anwar, 2018; Nurwidodo et al., 2022). In the context of education, collaboration is a type of cooperation where students support and enhance one another's performance on specific activities in order to jointly establish goals. (Jeong & Hmelo-Silver, 2016; Susantini, 2022). Collaborative learning offers advantages that enable students to observe and identify errors in one another, as well as learn how to fix them, making them more resilient to similar situations down the road. (Mujahid, 2022). Furthermore, it is anticipated that every student would be able to create a variety of learning materials by grasping collaborative learning, which is one of the 21st-century abilities like the capacity to work in teams, solve complicated problems, and apply the knowledge acquired to different other scenarios.

Student learning unsuccessful attempts are going to go with greater efficiency if they have these abilities, and each of these efforts have been developed and encouraged through various learning models that are compatible with the learner's personality. Besides that, there is the significance of suitably qualified and literate instructors are there in dealing with the challenges of students for them to accomplish maximum educational outcomes as meant it to be received a combination of multiples learning approaches contributes to one of them (Nurwidodo et al., 2022). Problem-based Learning (PBL) is a leaning model that can assist students in increasing their capacity for collaborative learning since it uses the teacher as a facilitator throughout the learning process, with an emphasis on student performance.(Ramadanty Prasutri et al., 2019). Hutama correlates that the PBL model is a great solution for developing the children's critical thinking skills (Hutama et al., 2021). The use of the PBL model during the educational process encourages activities to improve critical and analytical thinking skills and solve difficult problems in real life to foster a "culture of thinking" and develop students' potential and abilities. In essence, the PBL model is a learning process based on constructivist principles, which is useful for improving and building students' cognitive abilities. (Duch et al., 2001; Hidayah et al., 2022). So that the

existence and implementation of the PBL model can help implement the learning process better and increase the knowledge and skills of each student.

The following are some of the elements that encourage PBL use in the educational process: PBL can assist in forming pupils' optimistic outlooks (Riwayani et al., 2019), students are encouraged to practice their critical thinking skills so they can create a learning community wherever they are and can share knowledge together (W. P. Sari & Ma'rifah, 2020). According to studies by Prasutri et al. (2019), learning using the PBL model can enhance group collaboration in a variety of settings with favorable outcomes. The results of a study conducted in (2021) by Masruroh and Arif also showed that the class VIII IPA students at SMP Negeri 4 Ponorogo greatly improved their collaborative skills when problem-based learning models were used in conjunction with traditional models and the science education for sustainability approach.

Efforts to improve collaborative skills are not enough just to implement the PBL model but can be developed with teaching materials used in the learning process. One of the causes is not solely due to the inaccurate measurements of the learning model implemented, but also a lack of resources for teaching that are that are suitable for the time and characteristics of students. Student worksheets are a particular kind of educational material that could potentially use for improving students' collaborative abilities. (K. A. Sari et al., 2017). In line with research (Octaviana et al., 2022), that a category in the developed scientific worksheet is useful enough to help seventh-grade junior high school students' teamwork skills, making it a useful resource and substitute for other teaching materials when creating worksheets with a different subject.

The importance of developing this natural science student worksheet is also found in the material on temperature and heat, which is about the effect of ambient temperature on body temperature. This is important because temperature and heat materials associated with the body and the environment are rarely explained specifically. The material heat and temperature were one material that students find challenging (Latifah, 2016). The importance to developing educational materials centered around temperature and heat cannot be overemphasized, hence these assets must be developed. So that through this research, it is important to find out how the feasibility and practicality of participant worksheets based on heat material can help students in developing students' 21st-century skills, especially collaboration skills.

Based on the background of the problem, the latest and innovative research was needed in the development of teaching materials, especially the development of PBL-based worksheets for science learning, especially regarding the effect of environmental temperature on body temperature. For this content, a PBL-based student worksheet is desperately needed, as it needs to be tied to the learning process. This can be applied to help the educational process succeed. Another well-known explanation is that students may find the learning process dull and uninteresting if the lessons they have been taught are not accompanied by the proper worksheets. The undertaking aimed to establish PBL-based worksheets on the effects of environmental temperature on body temperature, which would improve the collaborative skills of middle school students.

2. METHODS

This study employed a research and development methodology, utilizing the Four D (4D) development model. There are four steps in the Four D development model, namely define, design, develop, and disseminate—that are utilized to create PBL-based worksheets on how body temperature is affected by ambient temperature (Thiagarajan et al., 1974). This study's scope was restricted to the development stage, specifically the stage of product practicality and feasibility testing. The 4D research model was utilized to investigate the creation of worksheets based on the PBL model that covered the subject of the relationship between environmental temperature and body temperature. The Four-D Model provides a structured and systematic framework, with each stage having a specific focus and goal, making it easier for developers to follow the process in an orderly manner (Mesra et al., 2023). Therefore, this model is better suited for the creation of instructional materials in the form of specific

model-based worksheets. Another reason for taking this model is because this model can be developed systematically, easy to understand, and studied for the learning process. The purpose of this study was to develop PBL-based worksheets that would enhance students' collaboration skills by teaching them how the temperature of the environment affects body temperature.

This study was undertaken on May 22, 2023, during the school year 2022/2023. The subjects in this study were four feasibility experts, six experts as a team of practitioners, and 20 class VII students of SMPIT Al-Ihsan Boarding School to carry out the learning process with PBL-based worksheets on the effect of environmental temperature on body temperature, which was developed to improve students' skill collaboration. The selection of research subjects was carried out by random sampling method.

The validation sheet, which has five indicator aspects (content, language, presentation, graphics, and PBL components), and the practicalization sheet, which has three indicator aspects (ease of use, attractiveness, and efficiency), are the instruments used in the research on the development of PBL-based student worksheets on the influence of environmental temperature on body temperature to improve students' collaborative skills. The student worksheet's viability was checked by media and content experts, junior high school science teachers, and seventh-grade junior high school students assessed the worksheet's usefulness in relation to the impact of ambient temperature on body temperature. The physical data analysis results on the impact of ambient temperature on body temperature were analyzed using a qualitative descriptive technique, which allowed the results to be classified into predetermined groups.

The feasibility and practicality of student worksheets on the effect of environmental temperature on body temperature based on PBL were determined through limited trials in the field. In order to determine an average score for each assessment aspect component using Equation 1, the quality of the student worksheet's viability and practicality will be discussed by averaging the ratings of all raters.

$$\bar{x} = \frac{\sum X}{N}$$

Information

$\bar{x}$	:	mean score
$\sum X$	:	total score of each component
N	:	number of validators/appraisers

Furthermore, all data that has been obtained on each assessment item will be added up so that it is called the actual score (X). Quantitative actual scores will be converted into qualitative values with reference to the conversion of scores to a scale of five to determine the feasibility and practicality of the quality of the developed PBL-based worksheets. References to changes in scores to a scale of five according to Widoyoko (2009) can be seen in Table 1

Table 1. Ideal Assessment Criteria

No	Score Range	Category
1	X > Mi + 1,8 SBi	Very good (A)
2	Mi + 0,6 SBi < X ≤ Mi + 1,8 SBi	Good (B)
4	Mi - 0,6 SBi < X ≤ Mi + 0,6 SBi	Enough (C)
3	Mi – 1,8 SBi < X ≤ Mi - 0,6 SBi	Not enough (K)
5	X < Mi - 1,8 Sbi	Very less (SK)

Information

X	:	respondent score
Mi	:	1/2 (ideal maximum score + ideal minimum score)
SBi	:	1/6 (ideal maximum score - ideal minimum score)
Ideal maximum score	:	Σ item criteria x highest score
Ideal minimum score	:	Σ item criteria x lowest score

3. FINDINGS AND DISCUSSION

The authenticity of the problems related to students' collaborative skills to solve real problems has been established. Collaboration is one of the 21st-century skills that must be developed because it can foster positive character traits like sharing ideas, showing respect for others, building relationships, and cooperating to accomplish shared objectives while taking full responsibility for one's actions. The development of problem-based student worksheets is one effort that can be given to hone students' collaborative skills. The achievement of this effort is the goal of developing appropriate and practical student worksheets for junior high school students.

It is an assignment which includes gathering information and identifying issues in junior high schools that will serve as a starting point for the creation of student worksheets as the stages of establishing the analysis of the needs and characteristics of students are characterized. For the purpose of to improve effectiveness, which is this stage is extremely beneficial for research and development that will be evaluated on teaching materials in the form of student worksheets.

3.1. Student Worksheet Design

The design was carried out to create something new that was more interesting to develop and perfect the learning program, namely through the development of student worksheets. The initial design that has been done is to determine the contents of the LKS with material, curriculum, and student characteristics. The material that has been taken and developed is temperature and heat material in class VII SMP. The development of these instructional resources must be done as well as possible to increase student interest and comfort levels; one way to do this is by how the resources look.

The Canva software was used to design the student worksheets. These worksheets include cover pages, instructions, objectives, basic competencies, supplies, and practice problems that correspond to the PBL model stage's activities. Student worksheets created with Canva are transformed using the Flipbook app, which could convert PDF files. The PBL-based student worksheet on the effect of environmental temperature on body temperature based on the display cover design uses images of thermometers and running activities as illustrations of the module content. As seen in Figure 1, the cover color has been designed in full color with a green base color. A student worksheet is a form of instructional material that has been thoroughly and logically organized, with many learning experiences designed to support students' comprehension of certain learning goals.

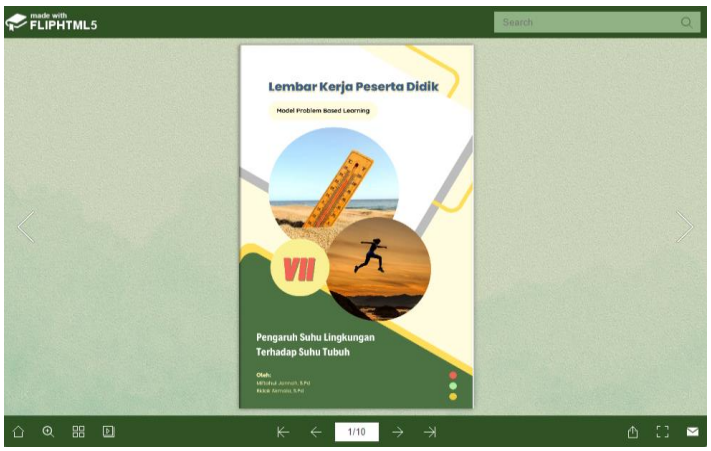

Figure 1. PBL Model-Based Student Worksheet Cover Design

The student worksheets based on the PBL model were designed with the PBL model syntax in mind. Figure 2 shows the layout of the worksheet material for students, and Figure 3 shows the content of the worksheets for PBL-based students. To ensure the achievement of the learning objectives and activities, the PBL phases are implemented to explain the content in the student worksheets that links the impact of external temperature to body temperature.

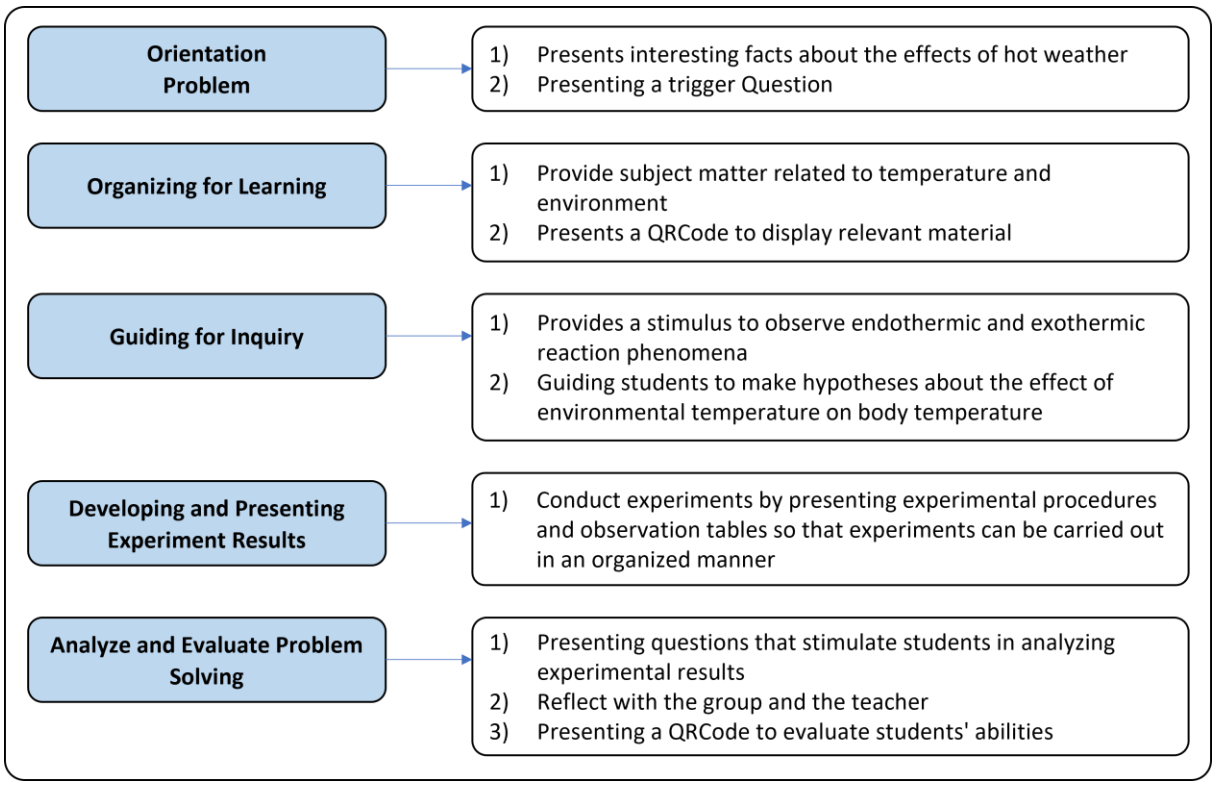

Figure 2. PBL Model-Based Student Worksheet Content Design

Figure 3. PBL Model-Based Student Worksheet Contents

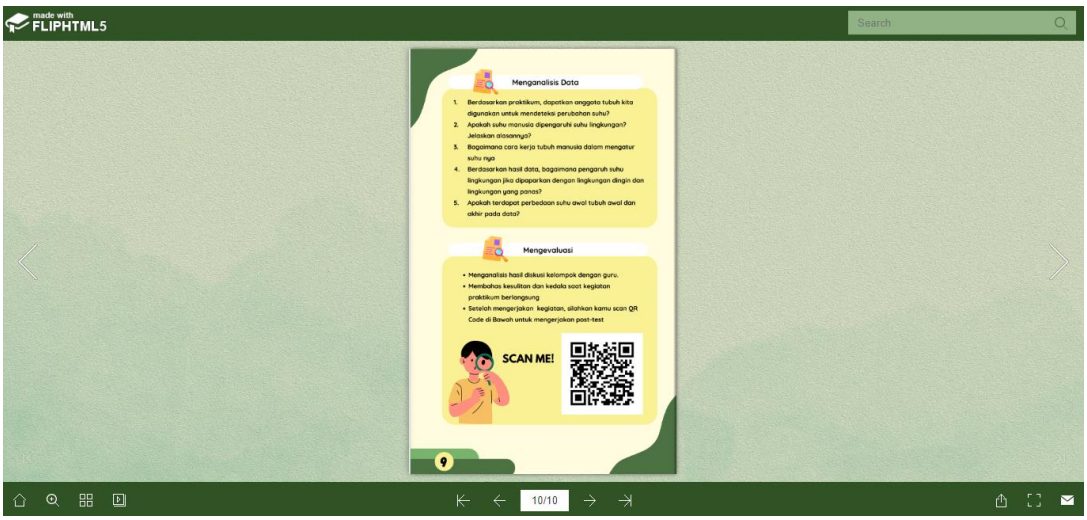

Figure 4. Evaluation in Student Worksheet

Developing worksheets for students is crucial for various reasons, including how the assessment will be used to gauge the understanding and skills of learners. Figure 4 shows the evaluation's display on the student worksheet. The evaluation in this student worksheet has been designed using a Google form so that it is easy to display the answers directly, then the Google form link has been converted into a QR-Code so that it is easy to access with each student's smartphone.

3.2. Feasibility Analysis of Student Worksheets

The feasibility of student worksheets based on the PBL model about the Effects of Environmental Temperature on Body Temperature has been determined from the assessment of experts, teachers and students. Feasibility was assessed using validation instruments with 5 aspects and practicality with 3 aspects. Data from the feasibility assessment results of student worksheets have been converted into a 5 scale value presented in Table 2 and the results of the feasibility assessment in Table 3.

Table 2. Criteria for the Feasibility Assessment of Student Worksheets According to Experts

Score Range	Category
$X > 134.34$	Very good (A)
$108.78 < X \leq 134.34$	Good (B)
$83.22 < X \leq 108.78$	Enough (C)
$57.66 < X \leq 83.22$	Not enough (D)
$X < 57.66$	Very less (E)

The feasibility assessment of PBL-based student worksheets based on expert assessment of four people has a total average score of 138.2. The total average score of the feasibility of the student worksheets is included in the range of scores X > 134.34, which is included in the very good category with predicate A, as presented in table 3. This finding shows that the PBL-based student worksheets about the effect of environmental temperature on body temperature are feasible to be tested in schools with the condition that it must make improvements first according to the suggestions and input that have been given.

Table 3. Average Score of Student Worksheet Feasibility Assessment According to Experts

Assessment Indicator	Score
Content Aspect	25
Language Aspect	18
Presentation Aspects	18
Graphic Aspects	27
Aspects of PBL Components	50.2
Total Score	**138.2**
The ideal High Score	160
The ideal Lowest Score	32
Average Ideal Score (Mi)	96
Standard Deviation of Ideal Score (SBi)	21.3
Final score	**Very Good (A)**

The results of the conversion of scores using a scale of 5 to categorize the practicality evaluation of PBL-based worksheets on the effect of environmental temperature on body temperature that each of the six teachers has assessed, and each of the 17 students as practitioners are shown in Table 4. The participants' worksheets for PBL-based students received an overall mean score of 63.32 for the practicality assessment, which was based on the evaluation of six teachers and 17 students. The overall average score for the student worksheets' sustainability falls within the range of scores X> 63 and therefore qualifies as very good with predicate A in Table 5. The result of this data analysis indicates that student worksheet that have been tried out in school are practical for use in learning activities.

Table 4. Criteria for Assessing the Practicality of Student Worksheets According to Teachers And Students

Score Range	Category
$X > 63$	Very good (A)
$51 < X \leq 63$	Good (B)
$39 < X \leq 51$	Enough (C)
$27 < X \leq 39$	Not enough (D)
$X < 27$	Very less (E)

Table 5. Average Score of Student Worksheet Feasibility Assessment According to Experts

Assessment Indicator	Score		Average
	T*	S*	
Ease of Use Aspect	21	20.44	22.72
Aspects of Attraction	21.25	21	21.22
Efficient Aspect	21.50	21.44	21.47
Total Score	**63.75**	**62.89**	**63.32**
The ideal High Score	75	75	75
The ideal Lowest Score	15	15	15
Average Ideal Score (Mi)	45	45	45
Standard Deviation of Ideal Score (SBi)	10	10	10
Final score	**(A)**	**(B)**	**(A)**

*Teacher (T), student (S)

Discussion

The feasibility and practicality of PBL model-based worksheets on the Effect of Environmental Temperature on Body Temperature are respectively included in the very feasible and very practical category for use in improving students' collaborative skills. This finding is in line with research conducted by Susanti et al (2019), that PBL-based worksheets can significantly improve students' scientific literacy skills. Apart from that, this opinion is also related to research (Gusti & Ratnawulan, 2021), that integrated science student worksheets based on 21st century integrated PBL learning are

able to improve students' attitudes significantly. These results show that PBL-based student worksheets can improve various skills needed in the 21st century, including collaborative skills. Moreover, as stated by Masruroh & Arif (2021), when using the PBL model, collaboration is the key. With this PBL-based student worksheet which has been designed to promote teamwork, effective communication, and joint problem solving between students. This enables the development of vital collaboration skills in the professional and social environment of the 21st century. Mustofa et al (2021) added that through PBL students can develop the ability to think in using the insights they have without having to think about the quality of the opinions expressed, so they can freely develop their thinking and thinking abilities.

The benefits and urgency of collaborative skills have become clearer through this research needs analysis, including skills that can be improved if students engage in collaboration to solve a problem seriously when collaboration is supported by appropriate learning resources and can be applied to student characteristics, such as in the form of a PBL-based worksheet on the influence of environmental temperature on body temperature. Through ongoing experience with implementing this PBL model, students not only gain knowledge about a particular subject, but also develop 21st century skills that are important for future personal, professional, and social success (Tan, 2003). Therefore, carry out longer and more sustainable research to see the development of students' 21st century collaboration skills over time. This will provide a deeper understanding of how student worksheet can influence collaboration skills over time.

4. CONCLUSION

Student worksheets that have been developed based on PBL to explore the influence of environmental temperature on body temperature are found to be feasible and practical for improving students' collaborative skills. The average total score was 138.2 with a 'very good' classification, indicating positive results in terms of feasibility and practicality. This feasible and practical student worksheet can be used as a reference for conducting further research to determine its effectiveness in improving students' collaborative skills on a wide scale so that this student worksheet can also be disseminated after testing its effectiveness.

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