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DEVELOPMENT OF PHYSICS WORKSHEET BASED ON HIGHER ORDER THINKING SKILLS (HOTS) INTEGRATED WITH BILINGUAL CLASS LEARNING

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ABSTRACT

The purpose of this research is to create physics worksheets on Higher-Order Thinking Skills (HOTS) Integrated with Bilingual Learning. The method employed was research and development. This research was carried out at MA Diniyah Putri and SMA Global Surya. Non-test instruments in the form of questionnaires and test instruments in the form of questions were used to collect data. The results of the validation of material experts obtained a score of 4.22 with very feasible criteria, and media experts obtained a score of 4.32 with very feasible criteria. The results of the trial in the limited group obtained a score of 3.77 with high criteria and in the field trial a score of 4.45 with excellent criteria. The increase in students' HOTS abilities can be seen after using the worksheet. Therefore HOTS-based physics worksheet integrated with bilingual class learning is feasible to use. It is suggested to further researchers to develop worksheets on different learning materials.

PENGEMBANGAN LEMBAR KERJA FISIKA BERBASIS *HIGHER ORDER THINKING SKILLS* (HOTS) TERINTEGRASI PEMBELAJARAN KELAS BILINGUAL

Kata Kunci:

Kelas Bilingual
HOTS
Lembar kerja fisika

ABSTRAK

Penelitian ini bertujuan untuk menghasilkan lembar kerja berbasis Higher Order Thinking Skills (HOTS) terintegrasi kelas bilingual pada pembelajaran fisika. Metode yang di gunakan ialah research and development. Penelitian ini dilaksanakan di MA Diniyah Putri dan SMA Global Surya. Pengumpulan data dilakukan dengan instrumen non tes berupa angket dan instrumen tes berupa soal. Hasil validasi ahli materi didapatkan skor 4,22 dengan kriteria sangat layak, dan ahli media didapatkan skor 4,32 dengan kriteria sangat layak. Hasil uji coba pada kelompok terbatas mendapatkan skor 3,77 dengan kriteria baik, dan pada uji coba lapangan mendapat skor 4,45 dengan kriteria sangat baik. Peningkatan kemampuan HOTS yang dimiliki peserta didik terlihat setelah menggunakan lembar kerja. Dengan demikian, lembar kerja berbasis HOTS terintegrasi kelas bilingual pada pembelajaran fisika layak digunakan. Disarankan kepada peneliti selanjutnya untuk mengembangkan lembar kerja pada materi pembelajaran yang berberbeda.

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1. INTRODUCTION

Education is defined as an effort to assist students in reaching their full potential [1], [2]. Education is a reference point in determining a person's quality and value as evidenced by learning outcomes in the form of cognitive and affective aspects [3]. Because a nation's progress requires high-quality human resources, the advanced and modern era of globalization necessitates high-quality education [4], [5]. Many people believe that the multifaceted crisis that this country is experiencing is the result of a failure in the education system [6].

Education in the twenty-first century is confronted with the era of globalization, which necessitates adequate life skills in the form of twenty-first-century skills. Critical thinking and problem-solving skills, communication skills, creativity and innovation skills, and collaboration skills are all classified as twenty-first-century skills [7], [8], where the four skills are components of higher-order thinking skills [9]. HOTS can assist students in interpreting, analyzing, or manipulating information [4], [10]–[12]. Higher-order thinking skills (HOTS) are closely related to problem-solving skills [10], [13]. HOTS are part of basic skills [14], and an important goal in science education [15]–[17].

By implementing meaningful learning, students' HOTS can be accommodated through the curriculum in education [18]. The KTSP and the 2013 curriculum emphasize the importance of learning that carries HOTS [18], [19]. This is in compliance with the Regulation of the Ministry of Education and Culture No. 69 of 2013 on Basic Competencies and Curriculum Structure for SMA/MA, in Core Competencies 3 and 4. Based on these two core competencies, it is clear that students must be more capable of thinking with HOTS in their learning, including physics [6].

Physics learning is a branch of science that necessitates the use of abstract concepts [20]. Learning physics necessitates students gaining hands-on experience with the scientific method through experiments or trials [21]. Physics education should not focus on knowledge as a product, but rather on developing skills through processes, problem-solving practice, and application in real life. Physics learning has three dimensions: the process of thinking ability (way of thinking) [13], the results (products), and attitude development [6]. Designing and distributing HOTS-based Student Worksheets is one learning component that can help develop these three dimensions. Student Worksheets are one type of teaching material designed to assist students in achieving Basic Competence [7].

Worksheet becomes an important teaching material for achieving learning activity goals [22] and an effective teaching strategy [23]. A worksheet is a means of helping and facilitating learning activities [24]. A worksheet is a method of assisting and facilitating learning activities. A worksheet is one of the teaching materials in the 2013 curriculum that has been shown to assist educators in training students' skills through work steps. A worksheet also aids students in their learning because it contains material derived from summaries of various relevant book sources [9]. A well-designed and structured worksheet will determine learning success [6], [13], particularly in schools that open RSBI, Preferred, or Bilingual classes.

To prepare students to compete nationally, regionally, and internationally, the government issued a policy for schools that were able to open international school classes, featured classes, or bilingual classes [25]–[28]. In a bilingual class, English is used as the medium of instruction [25], [26], [29]–[31]. This policy responds to teachers' demands for adaptability in the learning process, particularly regarding language, learning resources, learning media, teaching materials, and worksheets [32], [33].

Observations in several schools revealed that there were no HOTS-based worksheets integrated into bilingual classroom learning, particularly for Physics subjects. Worksheet-based teaching materials are still at the level of material and practice questions [34], [35], and do not relate problems to everyday life [36]. There are no sections to increase student HOTS. The questions did not demonstrate the existence of HOTS, which could aid in the understanding of physics concepts. It is critical to prepare HOTS-based worksheets in bilingual classes so that students can easily understand concepts and train and improve their HOTS.

Previous research on the development of HOTS-based worksheets indicates that worksheet is appropriate for use based on their validity [37], [38], can assist students in practicing their higher-order thinking skills [9], improves student learning outcomes [38], and has appropriate interpretations for use in learning [37]. The worksheet is designed with appropriate and effective problem-solving steps [39]. According to other research, bilingual worksheets can help improve students' ability to solve mathematical problems [40] and learning outcomes [41].

Recognizing the importance of HOTS for students, particularly in physics learning in bilingual classes, HOTS-based worksheets that are integrated into bilingual class learning are required. Worksheet preparation includes not only summaries of material and assignments but also incorporating HOTS indicators such as analyzing, organizing, linking and evaluating [38]. Furthermore, the development of worksheets must be integrated into bilingual class learning, in which English is used as the language of instruction throughout the learning process.

The goal of this research was to determine the feasibility of integrating HOTS-based physics worksheets in a bilingual class, determine students' responses to HOTS-based physics worksheets integrated into a bilingual class, and HOTS improvement through worksheets developed in a bilingual class.

There has been a lot of research on the development of worksheets. However, this worksheet's research and development were carried out in bilingual classes with different variables. As a result, the purpose of this research is to create HOTS-based worksheets that can be used in bilingual classroom learning. This worksheet will be used as a tool to help students improve their HOTS in bilingual classes.

2. METHODS

This research utilizes research and development methods to produce and develop specific products [42]. The Borg and Gall model, as modified by Sugiyono [43], is used in this research. This research aims to modify and develop products as well as test their feasibility in the field. Sugiyono's research and development at Borg & Gall required ten development steps to produce a usable final product [36], [43].

The purpose of this research and development is to validate and develop products. This means that the product already exists, and researchers are only testing the feasibility of product development at this stage, so researchers reduce research and development from ten steps to seven steps. Due to limited time and funds, this seven-step stage was only at the development stage of teaching materials, supported by problem limitations that only extend to feasibility and product trials. Figure 1 depicts the research stages:

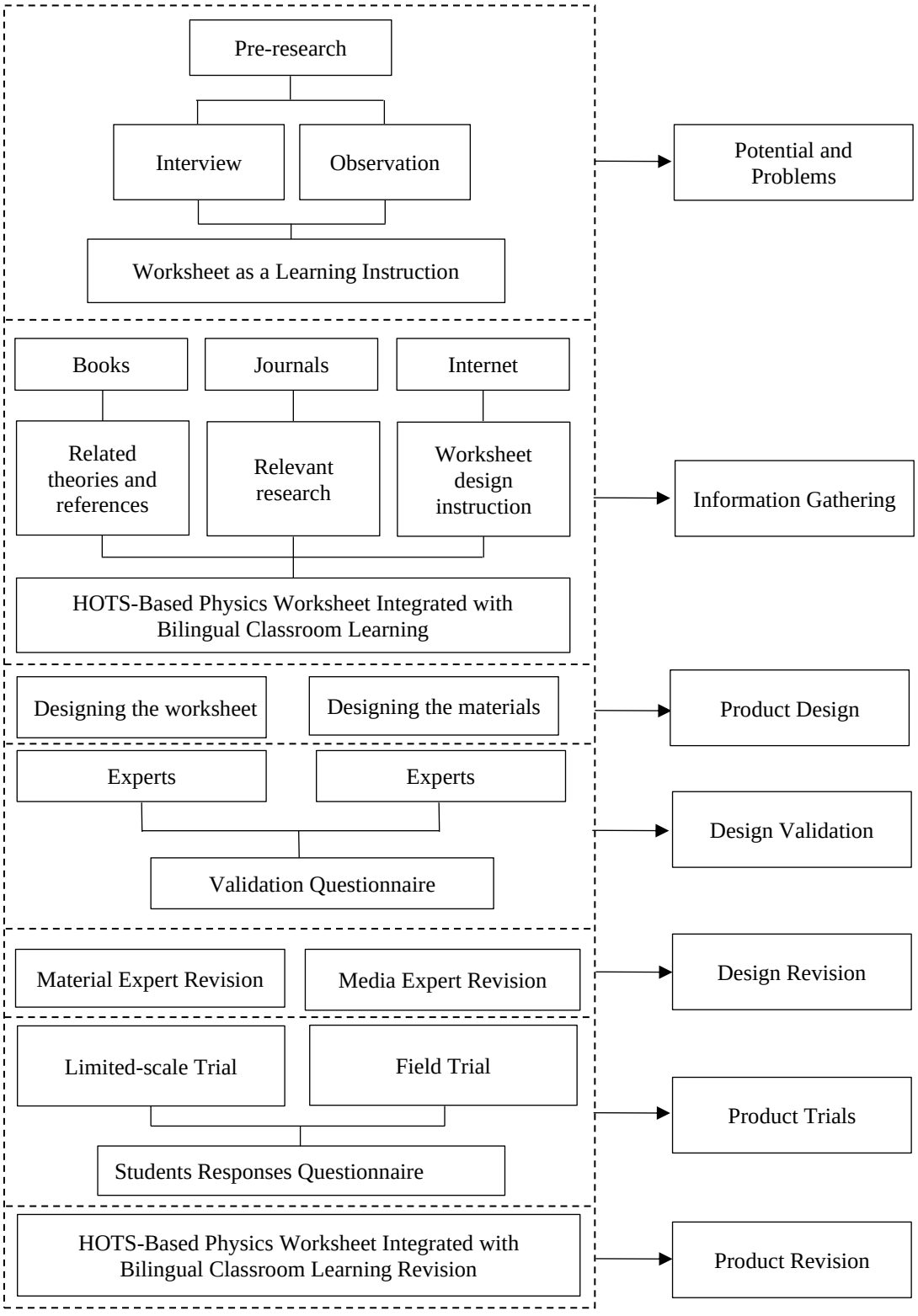

Figure 1. Research Stages

This study's test subjects included content/learning material experts, media experts, limited-scale trials, and field trials. Content/learning material experts, namely several lecturers/experts as material validators, validated the material. Three media experts who are experts in their fields conducted the design test. The limited trial was conducted at

MA Diniyah Putri and SMA Global Surya Bandar Lampung in the bilingual classes. Several students were randomly selected based on the research sample, namely three students who could represent the population.

Media expert validation instruments, material expert validation instruments, and student instruments were employed to determine whether the product was valid and reliable for students to use. In addition, test instruments were used to assess students' HOTS. The qualitative data in this research was processed and analyzed using a Likert Scale with a questionnaire for the validators and students. Table 1 shows the criteria for using the Likert Scale.

Table 1. Likert Scale Criteria [44]

Score	Description
5	Excellent
4	High
3	Moderate
2	Low
1	Poor

The score for each statement for all validation results was calculated and expressed as a percentage using the following equation [45].

$$\%SS = \frac{\overline{SS}}{S_m} x100\% \qquad (1)$$

Description:
$\overline{SS}$= Average Score
S_m= Maximum Score

To interpret the percentage of expert validation results, the following assessment criteria were used (see Table 2 below).

Table 2. The Interpretation of Validation Scores [38]

Interval	Assessment Criteria
81% - 100%	Excellent /Highly feasible
61% - 80%	High/Feasible
41% - 60%	Moderate/Moderately feasible
21% - 40%	Low/Less feasible
0% - 20%	Poor/Not feasible

If the percentage is less than 61%, the product will be revised or improved following the suggestions. If the results are greater than 61%, the product is appropriate for use in the learning process.

The results of HOTS tests given to students in bilingual classes showed that students' understanding of concepts improved. The data for this study came from respondents, specifically students in the Bilingual class. Data from expert validations and student response questionnaires were processed using qualitative descriptive analysis. This technique is carried out by grouping qualitative data information in the form of questionnaire suggestions for improvement. This data analysis served as a guideline for revising the HOTS-based worksheet development product used in Bilingual classrooms.

3. RESULT AND DISCUSSION

Based on the development procedure, the implementation of this research is only up to the seventh step due to the time and cost limitations of the research. The results of each stage are:

3.1 Potential and Problems

The research potential was the development of HOTS-based worksheets that integrate bilingual class-based learning. Starting with the issues observed in the two schools, it was clear that students were using internet-based learning resources whose validity was unknown. The test results for students' HOTS in bilingual classes were relatively low. The teachers employed the 2013 curriculum package books and worksheets from publishers, intended to be used as the tools for assigning assignments to students. The observations in the two schools showed that there were no HOTS-based worksheets integrated into bilingual classroom learning, particularly in physics subjects. Meanwhile, students required teaching materials tailored to their specific needs based on learning competency standards. The researcher developed teaching materials in the form of HOTS-based worksheets integrated with bilingual physics classes to address these issues.

3.2 Information Gathering

Gathering information is critical for determining the demands of students for the product they wish through research and development. The first step was to gather information from teachers at MA Diniyah Putri and SMA Global Surya Madani Bandar Lampung, particularly in the eleventh-grade science classes. Next, when needed, the researchers gathered reference sources to aid in the development of the worksheet, such as physics textbooks and physics publications related to the development of HOTS-based worksheets integrated with bilingual classrooms. The data was organized into core competencies and basic competencies, learning objectives, learning activities with physics content and HOTS-based practice problems, and integrated bilingual lessons.

3.3 Product Design

Product design was completed after gathering information previously required in product development from journals, books, or other relevant sources. Product development began with the creation of HOTS-based learning stages. The next step was to create a HOTS-based worksheet based on HOTS cognitive level indicators tailored to the core and basic competencies in the 2013 curriculum. The worksheet created must also maintain integrity in the bilingual classroom by using English as the language of instruction. The worksheet was organized progressively, with learning activities containing material, material descriptions, and practice questions based on HOTS and bilingual class integration. Figure 2 depicts the HOTS-based worksheet design connected with bilingual class learning.

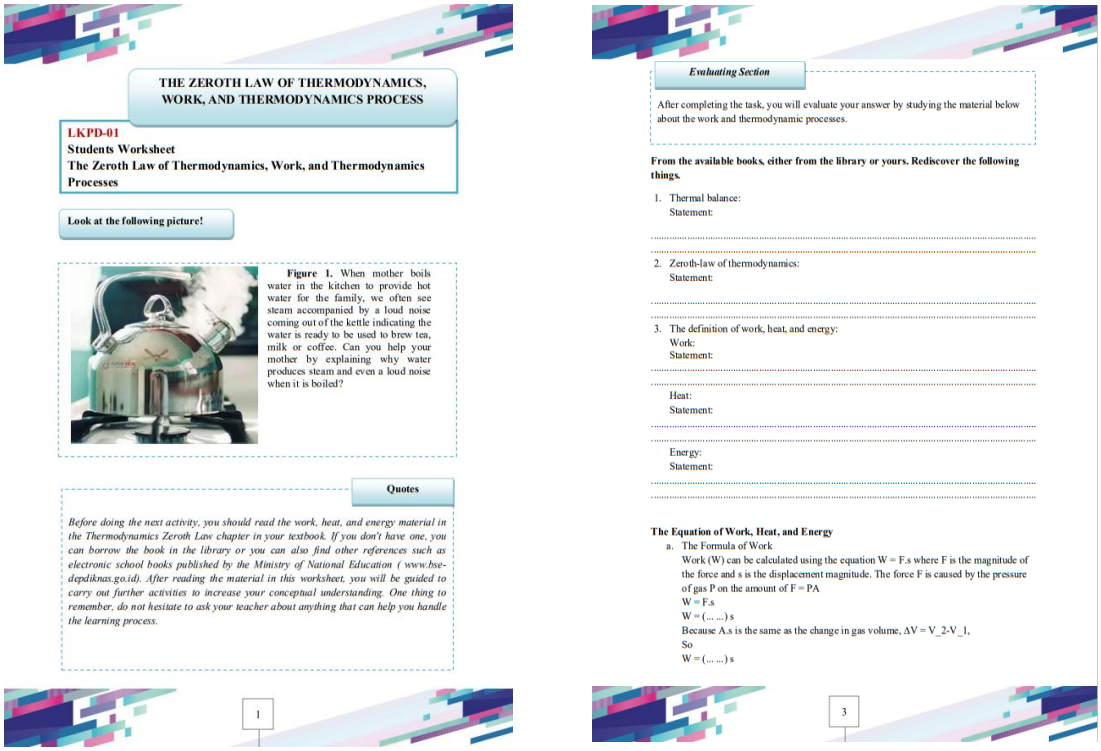

Figure 2. The Design of the Worksheet

3.4 Design Validation

Design validation is the process of determining whether rational product design will be more effective. Validation was performed on the HOTS-based worksheet integrated with bilingual class learning, which included material validation and media validation.

3.4.1 Material Validation

The content feasibility, presentation feasibility, language eligibility feasibility, and contextual feasibility of the material on the HOTS-based worksheet integrated into bilingual classroom learning were all evaluated. Material validation examined the feasibility of the material created from worksheets. Table 3 shows the results of material validation by the material expert validator.

Table 3. Material Validation Result

No	Aspects	Average Score	Percentage	Criteria
1	Content feasibility	3,83	76%	Feasible
2	Presentation feasibility	4,50	90%	Highly feasible
3	Language feasibility	5,00	100%	Highly feasible
4	Contextual feasibility	3,58	72%	Feasible
The Total average score of the whole aspects		4,22	84%	Highly feasible

According to the table, the average score of the four material feasibility aspects is 3.83, or 77%, which is included in the feasible criteria. Based on the material validation results for all aspects of the assessment, it is clear that the worksheet developed has very feasible criteria. Even though the worksheet has been validated and classified as highly feasible, it must still be revised following the guidelines provided.

3.4.2 Media Validation

Media validation on HOTS-based worksheets integrated into bilingual classroom learning was assessed based on 3 aspects including size, cover design, and content design. Media validation aims to see the feasibility of the media developed as physics teaching materials in the eleven-grade science class. The results of media validation by media expert validators are presented in the following table.

Table 4. Media Validation Result in Stage I

No	Aspects	Average Score	Percentage	Criteria
1	Size	4,50	90%	Highly feasible
2	Cover Design	4,35	87%	Highly feasible
3	Content Design	4,11	82 %	Highly feasible
Total Average of all aspects		4,32	86%	Highly feasible

According to the table, the average score of the three aspects of media assessment is 4.32, or 86%, which falls under the highly feasible criteria. The worksheet developed has highly feasible criteria to use, based on the results of media validation for all aspects of the assessment. Even though the worksheet has been validated and classified as feasible criteria, it must still be revised following the instructions.

3.5 Design Revision

Following the design validation by the expert validators, the next step was to improve the HOTS-based worksheet design integrated into bilingual class learning as physics teaching material in the eleventh grade following the expert validators' criticisms and suggestions. The validator's validation results provide researchers with information about flaws in the developed worksheet. Material experts' criticism and suggestions include adjusting the content of the material with readjusted learning objectives so that students can understand the material being studied and adjusting the use of English as the language of instruction in class. Then, media experts' criticism and suggestions include improving the cover design by paying attention to the suitability of the colors on the cover and the worksheet's contents. The researcher made revisions to correct existing errors and deficiencies based on the expert validator's advice on HOTS-based worksheet integrated bilingual class learning as physics teaching material in the eleventh grade.

3.6 Product Trial

Following product improvements, the product was tested in two ways: limited group and field trials.

3.6.1 Limited-Group Trial

The limited group trial included 20 students from two classes at two different schools who completed a statement questionnaire that assessed three aspects of assessment: interest, material, and language. The limited group trial seeks to determine student responses to a smaller number of worksheets. Table 5 shows the results of student responses to the limited-group trial.

Table 5. Students Responses in the Limited Trial

No	Aspects	Average Score	Percentage	Criteria
1	Attractiveness	3,80	76%	Baik
2	Material	3,66	73%	Baik
3	Language	3,86	70%	Baik
Total Average of all aspects		3,77	73%	Baik

According to the table, the average score of the three aspects of assessing student responses in the limited group trial is 3.77 or 73%, which falls into the high category. Based on the results, high criteria were obtained for all aspects of the assessment of the developed worksheet, implying that students respond positively to the developed worksheet.

3.6.2 Field Trial

The field trial included 63 students from two classes at two different schools, who completed a statement questionnaire that assessed three aspects of assessment: interest, material, and language. The goal of the field trial is to determine how many students responded to the developed worksheet. Table 6 shows the outcomes of student responses to the field trial.

Table 6. Students Responses in the Field Trial

No	Aspects	Average Score	Percentage	Criteria
1	Attractiveness	4,42	80%	High
2	Material	4,42	80%	High
3	Language	4,51	90%	Excellent
Total Average of all aspects		4,45	83%	Excellent

According to the table, the average score of the three aspects of assessing student responses in the large group trial is 4, 45, or 89%, which falls under the very good criteria. Based on the results, it is clear that the criteria are excellent in all aspects of the evaluation of the developed worksheet. It means that the developed worksheet is well received by students.

3.7 Product Revision

Students will evaluate the results of testing the products developed in the two groups. Based on the results of previous product trials, it was discovered that the worksheet developed for a limited group met the good criteria. Field tests were then conducted on large groups, and the worksheet's results were adapted to meet the very good criteria and were suitable for use. The final product of the HOTS-based worksheets integrated with bilingual class learning as physics teaching materials in eleventh-grade science classes is the obtained results. The worksheet has been developed and tested for feasibility and usability for integrated HOTS-based bilingual class learning to be used as physics teaching materials for the eleventh-grade science student at the senior high school level.

Researchers discovered both supporting and inhibiting factors during the development of the worksheet from its initial conception to its final product. These assisting factors are as follows: HOTS-based worksheets assist schools in the bilingual learning process and support the 2013 curriculum, which encourages students to be more active in the learning process. This can be seen when students are passive in their learning in the early stages because the teaching materials used in the form of books and worksheets are still oriented as a tool for giving only training assignments to students. Meanwhile, students were more active after using the HOTS-based worksheet that was integrated into the bilingual class because the material presented on the worksheet invited students to carry out activities to find information based on phenomena commonly found in everyday life. Furthermore, this worksheet can assist students in honing their HOTS.

The result of this research and development is a HOTS-based worksheet that integrates bilingual class learning and has benefits as physics teaching material in the eleventh grade. These benefits include: overall, the HOTS-based worksheet developed received an assessment with excellent criteria for all aspects of learning, allowing it to be used as a teaching material both inside and outside the classroom, particularly in schools with bilingual classes. The HOTS-based worksheet is not only used in class, but it can also be used when a teacher is unable to attend; HOTS-based worksheet is not only used as teaching material, but it also provides analysis, evaluation, and creative power; and HOTS-based worksheet in analysis sessions allows students to share their ideas, thoughts, and hypotheses. Students are also expected to be able to communicate the results of the analysis in writing and a systematic manner; the HOTS-based worksheet in the evaluation session provides theory from the analysis session. The theory presented is not only the theory in its entirety, but it also helps students understand the formula with several unequal columns. Students will fill in the gaps in the columns until they find a theory from the sub-material. Students not only know and memorize the theory, but they also understand it. The HOTS-based worksheet in bilingual classes encourages students to become more active participants in their learning by encouraging them to discover their knowledge based on everyday phenomena. Furthermore, the worksheet gaps allow students to practice their HOTS through learning activities.

The HOTS-based worksheet in the creation session boosts students' creativity by creating a tool that applies the theory learned in the evaluation session. As a result, students will have real-world experience after studying thermodynamic material. The tools developed can also be used for the next generation.

HOTS-based worksheets have advantages as learning media but also disadvantages. These weaknesses include the worksheet on several sessions requiring educator assistance. Because the worksheet has many pages, it is expensive to reproduce.
The HOTS ability test results were obtained by posing questions to students in two schools, which served as research objects and are shown in Table 7 below.

Table 7. HOTS Test Results

No	Criteria	Initial Score	Final Score
1	MA Diniyah Putri	56,6	70,3
2	SMA Global Surya	60,4	72,7

According to the table of HOTS ability test results before and after using the developed worksheet, there is a significant increase in HOTS, even though the score has not yet reached the expected minimum standard. The findings of this research are consistent with previous research indicating that HOTS-based worksheets can help students become more active during learning by practicing their HOTS [9], [46].

HOTS-based worksheets begin with examples of thermodynamic phenomena that occur in everyday life; at this point, students are invited to explain why these phenomena can occur. Additionally, students are asked to analyze their understanding by answering the questions provided in the analysis session, allowing them to practice their HOTS abilities. During the evaluation session, students were asked to return to answering material-related questions by organizing, connecting, and relocating the items requested in the worksheet. This evaluation session indirectly assists students in learning on their own to determine their understanding of the material. During this evaluation session, students were also asked to design or plan their experiments, from the tools and materials required to the experimental sketches and steps. Students have real work after studying thermodynamic material thanks to this experimental planning.

The created worksheet was put together by incorporating HOTS indicators like analyzing, organizing, connecting, and evaluating. The developed worksheet can thus improve HOTS capabilities. The findings of this study are consistent with previous research, which found that HOTS-based worksheets can help students become active participants in their learning by practicing their HOTS [9], [46], such as the use of worksheets to aid and facilitate learning activities [47], increasing student activity in improving thinking skills [46] and assisting students in meeting learning indicators [39].

4. CONCLUSION

HOTS-based physics worksheets integrated with bilingual class learning have been declared feasible. The material experts validated the worksheet's feasibility, with an assessment score of 4.22 in all aspects of the highly feasible criteria. The media expert validation provided a total assessment score of 4.98 in the highly feasible criteria.

Student responses to the attractiveness of the developed worksheet were obtained from a questionnaire distributed to bilingual class students, which included ease of understanding, clarity of the material, effectiveness when used for learning, and the practicality and clarity of material under HOTS. Based on the results of the limited group trial, the worksheet received a score of 3.77 with high criteria. In the field trial, the worksheet received a score of 4.45 with excellent criteria. Based on the responses from the two groups, the developed worksheet is feasible.

The feasibility of the developed worksheet increased students' HOTS based on the learning outcomes of the bilingual class students. They provided HOTS-related questions. The findings revealed that there was a significant increase in HOTS before and after using HOTS-based worksheets.

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