



Research Article

Developing Physics Learning Tools Based on Local Wisdom in the Form of Musical Instrument of Gandrang Bulo Dance as Learning Source in Sound Wave

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Abstract

This is a development research that aimed to (1) produce physics learning tools based on local that are feasible to be used in learning, and (2) determine the quality of learning tools that have been developed. This research was using 4D model which consisted of defining, designing, developing and disseminating. Learning tools that were developed consist of Lesson Plan (RPP), Student Worksheets (LKPD), teaching materials, and learning media. The results of the feasibility test showed that the learning tools were in the good and feasible categories based on qualitative and quantitative assessments of experts, physics teachers, and peers with an average score of 26,4 – 35,2. In addition, the results of testing the learning tools in 30 randomly selected students showed a result of the average response responses of students of 3.08 with good and feasible categories to be used in the learning process on a larger scale. Furthermore, each phase of activity contained in the lesson plan has been carried out very well in each of its meetings based on the observations of learning implementation with achievement scores reaching 80% - 100%

Keywords:

learning tools, local wisdom, lesson plan, learning media, student worksheet

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Introduction

One of the scientific disciplines that has a very crucial role in the development of science and technology is physics. This requires humans to continue to improve the latest knowledge and innovations related to physics. The same is true for students who are required to have a better understanding of physics. Thus, the role of the teacher is very important to design learning that is more focused on mastering the concepts of physics, including in terms of designing learning devices that suit the needs and characteristics of students (Naqiyah, Jumadi, Wilujeng, 2019).

Based on Minister of Education and Culture Regulation No. 22 of 2016 concerning process standards in elementary and secondary school learning, it is recommended to use problem-based learning as one of the approaches to learning in order to encourage the ability of students to produce work individually and / or in groups (Presiden Republik Indonesia, 2016). In addition, one of the core competencies expected of high school students is to be able to bring themselves to represent the nation's culture in the world community and be able to understand knowledge that is humanitarian, national and state (President of the Republic of Indonesia, 2016). Therefore, the learning tools prepared by the teacher should contain aspects of problem solving and cultural integration

Regarding the preparation and implementation of learning tools by teachers, there are several problems that are often found. One of them is based on the results of observations conducted by Sulardi, Nur, and Widodo (2017) most teachers do not associate subject matter with authentic problems in everyday life while teaching. This indicates that in learning activities, the teacher still has not compiled and implemented it optimally to help students in developing knowledge independently.

The results of a study conducted by Diani (2015) found that the physics learning tools used by teachers in physics learning did not support the achievement of the competencies to be achieved. One of them is the Lesson Plan (RPP) used by the teacher still does not have a complete component. In addition, the teaching materials used are not in accordance with the characteristics of students and have not been able to optimize the results of student achievement. Furthermore, Student Worksheets (LKPD) used by teachers have not been able to guide students optimally in carrying out experiments. Thus, learning activities become less than optimal.

On the other hand, integrating local wisdom into learning tools is an alternative in providing teaching materials that are appropriate to the characteristics of students. Squire, Makinste and Barnett, (2013) suggest that curriculum design with local wisdom and technology can build new knowledge. In addition, teaching materials developed by integrating local potential can help develop students' skills (Lathifah & Wilujeng, 2016).

Lesson Plan

The Ministry of Education and Culture Regulation (Permendikbud) No. 22 of 2016 concerning process standards states that Lesson Plan (RPP) are scenarios of learning stages for one or more face-to-face meetings. This RPP was developed with the aim that basic competencies (KD) can be achieved by students. The RPP component consists of: (1) school identity, (2) subject identity or theme / sub-theme, (3) class / semester, (4) subject matter, (5) time allocation, (6) learning objectives, including affective, cognitive, and psychomotor, which can be measured or observed, (7) basic competencies and achievement indicators of competencies, (8) learning materials, (9) learning methods, (10) learning media, (11) learning resources, (12) stages of activities learning, including introduction, core, and closing, and (13) assessment of learning outcomes.

The drafting of the lesson plan should be based on the principles written in Permendikbud No. 22 of 2016 concerning process standards, namely taking into account several important points, including: (1) individual differences in learning, (2) active participation of students (3) student-centered, (4) providing positive feedback and follow-up in the form of reinforcement, enrichment, and remediation, (5) linkages between each point in the lesson plan, (6) accommodating integration across aspects of learning and cultural diversity, and (7) integration between the application of technology and information as a means of effective and efficient communication.

Student Worksheet

Student Worksheet (LKPD) is a sheet that contains instructions or steps in solving a problem. This sheet also usually contains tasks that can increase the active participation of students so that it makes it easier for teachers to help students obtain concepts, both independently and in groups (Darmodjo & Kaligis, 1993).

Trianto (2009) wrote that LKPD is one part of a learning tool that helps students to conduct investigations or solve problems. In addition, Kaymacki (2012) states that LKPD is an instruction material that is presented and prepared regularly by the teacher to help students get knowledge, skills, and values in helping students to do *learning by-doing*.

Prastowo (2011) writes that in compiling the LKPD, there are several requirements that must be met, including: (1) didactic requirements, which means that the LKPD must follow the principles of effective learning, (2) construction requirements, which relate to language usage, arrangement sentence, vocabulary, and clarity in the LKPD, (3) technical requirements, namely relating to writing. Things that need to be considered include the use of letters and frames that are provided to write the command sentences and answers of the students

Teaching Material

Teaching materials are not only seen as a tool to teach students, but as a source that can be used by students so that they can learn. Related to this, it is important that the books or teaching materials presented are integrated with the current curriculum at certain levels of education. Therefore, teachers are required to prepare teaching materials before conducting classroom learning. (Lestari, 2013).

Gintings and Abdorrakhman (2008) stated that teaching material is a summary of the material taught to students, both in print and soft files in the form of writing and / or oral. This teaching material should be given to students before the material is taught. This is intended so that students have initial knowledge related to the material to be taught and are able to actively participate in the learning that will be conducted.

Teaching materials can also be interpreted as learning material that has been systematically arranged to be used in the learning process (Pannin, Paulina, & Purwanto, 2001). In addition, Prastowo (2011) in his book writes that teaching materials are all forms of information that are arranged systematically and have represented all types of competencies to be achieved by students. This material is then used with the aim of planning and reviewing learning implementation.

Learning Media

Learning media is a messenger technology that is used for learning purposes (Rusman *et al.*, 2012). Nurseto (2011) suggests that learning media is a vehicle for channeling messages or learning information. From the explanation above it can be concluded that learning media is a technological tool used by teachers to convey information or messages to students in the form of learning so that it can encourage the learning process.

Learning media can also be defined as a tool that is used by teachers to deliver learning material to students. Learning media can be in the form of graphic media, audio media, silent projection media, and playing media (Nugroho, Raharjo, and Wahyuningsih, 2013). The use of instructional media will affect the activities of students during the learning process. Therefore, the selection of learning media must be adapted to the conditions of the students and the material taught so that participants can be actively involved in the learning process.

Local Wisdom of Musical Instruments in Gandrang Bulo Dance

Local wisdom was first introduced by Wales. This is the ability of a particular culture to maintain foreign cultural influences when they relate to one another. Local wisdom refers to a set of specific community knowledge and practices taken from previous generations and experiences in relation to other communities to solve problems (Setiyadi, 2013).

Local wisdom contains the meaning of norms, conceptual ideas, values, knowledge, perspective of life, and ways of individuals and communities to fulfill their life needs and to solve various problems faced in their environment. The intended environment is the space of interaction of a group of people where they live together, or mingle together. Local wisdom of the community in an area can be in the form of words or expressions, actions or behaviors, writings and man-made objects (Martawijaya, 2014).

Local wisdom-based learning is character education. Nurma (2007) mentions that local wisdom can also be interpreted as a human effort to use his mind to react to something. Sibarani (2012) also emphasizes that local wisdom is a policy in certain community groups as a result of the existence of noble values and cultural traditions as a tool to regulate people's lives.

One of the local wisdoms that can support physics learning in sound waves is a musical instrument in the *gandrang bulo* dance. *Gandrang Bulo* dance is one of the performing arts that combines elements of dance, music, and theater. This dance has developed since the era of colonialism which was used as a media for propaganda to the community to fight the injustices perpetrated by the invaders. This dance has been passed down from one generation to another along with the inheritance of the wisdom of the Bugis-Makassar community to always cooperate in fighting injustice. This dance is further known as an entertainment medium by displaying certain characters (Masnaini, 2015).

Gandrang Bulo dance is a traditional dance of cultural arts originating from Bugis-Society that combines elements of music, dance, and critical dialogues that are jokes. This dance began to be known among the public around 1960 and was performed in events, such as in wedding events, reception of royal guests, and other banquets. This dance performance is accompanied by traditional music consisting of pieces of bamboo, drum, and flute or other traditional Makassar friction tools. By wearing traditional clothes, the dancers bring cute characters or innocent villagers to face the arrogant officials or powerful people. One characteristic of this dance is the musical instrument used which is a typical South Sulawesi musical instrument, namely *gendang bulo*, *suling bambu*, and *kacapaing* (Syair, 2014).

Overall, the education recommended in each education unit is education that is able to develop the potential of students so that the person concerned is able to deal with and solve the life problems they face. Related to this, the development of a learning tools that is integrated with local wisdom is expected to develop the potential of each region and increase the creativity and character of students (Mannan, 2016). Therefore, this study aims to develop learning tools that are integrated with the local wisdom of the local community as a source of learning that fits the needs of students.

Method

Research Model

This research is a development research using a 4D model consisting of define, design, develop, and disseminate (Thiagarajan & Semmel, 1974). The learning tools developed in this study are lesson plan (RPP), student worksheet (LKPD), teaching materials, and learning media.

Participants

The subjects of this study were students, experts, physics teachers, and peer reviewers. The testing of the learning tools involved students in class XII MIA 2 of Gowa 1 Public High School (SMAN 1 Gowa), South Sulawesi, in the even semester of school year 2018/2019. Whereas two experts, three physics teachers, and four peer reviewers were involved in content validation

Data Collection Tools

Data collection is done using the method of interview, observation and questionnaire. Interviews are carried out to students and physics teachers in the form of question and answer or semi-structured interviews with the aim of identifying the needs and obstacles of students in physics learning. The results of this interview are then used as a reference in developing the learning tools.

The validation sheet is used to determine the feasibility of the products developed, while the questionnaire sheet is used to determine the response of students to products that have previously been assessed by experts. In addition, the observation sheet is used to determine the implementation of learning using the products that have been developed.

Data Analysis

Content validation is done through validation with experts consisting of lecturers, teachers and peer reviewers. Validators will be given validation assessment instruments to conduct quantitative and qualitative assessments related to material, construction and language. Quantitative assessment is obtained based on the scores given by the validator with assessment categories 1 to 4 on each item assessed by referring to the achievement score indicator. The data is then converted into quantitative form and classified into the actual score group which states the validity of the product that has been validated. Widoyoko (2017) made a classification based on a comparison of the average ideal score (X_i) and the ideal standard deviation score (SB_i). The qualification level is divided into four categories with the criteria in Table 1.

Table 1.*Quality Score Classification*

No	Average Score Range	Quality Category
1	$X \geq Xi + 1,8 SBi$	Very Good
2	$Xi + 0,6 SBi \leq X < Xi + 1,8 Sbi$	Good
3	$Xi - 1,8 SBi \leq X < Xi + 0,6 SBi$	Less Good
4	$X < Xi - 1,8 SBi$	Bad

The average ideal score (X_i) and ideal standard deviation (SBi) can be determined using equations (1) and equation (2)

$$Xi = \frac{\text{ideal maximum score} + \text{ideal minimum score}}{2} \quad (1)$$

$$SBi = \frac{\text{ideal maximum score} - \text{ideal minimum score}}{6} \quad (2)$$

The ideal maximum score is the theoretically ideal highest score of all items and the ideal minimum score is the assumption if the entire sample gives the lowest response

Results and Discussion

Define

This stage is carried out to establish and define the learning conditions needed in the development of physics learning tools based on local wisdom of the musical instruments of Gandrang Bulo dance. The results of this stage are used as a reference in developing learning tools that suit the needs of students. This stage is carried out by conducting field studies into schools.

Field study is conducted by conducting surveys to schools to obtain information about the implementation of physics learning. Information needed related to learning tools used by teachers, teacher activities, school learning environment, students' activities and views, also supporting and inhibiting factors during learning. The results of the identification of these problems were used as the basis for the development of learning tools. This field study was conducted at SMA N 1 Gowa in South Sulawesi Province.

This field study begins with conducting semi-structured interviews with physics teachers regarding the curriculum and the completeness of the learning tools used. From the results of the interview, information was obtained that SMAN 1 Gowa had implemented the 2013 curriculum from 2015 until the interview was conducted. The completeness of learning tools prepared by the teacher includes syllabus, lesson plans, student handbooks, teacher handbooks, semester programs, and annual programs. Since using the 2013 curriculum, students are required to be able to integrate physics concepts into everyday life, including those related to local wisdom.

One physics material that has the potential to be integrated with local wisdom is sound wave with analysis as shown in Table 2

Table 2.

Identification of Physics in Local Wisdom of Musical Instruments of Gandrang Bulo Dance

Core Competency (KI) and Basic Competency (KD)	Subject Matter	Class/Semester
KI 3 and 4, KD 3.10 and 4.10	Sound Wave	XI/ Even

Furthermore, interviews were conducted with students. Based on the results of the interview, it was obtained that the teacher tended to use the lecture method, solve the questions, and rarely do the practicum. In addition, students are allowed to bring smartphones and laptops in class for the learning process, so that the use of learning media in the form of videos and simulations can be done.

Related to the learning process, students have varied attitudes during the learning process. There are those who pay serious attention, there are those who joke with other students and those who don't pay attention to the lesson at all. Even though students showed different attitudes, the class remained conducive to the learning process. Students answer the questions given by the teacher with enthusiasm. Occasionally students also ask questions that they don't understand to the teacher. In addition, almost all students already know the local wisdom of Gandrang Bulo dance and what musical instruments are used in it.

On the other hand, learning by integrating local wisdom into physics subject has never been done. Thus, the ability to solve concrete problems related to everyday life has not been maximized. Therefore, through the physics learning tools developed, it will help students in maximizing the learning process

Design

Lesson Plan (RPP)

Preparation of lesson plan is based on the 2013 curriculum which refers to Regulation of Minister of Education and Culture No.22 of 2016. The draft of RPP with Sound Wave material is arranged for meetings consisting of: identity, KI, KD, competency achievement indicators, teaching materials, learning activities, time allocation, learning methods, assessment of learning outcomes and learning resources. Learning activities contain 4 meetings with an allocation of 2 x 45 minutes for each meeting. The approach used is a scientific approach with Problem Based Learning (PBL) model. The design of learning activities in lesson plan can be seen in Figure 1.

Kegiatan	Deskripsi Kegiatan		Aspek Nasionalisme	Alokasi Waktu	
	Guru	Peserta Didik			
Pendahuluan	Mengucapkan salam dan meminta peserta didik untuk berdoa	Mem balas salam dan ketua kelas memimpin pembacaan doa		10 menit	
	Mengecek kehadiran dan menyiapkan peserta didik untuk belajar	Menyiapkan diri untuk menerima pembelajaran			
	Menyampaikan tujuan pembelajaran pada pertemuan hari ini	Mendengarkan penyampaian tujuan pembelajaran			
	Pemberian Apersepsi				
	Mem benarkan naras tentang fenomena gelombang bunyi yang sering ditemukan dalam kehidupan sehari-hari sebagai motivasi untuk menanamkan sikap nasionalisme, salah satunya pada alat musik yang digunakan dalam tari tradisional <i>Candang Bulo</i>	Mem perhatikan dengan seksama narasi yang disampaikan oleh guru	Cinta tanah air		
Fase 1 (Orientasi Masalah)					
Guru mem benarkan pertanyaan "saat menyaksikan kaki di Bulan, dapatkah seorang astronom mendengarkan suara mesin pesawat yang ditidapkan? Mengapa demikian?"	Mem benarkan jawaban atas pertanyaan yang diberikan oleh guru	Toleransi			
Inti	Fase 2 (Mengorganisasi untuk Belajar)				
	Mengatur peserta didik a pair	Duduk secara			

Figure 1.
Design of Learning Activities in RPP

Student Worksheet (LKPD)

The worksheet designed contain topics of inquiry, instructions for use, competencies to be achieved, and work steps. LKPD is designed for 4 meetings with different sub-material using the Problem Based Learning (PBL) model. The steps of investigation in the LKPD are arranged to direct students not only to focus on cognitive aspects, but also on aspects of attitude (nationalism) in solving problems given. The LKPD design is presented in Figure 2.

Orientasi Masalah

Diko menghadiri acara pertunjukan tari tradisional di sebuah gedung sebagai salah satu bentuk kecintaannya terhadap kekayaan budaya yang dimiliki Indonesia. Di dalam aula, Diko memilih untuk duduk di baris paling depan. Di tengah pertunjukan sedang berlangsung, Ia harus meninggalkan ruangan karena ingin mengangkat telepon dari temannya. Saat itu ia berpikir mengapa bunyi dari alat musik pertunjukan tradisional yang didengarkan saat berada di baris paling depan berbeda dengan bunyi yang ia dengarkan saat berjalan menuju pintu keluar?

Mengorganisasi untuk Belajar

- Tujuan
 - Kognitif : Menganalisis frekuensi pendengar pada fenomena efek Doppler
 - Afektif : Mengembangkan sikap nasionalisme dalam bentuk cinta tanah air, toleransi, dan kerjasama
- Alat dan Bahan : Lembar Kerja dan media simulasi

Membimbing Penyelidikan

Lakukanlah kegiatan berikut dengan mengutamakan kerjasama dalam kelompok!

- Bukalah file simulasi efek doppler yang telah diberikan sehingga akan muncul tampilan seperti gambar berikut

Figure 2.
Design of LKPD

Teaching Material

The teaching material developed contains a discussion on sound waves that are associated with the local wisdom of musical instruments in the Gandrang Bulo dance. The sub-material discussed in this teaching material is the characteristics of sound waves, Doppler Effect, sound resonance, and intensity and sound intensity level.

This teaching material is structured like teaching materials in general which contains material, formulas, and examples of problems related to sound waves. The difference is that an explanation of the basic concepts of sound waves is always integrated with events related to the local wisdom of musical instruments used in the Gandrang Bulo dance. In addition, this teaching material is also equipped with some information regarding local wisdom to further increase awareness of the local culture. At the end of each sub-material is also included with the self-reflection section to strengthen the affective domain of the students. The design of the teaching materials developed is shown in Figure 3.



Figure 3.

Design of Teaching Material

Learning Media

The learning media used was developed using the Macromedia Flash 8 program. This media was developed as a supporting media in the learning process. This media contains simulations related to sound waves which are presented in three activities, namely string material simulation in Kacaping menu, organa pipe material simulation on Gendang menu, and material simulation of Doppler Effect on *Efek Doppler* menu. The design of learning media is presented in Figure 4.



Figure 4.
Design of Learning Media

Development Stage

Validity of Learning Tools

Learning tools that have been developed in the form of RPP, LKPD, teaching materials, and learning media are validated by experts, physics teachers, and peer reviewers. The feasibility assessment process is conducted to assess RPP, LKPD, teaching materials, and learning media based on several assessment indicators. The results of feasibility assessment of RPP are presented in Table 3. In Table 3, the results of the content validation of local wisdom-based RPP by experts show an average score of 27,47. Based on the criteria referring to Table 1, the RPP developed has good criteria and is suitable for use in the learning process

Table 3.
Results of the RPP Quantitative Assessment by Experts

No	Aspect	Score
1	Subject Identification	28
2	Formulation of Learning Indicators	27
3	Formulation of Learning Objectives	56
4	Material Selection	109
5	Selection of Learning Methods	28
6	Scenario / Steps of Learning activities	56
7	Selection of Learning Resources / Learning Media	54
8	Learning Outcomes Assessment	27
9	Linguistics	28
Total		412
Average Score		27,47

The results of the LKPD feasibility assessment are presented in Table 4. The results of the content validity of LKPD conducted by 8 experts showed that the

average score was 29,4. Thus, it can be concluded that the LKPD developed in this study is in the good category and feasible to be used in learning process

Table 4.

Results of the LKPD Quantitative Assessment by Experts

No	Aspect	Score
1	Completeness of LKPD's content	29
2	Formulation of LKPD's objectives	27
3	Suitability of LKPD with material	30
4	Design	31
5	Linguistic	30
Total		147
Average Score		29,4

The results of assessment of teaching materials that have been developed are presented in Table 5. Based on the results of the assessment it can be seen that the average score is 28,5. Thus, it can be concluded that the teaching material developed in this study is in the good category and feasible to be used in the learning process.

Table 5.

Results of the Teaching Material Quantitative Assessment by Experts

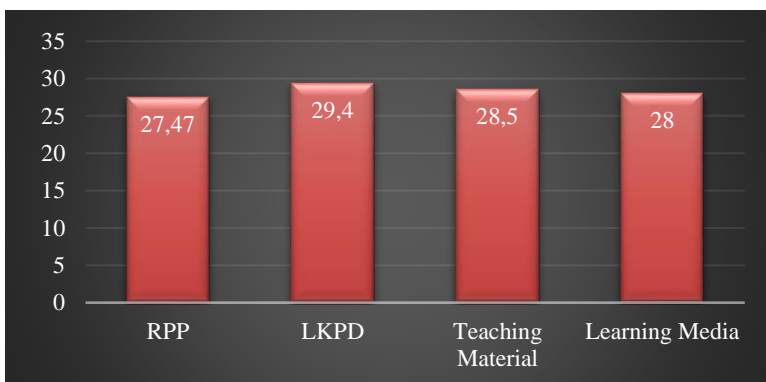
No	Aspect	Indicator	Score
1	Material	Clarity of material concepts	28
		Suitability of pictures with learning material, and prioritizing problem solving abilities and nationalism	28
		The attraction of material in the media, and prioritizing the ability to solve problems and attitudes of nationalism	30
		The accuracy of writing equations	30
		The integration of learning material in accordance with the theme of local wisdom	28
		The accuracy of contextual material usage	29
2	Linguistic	Appropriateness of language use	27
		the sentence used does not rise multiple interpretations	28
Total			228
Average Score			28,5

Feasibility assessment of learning media can be seen in Table 6. The results of these assessments show an average score of 28,0. Therefore, it can be concluded that the learning media developed in this study are in the category of good and appropriate to be used in the learning process.

Table 6.*Results of the Learning Media Quantitative Assessment by Experts*

No	Aspect	Score
Material		
1	The media used is in accordance with the sound wave material	28
2	The media used is in accordance with the learning objectives	29
3	The media used is in accordance with the local wisdom of musical instruments in Gandrang Bulo dance	28
Illustration		
4	Illustrations are presented contextually	28
5	Animation is used to help students understand the related material	26
6	Illustrations presented are easy to understand	29
Appearance		
7	Selection of the appropriate color, type, and size of letters / numbers	27
8	Button display consistency	29
9	Attractive media display	28
Software		
10	Learning media follows the development of science and technology	27
11	The media presented has the opportunity to be further developed	31
12	The media presented provides innovation in the learning process	26
Total		336
Average Score		28,0

Overall, the feasibility assessment of learning tools that have been developed is presented in Figure 5. Based on the results, it can be concluded that the learning device is in the category of good and feasible to be used in the learning process.

**Figure 5.***Results of the Learning Tools Feasibility Assessment***Student Response**

The response of students is obtained by conducting trials on learning tools that have been tested for their feasibility by the validator. The trial was conducted to obtain product quality scores based on the assessment given by 30 randomly selected students. Based on this trial, we can find out the weaknesses of the products developed from the aspects of teaching materials, learning media, and LKPD. Comments, suggestions, and criticisms given by students are used as reference revisions for further improvements. The results of the assessment obtained are then categorized according to the Standard Scale on a scale of 5 (Widoyoko, 2017) as presented in Table 7.

Table 7.
Feasibility Assessment Criteria in Scale 5

Score Range	Feasibility Category
$\bar{X} \geq 3,40$	Very Good
$2,80 < \bar{X} \leq 3,40$	Good
$2,20 < \bar{X} \leq 2,80$	Good Enough
$1,60 < \bar{X} \leq 2,20$	Less Good
$\bar{X} \leq 1,60$	Bad

The results of the assessment of local wisdom-based learning tools can be seen in Table 5. Based on the results of the feasibility assessment of the products developed, the average score was 3,08. Based on the assessment in Table 8, the products developed are in the good category. Therefore, it can be concluded that the learning tools based on local wisdom of musical instruments in the Gandrang Bulo dance are feasible to be used in the learning process on a larger scale.

Table 8.
Assessment Result of Product Testing

No	Total of Students	Aspect	Score	Category
1	30	Teaching Material	3,10	Good
2		Learning Media	3,08	Good
3		LKPD	3,14	Good
Average Score			3,08	Good

Implementation of Learning

Data related to the implementation of learning is obtained through observation. When testing learning devices is conducted, observers consisting of two colleagues observe the implementation using the tools that have been developed. The results of the observations are then transformed into quantitative data presented in Figure 6. Based on these results, it can be seen that each phase of activity contained in the

RPP has been conducted very well at each meeting, with an achievement value of 80% - 100%.

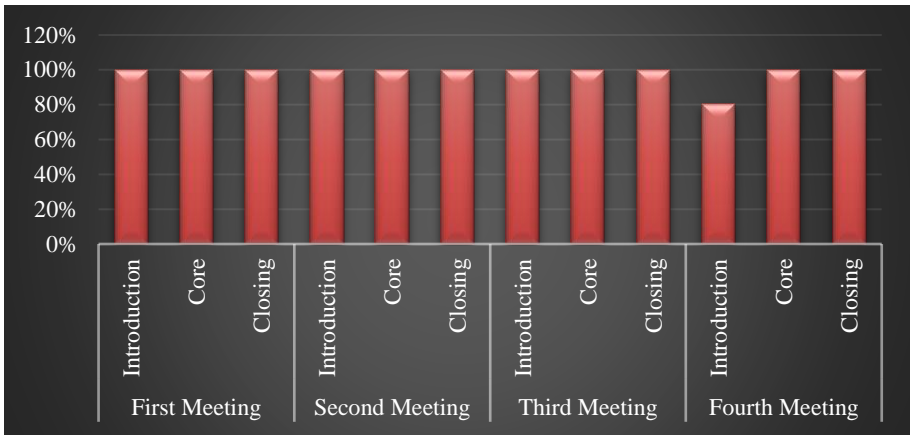


Figure 6.
Results of Learning Implementation Observation

Conclusion

The conclusion of this study are:

1. Learning tools that have been developed are Lesson Plan (RPP), Student Worksheet (LKPD), teaching materials, and learning media. This learning tools are in the category of good and feasible to be used on learning process based on expert judgment and student response. These results are in accordance with the proper learning tools recommended by the government and experts.
 - a. The lesson plan that was developed meet the criteria set by the he Ministry of Education and Culture Regulation No. 22 of 2016 (Pemerintah Republik Indonesia, 2017).
 - b. Student worksheet that was developed meet the criteria explained by the experts which are contained the instruction to help increasing students' participation (Darmodjo & Kaligis, 1993; Trianto, 2009). Moreover, this student worksheet has met the criteria of didactic, construction, and technical (Prastowo, 2011)
 - c. Teaching material that has been developed contain the summary of material that is properly presented to help student in learning which accordance with the expert's recommendation (Prastowo,2011)
 - d. Learning media that has been developed meet the criteria in several aspect such as material, illustration, appearance, software (Nugroho, Raharjo, and Wahyunungsih, 2013
2. The quality of learning tools that have been developed are as follows:

- a. The qualitative and quantitative values of learning devices by experts, physics teachers, and peer reviewers are in the range of scores of 26,4 – 35,2 which are in the good category. This result is accordance with the classification based on a comparison of the average ideal score and the ideal standard deviation score calculated by Widoyoko (2017)
- b. Learning tools developed are in a good category based on students' responses obtained in the results of the trial with an average score of 3.08 which calculated by using Widoyoko (2017) classification.
- c. In the learning process using the tools that have been developed, each phase of the activities contained in the lesson plan has been conducted very well at each meeting, with achievement values reaching 80% - 100%.

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