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DESIGN OF LEARNING SET BASED COMBINATION OF KNOWLEDGE DIMENSIONS AND THINKING PROCESS LEVEL FOR PHYSICS LEARNING

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ABSTRACT

The 2013 curriculum for high school physics lessons mandates teachers to change learning patterns that are "tell" to "find out" through a combination of various dimensions of knowledge and levels of thinking processes that students must master. It's hoped that through learning, there will be an increase in students' knowledge competence and thinking process abilities. The initial study results indicate the need for a design of a combination of knowledge dimensions and levels of thinking processes in the form of learning sets. This study aims to develop a learning set design oriented to the combination of the dimensions of knowledge and the level of the thought process of parabolic motion material for physics learning at State Senior High School (SSHS) in Pekanbaru City. The type of research is Research and Development (R&D), with the ADDIE development model reduced to the development stage. This study involved three physics lecturers as expert judgment and learning practitioners, namely three physics teachers at three SSHS in Pekanbaru. The research object is lesson plans, teaching materials, and evaluation instruments. The results showed that the theoretical validity of learning sets consisting of lesson plans, teaching materials, and evaluation instruments according to the expert team was 0.74 and was in the medium category or with valid interpretations. According to the practitioner team, the theoretical practicality of learning sets was 0.96 and is in the high category or very practical. Thus, the learning set can be continued with field trials to learn physics at SSHS in Pekanbaru City.

Keywords :*Learning Set; Knowledge Dimensions; Process Level Thinking; ADDIE Model.*

I. INTRODUCTION

Life in the 21st century is marked by increasingly complex knowledge and high levels of abilities that every student must master to solve various problems in learning. In addition, by having the ability, students can make the right decision to solve the issues they face [1]. The ability that must be possessed is not enough with one or two knowledge, and students must have the four dimensions of knowledge in a complex manner in every learning that is concrete to abstract. The four dimensions of knowledge consist of factual knowledge, conceptual knowledge, procedural knowledge, and metacognitive knowledge [2,3].

One of the learning principles adopted in the 2013 curriculum is to change learning that is dictating or stuffing various knowledge in the form of "telling" into education that is providing learning experiences with student activities "finding out" various dimensions of knowledge from relevant sources [4]. This means that various knowledge is instilled in students through thinking process exercises that are improved step by step from the lowest level of thinking processes, remembering, understanding, applying, analyzing, evaluating, to the highest stage, namely the ability to be creative. The application of the revised Bloom's taxonomy in the 2013 curriculum is the government's attitude in applying the principles of learning according to the 2013 curriculum. This taxonomy has combined four dimensions of knowledge and six levels of thinking processes as the direction and identity of planning, implementation, and learning assessment according to the needs of the 21st century [3,5]. The four dimensions of knowledge and six levels of thinking processes have been outlined in the core competencies and basic competencies in the 2013 curriculum as the minimum level of ability that every student must have to guide educators to design learning sets. If all these aspects have been met, then the feasibility of the physics learning set used has been completed.

The learning sets are lesson plans, teaching materials, and evaluation instruments. Lesson plans are a learning activity plan prepared in one or more meetings to achieve basic competencies developed based on the syllabus. At least the lesson plans have essential components in its preparation including: (1) school identity, subject identity, class/semester; (2) time allocation; (3) core competencies, basic competencies, and competency achievement indicators; (4) learning materials; (5) learning activities; (6) media/tools, materials, and learning resources; and (7) assessment [6]. Teaching materials are a set of materials that are arranged in a coherent manner which results in the creation of an environment or atmosphere that allows students to learn with components (1) title/identity; (2) study instructions; (3) the competencies to be achieved; (4) supporting information/summary of material; (5) work instructions/students worksheet, evaluation, and feedback [7]. Evaluation instruments are everything used in learning activities to make it easier for teachers to carry out tasks to achieve learning objectives effectively and efficiently [8]. Assessment of learning outcomes carried out by teachers is: (1) attitude assessment includes self-assessment, peer-assessment, and assessment using observation techniques; (2) knowledge assessment includes written test techniques, oral tests, and assignments; (3) skills assessment includes practice assessment, product assessment, project assessment, and portfolio assessment [9].

However, the reality in the field has not been as expected when observations and interviews with class X SSHS subject teachers in Pekanbaru City are made, namely three SSHS in Pekanbaru. The observations and interviews are described with the first results, indicators of competency achievement and learning objectives applied by teachers do not include the four combinations of knowledge dimensions and the six levels of thinking processes. This can be seen from the lesson plan prepared by the teacher, who is still copying the existing lesson plan. Second, the scope of knowledge dimensions in teaching materials has not been presented optimally and proportionally marked by the intensity of factual knowledge dimensions 15.18%, conceptual knowledge 27.27%, procedural knowledge 21.27%, and metacognitive knowledge 0%. Third, the range of thinking process levels available in teaching materials and evaluation instruments is not evenly distributed. This is indicated by being dominated by level 1 and 2 ability levels, while level 3 abilities are still very few and tend to be invisible. The teaching materials are characterized by the ability to remember 9.57%, understand 19.07%, apply 11.93%, analyze 9.57%, evaluate and create 0%. While on the evaluation instrument, the level of ability to remember 5%, understand 5.28%, apply 10.72%, analyze 6.64%, evaluate and create 0%. Fourth, aspects of the scientific approach in the lesson plans and teachers have not been implemented optimally in the learning process. In the aspect of observing 9.28%, questioning 16.67%, experimenting 7.39%, associating 3.72%, and communicating 5.56%. Fifth, the results of interviews with teachers revealed that teachers need learning set designs that are oriented to a combination of knowledge dimensions and levels of thinking processes as reference materials for planning, implementing, and evaluating learning.

One of the materials that are considered difficult for students to understand is parabolic motion material, especially concerning the elaboration of the parabolic motion formula as a combination of motion, the conditions for determining the position and time for the highest point and the farthest point, and choosing the equation for the position of the parabolic motion trajectory, so that the best learning outcomes can be achieved. Obtained on the parabolic motion material shows the lowest average of other materials. In line with this, students also experience misconceptions about parabolic motion material by assuming the time required for a heavy ball is less because the greater the mass of an object, the greater the gravitational attraction [10,11], and consider objects with heavier masses will travel a total displacement, which is closer to the launch point when compared to lighter mass objects [10,12]. Learning outcomes data from the daily assessment are presented in Table 1.

Table 1. Daily Assessment At 2020/2021 School Year

	Average Grade on Material		
	Staight Motion	**Parabolic Motion**	**Circular Motion**
SSHSN 2 Pekanbaru	89,7	69,95	80,15
SSHSN 7 Pekanbaru	91,51	76,92	85,46
SSHSN 12 Pekanbaru	88,54	67,6	77,06

(Source: Physic Teacher at SSHSN 2, 7, and 12 Pekanbaru)

Based on Table 1, it is found that the parabolic motion material has a low daily rating compared to the daily assessment of other materials. The results of this daily assessment indicate that the parabolic motion material still needs to be developed so that in this study, the parabolic motion material was chosen.

This study aims to develop and determine the validity and practicality of learning sets oriented to the combination of the dimensions of knowledge and the level of thought processes of parabolic motion material that can be applied in high school physics learning.

II. METHOD

This research is included in Research and Development (R&D) research, methods used to produce products and test the effectiveness and quality [13]. The development model used is the ADDIE model, consisting of 5 stages: analysis, design, development, implementation, and evaluation with the development procedure is reduced to the development stage [14,15]. This study involved three physics lecturers, Universitas Negeri Padang, as expert judgment and three physics teachers at SSHS 2, 7, and 12 Pekanbaru as learning practitioners. The object in the research is a learning set consisting of lesson plans, teaching materials, and evaluation instruments that are oriented to the combination of the dimensions of knowledge and the level of thought processes on parabolic motion material in high school physics learning. Instruments in the research include interview guide sheets, assessment instruments, and validation/practical instruments. The interview guide sheet is an instrument used to reveal the needs analysis in field studies aimed at teachers of physics subjects. The assessment instrument is used to assess the instrument validation/practical. While the validation instrument is the instrument used to validate the product. The practicality instrument is used to assess the practicality of the product produced in the form of learning sets, including lesson plans, teaching materials, and evaluation instruments oriented to the combination of knowledge dimensions and levels of thought processes on parabolic motion material for learning high school physics. The data from the validity/practicality test results obtained were analyzed using the Aiken's V (V) item index with the formula:

$$V = \frac{\sum s}{n\,(c-1)} \qquad (1)$$

The decision results on the validity/practicality category obtained after processing the data are presented in Table 2.

Table 2. Decision Based On Aiken'V Index

Interval	Category
$0,8 < V$	High
$0,4 < V \leq 0,8$	Moderate
$V \leq 0,4$	Deficient

(Source: Modified [16])

Validation/practicality instruments and learning sets developed are valid or practical if the scores obtained are in the moderate or high category based on the index category.

III. RESULTS AND DISCUSSION

At the analysis stage, it was carried out to find out the problems in physics learning which consisted of initial studies, field studies, and literature studies with the following results: (1) the initial research was to know the needs analysis in conducting development research which was carried out through a review of articles in related journals with variables in the study; (2) field studies get results through interviews namely teachers still do not understand the dimensions of knowledge and levels of cognitive processes that can be applied in physics learning, learning sets made by teachers are still dominated by internet references or by editing existing learning sets. This results in the availability of learning sets in schools that still do not meet the optimal and maximum combination of knowledge dimensions and levels of thinking processes. Teachers feel that there is still a need to develop learning sets oriented to a combination of knowledge dimensions and thinking process levels that can improve students' abilities and competencies, parabolic motion material. It is also a material that students feel is difficult because the characteristics of the material are many formulas and a combination of several previous materials. The daily assessment of the parabolic motion material at 3 Pekanbaru City high schools is still in the lowest category compared to before and after the parabolic motion material. The results of observations of teacher learning sets on parabolic motion material regarding the implementation of the scientific approach along with the combination of knowledge dimensions and levels of cognitive processes have not been presented evenly and proportionally. Based on this problem, it is necessary to develop learning sets oriented to the combination of knowledge dimensions and levels of thought processes in parabolic motion material for high school physics learning.

At the design stage, all problems in physics learning are obtained, and their solutions will be applied to design the design of the learning sets developed. The parabolic motion material is the physics material chosen to develop the learning set design. The final results at this stage are in the form of validation/practical instrument design and learning set designs, including lesson plans, teaching materials design, and evaluation instrument designs oriented to the combination of knowledge dimensions and cognitive process levels in parabolic motion material for high school physics learning.

At the development stage, validation was carried out, followed by practicality on the design of learning sets oriented to the combination of the dimensions of knowledge and the level of thought processes for parabolic motion material for high school physics learning. Three lecturers of the Physics Department carried out validation, and three physics teachers carried out Universitas Negeri Padang and practicality in class X SSHS in Pekanbaru City. Lesson plan validation is carried out using lesson plan validation instruments by assessing aspects of the lesson plan components. The scientific approach includes observing, asking questions, trying/gathering information, reasoning, and communicating. The results of the lesson plan validation are presented in Fig. 1.

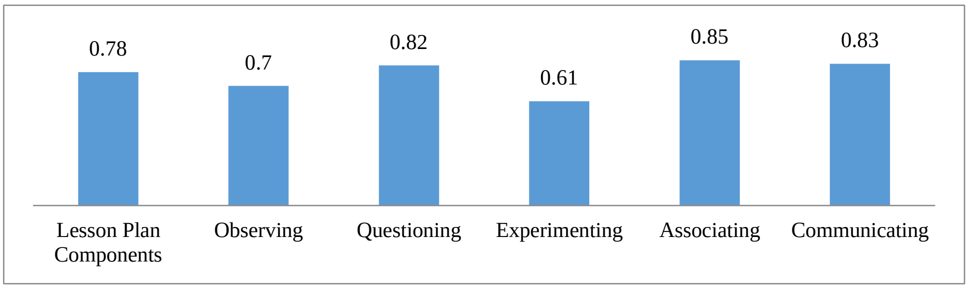

Fig. 1. Lesson plan validation result

Based on Fig. 1. it is known that the results of the lesson plan validation according to the expert team with a score of 0.78 and a decision can be made that the entire lesson plan component is considered moderate or with an interpretation in the valid category so that it is suitable for use for high school physics learning.

The validation of teaching materials is carried out using a teaching material validation instrument to assess three aspects, including first, the results of the validation based on the aspects of the knowledge dimension in the teaching materials presented in Fig. 2.

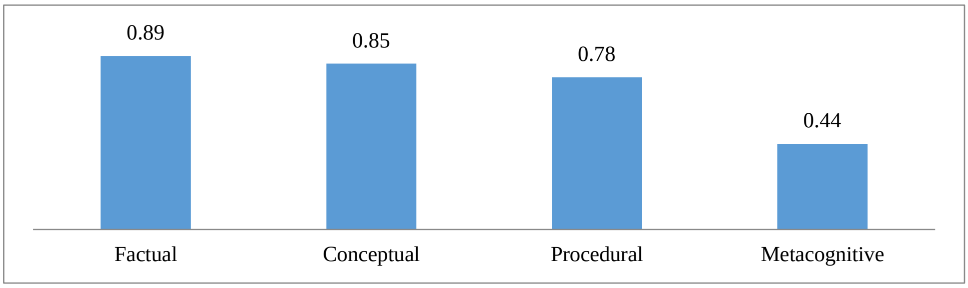

Fig. 2. Validation results based on knowledge dimensions in teaching materials

Based on Fig. 2. it is known that the results of the validation of teaching materials based on the knowledge dimension according to the expert team with a score of 0.73 and are in the moderate category or with interpretations in the valid category so that they are suitable for use for high school physics learning. Second, the validation results are based on the scope of cognitive process levels in the teaching materials presented in Fig. 3.

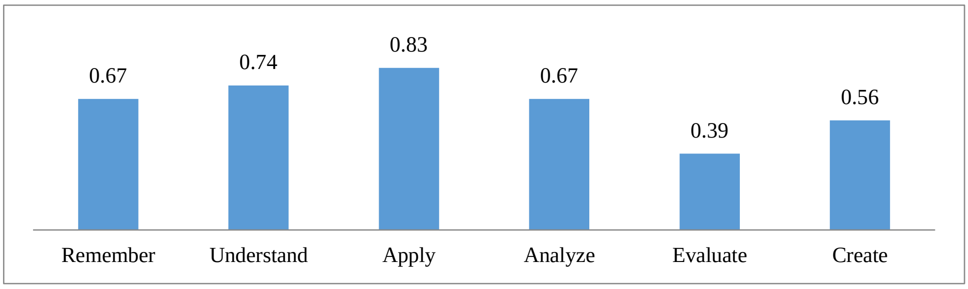

Fig. 3. Validation results based on the scope of cognitive process levels in teaching materials

Based on Fig. 3. It is known that the results of the validation of teaching materials are based on the scope of cognitive process levels according to the expert team with a score of 0.65 and are in the moderate category or with interpretations in the valid category so that they are suitable for use in high school physics learning. Third, the validation results are based on the teaching material requirements presented in Fig. 4.

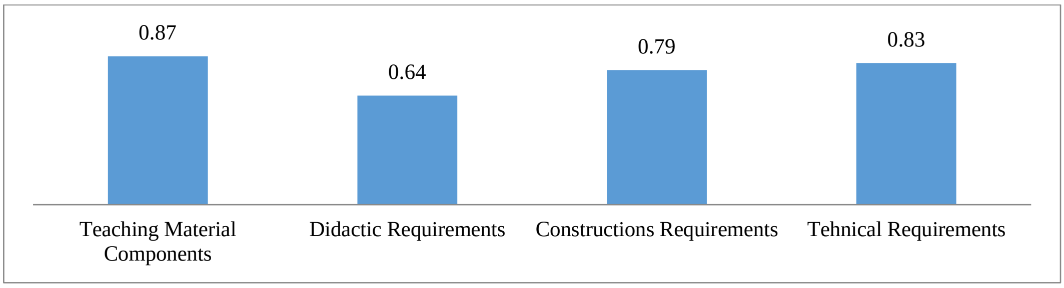

Fig. 4. Validation results based on aspects of teaching material requirements

Based on Fig. 4. it is known that the results of the validation of teaching materials are based on aspects of the requirements of teaching materials according to the expert team with a score of 0.79 and are in the medium category or with interpretations in the valid category so that they are suitable for use for high school physics learning. The overall results of the validation of teaching materials can be seen in Fig. 5.

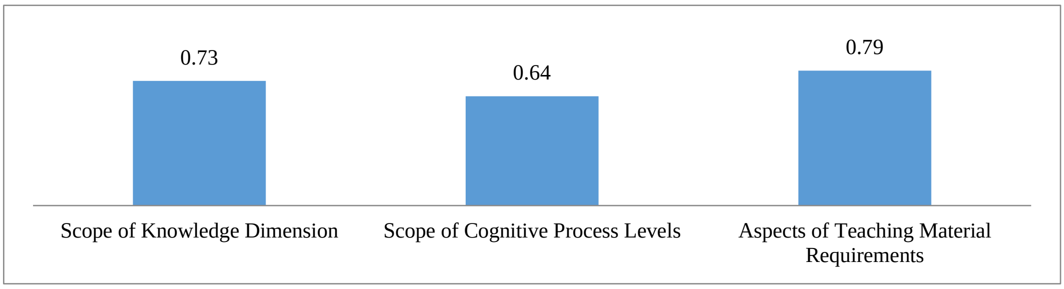

Fig. 5. Teaching material validation results

Based on Fig. 5. it is known that the results of the validation of teaching materials according to the expert team with a score of 0.72 and a decision can be made that all components of teaching materials are considered moderate or with interpretations in the valid category so that they are suitable for use for high school physics learning.

The evaluation instrument validation uses an instrument validation instrument to assess aspects of the cognitive process level, and the results of the validation instrument validation are presented in Fig. 6.

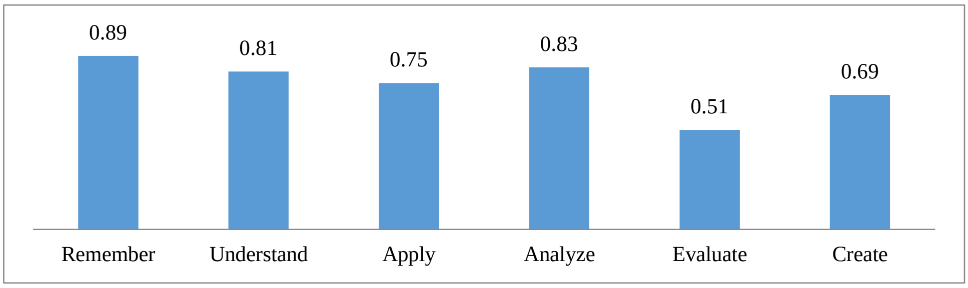

Fig. 6. Evaluation instruments validation results

Based on Fig. 6. it is known that the results of the evaluation instrument validation according to the expert team with a score of 0.73 and a decision can be made that all components of the evaluation instrument are rated moderate or with interpretations in the valid category so that they are suitable for use for high school physics learning.

Overall the results of the validation of learning sets, including lesson plans, teaching materials, and evaluation instruments according to a team of experts and a team of practitioners, are presented in Fig. 7.

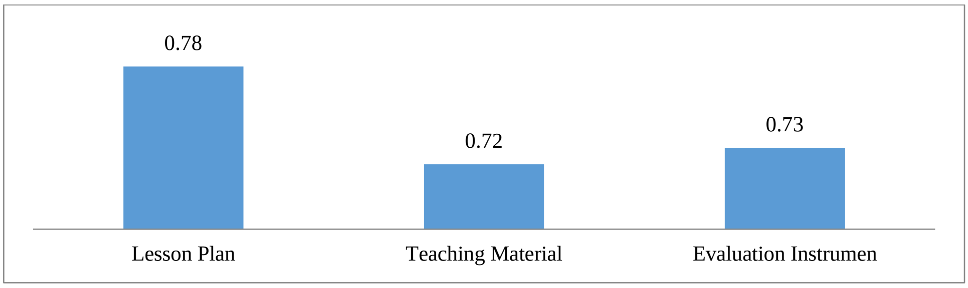

Fig. 7. Learning set validation results

Based on Fig. 7. it is known that the results of the validation of learning sets according to the expert team with a score of 0.74 and have a moderate category or with an interpretation in the valid category so that it is suitable for use for high school physics learning.

The learning sets that have been assessed for validity by three expert teams are then continued with a theoretical practicality test. All components in the practicality instrument are the same as components in the previous validation instrument. The practicality of the lesson plans is presented in Fig. 8.

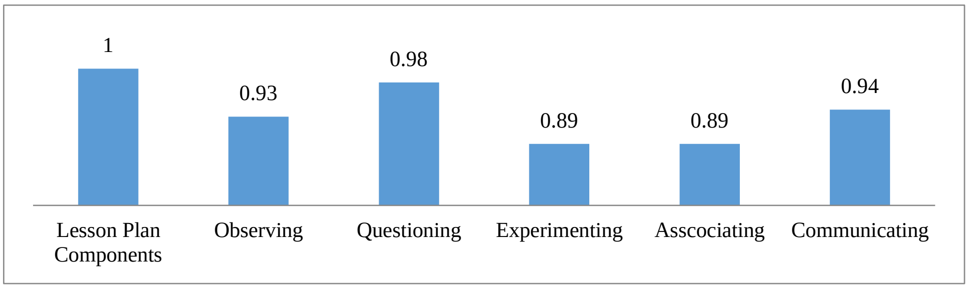

Fig. 8. Lesson Plan Practical Result

Based on Fig. 8. it is known that the results of the practicality of the lesson plan according to the team of practitioners with a score of 0.94 and a decision can be made that all components of the lesson plan are rated high or with an interpretation in the very practical category so that it is suitable for high school physics learning.

The practicality of teaching materials is carried out using practical instruments to assess three aspects. First, practicality results are based on knowledge dimensions in teaching materials presented in Fig. 9.

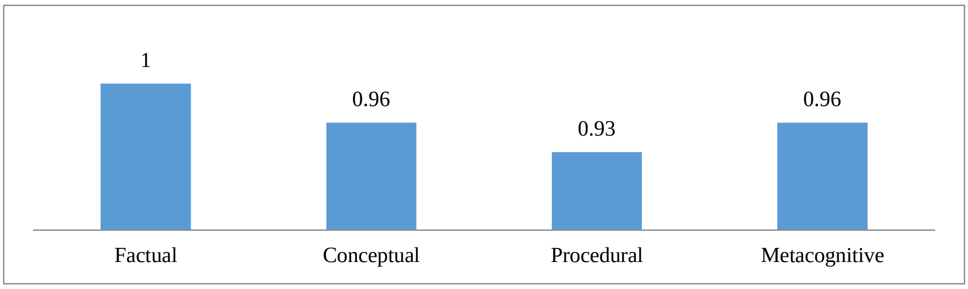

Fig. 9. Practical results based on knowledge dimensions in teaching materials

Based on Fig. 9. it is known that the results of the practicality of teaching materials based on the knowledge dimension according to the team of practitioners with a score of 0.96 and are in the high category or with interpretations in the very practical category so that they are suitable for high school physics learning. Second, the practical results are based on cognitive processing in the teaching materials presented in Fig. 10.

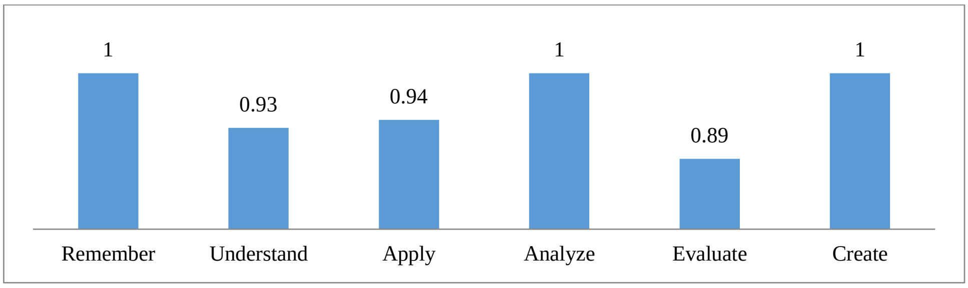

Fig. 10. Practical results based on the scope of cognitive process levels in teaching materials

Based on Fig. 10. It is known that the results of the practicality of teaching materials are based on the scope of cognitive process levels according to the team of practitioners with a score of 0.96 and are in the high category or with interpretations in the very practical category so that they are suitable for use in high school physics learning. Third, the practical results are based on the requirements for teaching materials presented in Fig. 11.

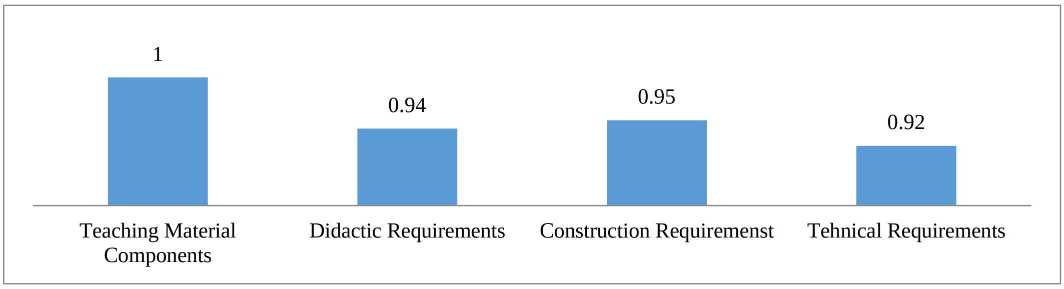

Fig. 11. Practical results based on aspects of teaching material requirements

Based on Fig. 11. it is known that the results of the practicality of teaching materials are based on aspects of the requirements of teaching materials according to the practitioner team with a score of 0.96 and are in the high category or with interpretations in the very practical category so that they are suitable for use in high school physics learning. Overall results of the practicality of teaching materials can be seen in Fig. 12.

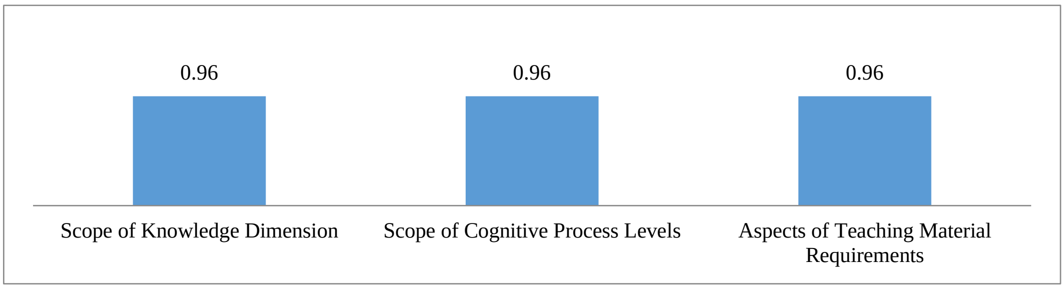

Fig. 12. Practical results of teaching materials

Based on Fig. 12. it is known that the practical results of teaching materials according to the team of practitioners with a score of 0.96 and a decision can be made that all components of teaching materials are rated high or with interpretations in the very practical category so that they are suitable for high school physics learning.

The practicality of the evaluation instrument using the practicality of the evaluation instrument to assess aspects of the cognitive process level and the results of the practicality of the evaluation instrument are presented in Fig. 13.

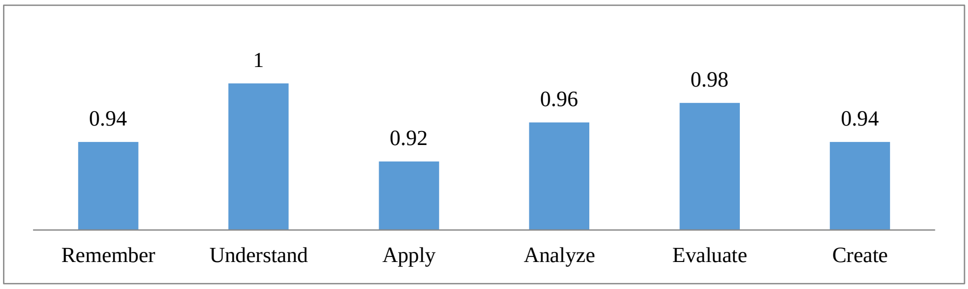

Fig. 13. Practical result of evaluation instruments

Based on Fig. 13. it is known that the practical results of the evaluation instrument according to the team of practitioners with a score of 0.96 and a decision can be made that the entire component of the evaluation instrument is rated high or with an interpretation in the very practical category so that it is feasible to use for high school physics learning.

Overall, the practicality of learning sets, including lesson plans, teaching materials, and evaluation instruments according to the team of practitioners, are presented in Fig. 14.

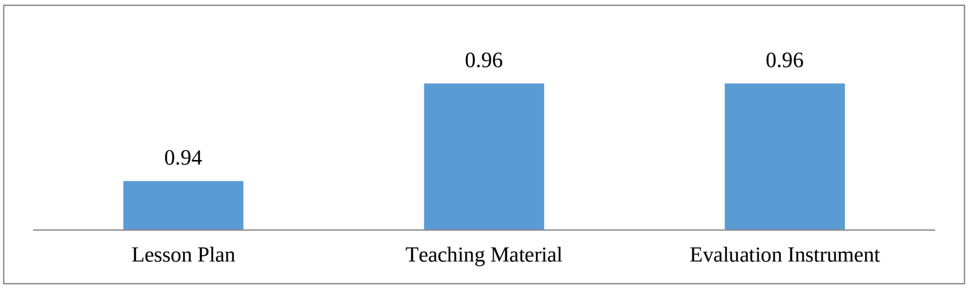

Fig. 14. Learning sets practical result

Based on Fig. 14. it is known that the results of the practicality of learning sets according to the team of practitioners with a score of 0.96 and have a high category or with an interpretation in the very practical category so that they are suitable for use in high school physics learning.

The results achieved in the research is described by following each outcome of the three stages carried out using the ADDIE development model. The three stages include the analysis stage, the design stage, and the development stage. The results of research that design products in the form of learning tools have adjusted between theories related to learning tools and the 2013 curriculum. The products designed have met the development criteria, namely the theoretical validation stage by a team of experts and the theoretical practicality stage by a team of practitioners so that the product. The results obtained can be of high quality and suitable for high school physics learning.

The analysis stage is through initial studies, field studies, and literature studies. The initial study aims to see whether it is essential to research reviewing articles in journals related to the variables in the study. The results of the article review indicate that there is still a need to develop learning tools that are oriented to the combination of knowledge dimensions and levels of thinking processes. The field study aims to see the implementation of the 2013 curriculum in physics learning at selected high schools. SSHS was chosen using a stratified random sampling technique to obtain three school representatives: SSHS 12 Pekanbaru in the low category, SSHS 2 Pekanbaru in the medium category, and SSHS 7 Pekanbaru in the high category. The results of field studies in SSHSs showed that the existing physics learning tools in schools were only in the sufficient available category based on a combination of knowledge dimensions and levels of cognitive processes. This proves that the existing learning tools in schools have not met the expectations according to the mandate of the 2013 curriculum. In addition, in the field study, it was found that the parabolic motion material has a lower average daily assessment value compared to other materials. While the study of literature is helpful in collecting theories related to the learning tools developed. This is intended to develop the learning tools by the applicable rules.

The design stage aims to produce learning tools that will be developed. At this stage, the design of a validation/practical instrument is created, which will later be used to assess the resulting learning sets, and the design of learning sets in the form of lesson plans, teaching material designs, and evaluation instrument designs that are oriented to the combination of knowledge dimensions and levels of thought processes on parabolic motion material.

The development stage aims to develop the designs that have been produced in the previous step. Each learning set has been developed using components according to the theory at the analysis stage. After the learning tools are developed, a product feasibility test is carried out through theoretical validation aspects by a team of experts and theoretical-practical aspects by a team of learning practitioners in the field. Validation and practicality feasibility tests are obtained through an assessment using a validation/practicality instrument. During the validation and practicality process, the product continues to be revised until it is in the criteria of valid or very valid for validity and practical or very practical for practicality.

After validation and practicality have been carried out on each aspect of the assessment, the learning tool oriented to the combination of the dimensions of knowledge and the level of the thought process for parabolic motion material for high school physics learning gets a moderate assessment or interpretation in the valid category from the expert team and gets a high rating or interpretation in the very practical category from the team practitioners, so that learning tools can be used for high school physics learning and can be continued for testing effectiveness in the field.

IV. CONCLUSION

Learning sets that are oriented to the combination of the dimensions of knowledge and the level of thought processes on parabolic motion material for high school physics learning get an average validity value of 0.74 and are in the moderate or theoretically valid category, and get an average practicality value of 0.96 and are in the category high or very practical theoretically. Thus, learning sets can be continued with field tests to determine high school physics learning effectiveness.

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