ATLANTIS PRESS

Advances in Social Science, Education and Humanities Research, volume 218

First International Conference on Science, Mathematics, and Education, (ICoMSE 2017)

The Validity of ARICESA-Based Learning Materials in Basic Science Concept for Student of Primary School Teacher Education Department

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***Abstract*—The learning motivation and science concepts comprehension must be fostered by students in the department of primary school teacher education. That is due to the diversity of high school background of this department students. This research aimed to determine the validity of ARICESA-based learning materials in the basic science concepts that consisting of learning book, lesson plan, and students' worksheet. The entire development stage was conducted according to the Plomp Model, which includes preliminary research, prototype stage, and assessment stage. The validation process is in the prototype stage with the criteria of validity used the Focus Group Discussion (FGD) process, expert appraisals results, and user response (students and lecturers). The validation scores for the learning book, lesson plan, and students' worksheet are 9.17, 8.93, and 9.88, all learning materials belong to first criteria. FGD results for these materials also have good comments, while the response of students and lecturers are also very good with an average percentage of 86.86%. Resulting from this, the prototype is feasible to be used for learning the basic science concepts in the department of primary school education, continuous improvement, and effectiveness test. This prototype is also expected to be an alternative model of learning materials to improve students' motivation and comprehension of basic science concepts.**

***Keyword*—ARICESA based-learning materials, Basic science concept.**

I. INTRODUCTION

Prospective primary teachers as the primary (PGSD) layers of science learning should comprehend science concepts and the contexts appropriately and be able to deliver to the students efficiently. Modern society desperately needs the mastery of science or technology problems [1]. World civilization advanced thanks to the application and development of science rapidly.

Basic concepts of science are one of the required courses for undergraduate students of primary school teacher education. This course provides a comprehension of the development of scientific concepts and theories required for prospective primary teachers both conceptually and practically. Primary school teacher education students are projected to become qualified and effective primary school teachers in the future. Effective teachers can forge intimate relationships with their students, create a loving, motivated learning environment, mastery of specific academic subjects and effective ways of teaching students, generate student motivation, and integrate technology in learning [2].

The passive attitude of PGSD students as prospective teachers during lectures makes learning less meaningful [3]. This condition will gradually make the students do not as the courses taught. As a result, many students stated that the course is challenging to learn. Therefore, it is essential for lecturers to cultivate students' positive attitude in studying a specific subject. This positive attitude can be constructed into a learning culture where students are active and independent [4]. Students will increase their motivation and understanding if the lecturer implements the learning model following the character of the course that is supported by adequate learning materials. Student achievement motivation must be built by taking account into the external factors of the students [5].

Keller has developed a set of motivational principles that can be applied in a learning process called the ARCS (Attention, Relevance, Confident, and Satisfaction) model [6]. Each teacher is expected to apply the principle of motivation in the learning process because the cast that can condition learners in learning is the teacher. The low teacher performance

can be caused by various factors that come from within and outside the students [7]. External factors such as learning facilities, teaching methods of lecturers, supporting learning materials, feedback systems and so forth. Internal factors include creative learning strategies, motivation and so forth.

Motivation contributes 11% -20% of learning achievement [8]. The study by Suciati [6] concluded that motivation contribution of 36% while Mc. Clelland showed that achievement motivation had 65% contribution to learning achievement. The conclusion that teachers should be able to generate motivation in students. To concentrate on studying in the classroom or outside as well as to raise the spirit of learning in achieving the expected learning objectives.

Motivation can be grown by applying ARCS in the learning process [9], the ARCS model succeeds in increasing the motivation supported by those materials [6]. So every teacher seeks to apply the above motivational principles to the learning process because the cast that can condition learners in learning is the teacher. Illustrating satisfaction with the achievement of students, explaining concretely, stimulating to get better achievement, various method, are any ways of generating passion for student learning. The ability of lecturers to excite the situation of teaching and learning process and design of learning, with the term achievement motivation is the driving force in students to achieve the highest level of achievement for self-esteem [10]. The use of learning model with Attention, Relevance, Confidence, and Satisfaction can change attitudes and behavior of individuals in support of learning. Here, the Enjoyment and Assessment components need to be added as part of the instrument to measure the success of the learning.

The preliminary study conducted by researchers in the undergraduate education program of primary school teacher STKIP PGRI Tulungagung, it is found that the input of students who enter into this program has a diverse high school background, ranging from high school majors exact and science, social, vocational and vocational schools with various wide range of fields. These diverse inputs led to a preliminary comprehension of science subjects especially physics getting the lowest score. Initial understanding of students from high school majoring in science is better than those from social, vocational and vocational schools [11]. When the researcher makes observations in the class during the lectures on basic science concepts of primary school, students responded variously to each other. Symptoms of weak motivation appear in the behavior of some students who are less enthusiastic about following the lecture. Chatting is less relevant to fellow students, working on other course tasks when the lecturer explains the material in class. This problem will be if it continues throughout a semester.

Based on the above facts, then taking into account various concepts and learning theories will be developed ARICESA-based learning materials (Assurance, Relevance, Confident, Enjoyment, Satisfaction, and self Assessment) adapted from ARCS model, inquiry model, enjoyment learning the concept, and self-assessment. According to the Directorate General of Education Personnel PMPTK Depdiknas (2008) motivation is essential in learning because it can encourage students to understand the information in teaching materials. As good as anything the design of teaching materials, if students are not motivated then there will be no learning event because students will not feel the information in teaching materials. The more innovative the teacher, the better the learning management.

In general, this study aims to produce learning materials based on ARICESA on Basic Science Concepts lectures for primary schools that can foster motivation to learn and improve comprehension of the concept of science candidate primary school teachers. Specifically, this article includes the research stages up to the validity of prototype learning materials.

Learning Materials Development

The learning tool is a set of material for the hand of a subject written and composed by the relevant field expert and fulfills the rules as a tool. In developing learning materials, it is necessary to pay attention to the principles of learning. Some principles that need to be considered in the preparation of teaching materials or learning materials include the principle of relevance, consistency, and adequacy [12].

ARICESA-based science learning tool is developed following the purpose of research to foster student motivation and understand the concept of science for primary school teacher education students. Device development is not to test a theory, but an attempt to develop an effective product for use in school [13]. Research development as a process used to develop and validate educational products [14]. Research development as a systematic review of the design, development, and evaluation of programs, processes and learning products that must meet the criteria of validity, practicality, and effectiveness [15]. In developing a learning tool, the feasibility of the development product must meet the criteria of validity, practicality, and effectiveness [16]. Learning materials developed are learning books, lesson plans, and student worksheets.

Learning Motivation

According to McDonald, motivation is a change of energy in a person characterized by the emergence of

feelings and preceded by the response of the goal [17]. Motivation can be said as an auxiliary variable used to cause specific factors within the student, which generate, manage, maintain, and conduct behavior toward a goal [18]. Motivation is a driving force for learning behaviors, materials for influencing learning achievement, directors toward achievement of learning objectives and building more meaningful learning systems [19-20].

A motivation that exists within a person cannot be directly assessed but can be seen from the person's behavior. For example, the efforts of the students, the selection of a task, perseverance or persistence in doing an activity [21] or verbal expression, for example, I want to do this science task. Besides, students who are motivated in a lesson, then the student will get a value or satisfactory learning outcomes on a particular subject. Thus the learning outcomes can be used as an indicator whether the student is motivated or not in a particular lesson. Assessment of motivation can be seen from behavioral indicator from motivation aspect called Indexes of motivation, that is (1) choice of task, (2) effort, (3) persistence, and (4) achievement [22].

Science Concepts Comprehension

Conceptual comprehension and scientific inquiry are the goals of science learning at all levels of education [23]. Bloom's taxonomy comprehension is the ability to interpret information by using its own words [2]. While in Bloom's taxonomic revision, comprehension is defined as the ability to construct a sense of teaching messages that include oral, written, and graphic communication [24]. Comprehension is the ability to build the meaning of information received, such as interpreting charts, diagrams or graphs, translating a verbal statement into mathematics or vice versa, forecasting based on a particular pattern of behavior of a variable that describes natural phenomena [25].

Four ways can be used to assess students' conceptual comprehension, i.e., students are asked: (1) defining concepts, (2) identifying concept characteristics, (3) linking concepts with other concepts, (4) identifies or gives an example of a concept that has never been encountered before. Assessment of the first and second way is the simplest way, but the assessment in that way has a weakness because the students have memorized before. While the more effective judgments are the third and fourth ways [26].

II. METHODS

This type of research is a development study used to produce a particular product and test the effectiveness of the resulting product [16]. The main products resulting from this research are the prototype of ARICESA-based science learning materials in the form of learning books, lesson plans, and student worksheets. The development of learning materials consists of three stages adapted from Plomp & Nieveen the preliminary research, prototyping stage and assessment phase [27]. This article only deals with the data results of the validation process on the prototype stage, especially the Focus Group Discussion (FGD) results, expert appraisals, and user responses on the modeling class. The aims part of the stage is to prototyping of learning materials before continued to next step, that is limited trial and field trial to determine the practicality and effectiveness of the final product. The FGD process involves eight lecturers with areas of expertise in the science concepts, education, and language. It is intended that the prototype get any comments and suggestions from each FGD participants based on the three areas of expertise. Their comments and suggestions are used as a basis for improving the prototype before proceeding to the expert appraisals step.

The expert appraisals are conducted in the field following the assessed aspects. This step required experts that compatible with the expertise of their respective disciplines to assess the teaching materials. The amount of expert in the appraisals step is three person that have each expertise. Each of them has three different areas of expertise, there are scientific concepts, education, and language, which appropriate to see the feasibility of the learning materials. Feedback from validators to materials for the improvement of ARICESA-based learning materials. The next step is to form a model class to simulate the learning process with three lecturers model and five students. The three lecturers will be modeled teachers on limited trials and field trials. The objective of this modeling class is to get the user's responses from the prototype of the learning materials that have been developed.

The instruments that are used in the FGD process guide sheet and questionnaire for the participants that consist of several open-ended questions. The instruments that are used in the expert appraisals step are instruments to assess the learning book, lesson plan, and student worksheet. That instrument was adapted from the national standard education institution (BSNP). There are four components of feasibility that consists of content feasibility, presentation, language, and visual graphics. The appraisal instrument of lesson plan includes two aspects of feasibility, which are the completeness of lesson plan components and learning activities management. For the identification of user responses, the researcher used the close-ended questionnaire consists of 5 aspects: presentation of material,

illustrations and graphics, retention of material, impacts to learning motivation, and ease of use.

Analysis of FGD results using qualitative descriptive techniques with simplification and summarizing each participant's comments and suggestions, whereas the feasibility justification of the experts was done by calculating the appraisal average on each component of the feasibility. There are four categories of feasibility appraisal results that are very valid, valid, less valid, and invalid. The reliability of expert appraisal results was determined using the percentage of agreement formula. The appraisal results are said to be reliable if the reliability value is more than 75% [28]. The description of the responses was used to explore the four categories that are very good, good, bad, and very bad.

III. RESULTS AND DISCUSSION

The prototype of learning material consists of learning book, lesson plan, and student worksheet. The textbook was a learning resource that presents the science concepts based on ARICESA model. The early learning books consist of learning objectives in each topic and indicators of their achievements. In addition, the beginning is also equipped with a concept to facilitate the understanding of concepts in one topic. The core of each topic in the study book contains the concept of material delivered based on the ARICESA sintering series of Attention, Relevance, Inquiry, Confidence, Enjoyment, Satisfaction, and Self-Assessment. This section also comes with some inquiry activities synchronized with lesson plans and student worksheets. In presenting the materials, lecturers are guided through each step by the lesson plan. Lecturers have also indicated time allocation in every step of the learning. Attention Phase, the lecture can stimulate students attention to focus on the class atmosphere and the material, for example by showing a video or simulation and start to question the complex phenomenon. Relevance Phase is a step taken to find the relevance of the concept with some phenomena they have come across. The Inquiry phase is a step that enables students to be active and collaborative steps with the steps of confidence, enjoyment, and satisfaction. It means, in the various steps of inquiry that already exist in the student worksheet, the lecture begins to apply the strategy of beliefs, fun learning, and provide answers in the student learning process. The last step is Self-Assessment which becomes the step of self-evaluation by the student. In this step, students are expected to know what they have got and to evaluate the learning process.

The validation process of learning materials prototype on basic science concepts for primary schools is conducted with Focus Group Discussion (FGD), expert appraisals, and user response (lectures and students). The FGD process involved eight lectures with three different areas of expertise, namely basic education, science education, and language. For the expert, assessment process involves three experts with areas of basic education and science education. As for the test user response involves three lecturers and five students.

Focus Group Discussion (FGD)

The FGD begins with the exposure of learning material prototypes by the researcher. This process is done to describe the product being developed. The researcher also conveyed to the participants about the ARICESA model as a learning materials development framework. The prototype was given to the FGD participants a week in advance for them to learn first. Subsequently, participants were asked to submit comments and suggestions for improvement on the prototype of learning materials. Summaries of comments and suggestions from each participant are shown in Table 1.

Based on Table 1, some suggestions from FGD participants include the need to provide video, simulation, or inquiry activities as the visualization supplements to generate motivation. The primary motivation is to arouse students' initial passion for carrying out lectures in the classroom [20, 29,30,31]. While inquiry activities are related to the process of understanding the concept that centered on the students to find it through the guidance of the lecturer [9, 32, 33, 34], but also to note the allocation of time required. This issue needs to be scrutinised so that students' comprehension is stronger and can transmit the process to their students later [35-36]. Furthermore, the researcher should be considered aspects of the writing language of the learning materials so that more readily understood by users both lecturers and students. The results of this FGD process are used for the refinement of the prototype of the learning device before an expert judgment is made. All of comments and suggestions from the participants have been followed up by the researcher and continuous to next steps

Table 1. Summaries of Comments and Suggestions from FGD Participants.

Participants	Comments	Suggestions
A	Overall it is good, but there is a lack of the illustration of concepts in the context of life.	• Add the components to the learning book that shows related concept and a brief explanation. • Provide media that can be used for visualization of phenomena or applied concepts (video or animation).
B	The content of the learning book is right, the drawback is no concept map that illustrates the concept set of the topic.	• Add a concept map on the start page of the topic.
C	Illustration of concept (picture) in the book is still too universal or rarely encountered in the environment of life.	• Give an image that is a local phenomenon or can be found in everyday life to support the aspects of concept relevance.
D	The inquiry activity in the learning book is lacking (only 1 activity).	• Give other inquiry activities as an alternative for students to do independent activities other than class activities.
E	Inquiry activities in learning book, lesson plan, and students worksheet have not been connected.	• Create a scenario in a lesson plan that refers to inquiry activity in the learning book, which students wrote it on a worksheet.
F	The time division in the lesson plan is still not proportional, and there is no source for lecturers to do virtual simulations in the lesson plan.	• Recalculate the equal time of each activity in the lesson plan. • Give virtual concept simulation applications as variations of learning to be more interesting (ex. PhET simulation).
G	Some parts still use ambiguous sentences.	• Use simple and clear sentences in outlining concepts.
H	The combination of learning book design, especially the coloring is still poorly.	• Improve the color combinations in the book

Expert Appraisals

The feasibility appraisals of prototype learning materials on basic science concepts is done by involving three experts, within the field of basic education and science education expertise. Learning materials include learning books for basic concepts of science, lesson plans, and student worksheets. The assessment results for each of these devices can be seen in Table 2, 3, 4.

The appraisals of learning books were conducted with an instrument that adapted the learning book assessment instrument of the National Education Standards. The instrument includes four components of feasibility, namely the content feasibility, presentation, language, and visual graphics. Values are given in range 1 to 10. Table 2 presents the results of learning book assessments made by experts with the following values: expert 1 (VD1) gives an average rating of all components of 9.24; for expert 2 (VD2) gives a value of 9.06, and expert 3 (VD3) gave a value of 9.15. So the average value of the three experts is 9.15 with the value category is "very valid". The three expert validators also stated that the developed basic concept learning book prototype is valid and feasible to use.

The assessment of the lesson plan was conducted with an instrument developed by the researcher. The instrument includes two aspects of feasibility, that is, the completeness of lesson plan components and learning activities. Each of these aspects has several feasibility components as shown in Table 3. The values are given for lesson plan range from 1 to 10. Table 3 presents the results of the lesson plan assessment performed by an expert with the following values: expert 1 (VD1) gives an average grade all components 8.93; for expert 2 (VD2) gives a value of 8.86, and expert 3 (VD3) rated 9.00. So the average value of the three experts is 8.93 with the value category is "very good." The three expert validators also stated that the prototype of the lesson plan for basic science concept is valid and feasible to use.

Table 2. Results of Learning Book Validation by Experts.

Components of Feasibility	Value			Average value	Category
	VD 1	VD 2	VD 3		
Contents	9.26	9.05	9.35	9.22	Very Valid
Presentation	9.41	9.01	8.89	9.10	Very Valid
Language	9.11	8.97	9.12	9.07	Very Valid
Visual Graphics	9.17	9.22	9.24	9.21	Very Valid
Average value	**9.24**	**9.06**	**9.15**	**9.15**	**Very Valid**

Note: VD : Validator/Expert

The assessment of student worksheets was done with the instruments developed by the researchers. The instrument includes four aspects of feasibility, that is, didactic, content, presentation, and time management. Each of these aspects has some feasibility components as shown in Table 4. The values given for the student worksheets range from 1 to 10. Table 3 presents the results of the assessment of student work done by an expert with the following values: expert 1 (VD1) average of all components 8,86; for expert 2 (VD2) gives a value of 8.57; and expert 3 (VD3) gave a value of 9.14. So the average value of the three experts is 8.86 with the value category is "very valid." The three expert validators also stated that the prototype of the student worksheet for the basic concept of science is valid and feasible to use.

Table 3**.** The validation results of lesson plan by experts.

No.	Components of Feasibility	Value			Average value	Category
		VD 1	VD 1	VD 1		
The completeness component of the lesson plan						
1.	Clear identity	10	9	10	9.67	Very Valid
2.	Indicators according to learning achievement	9	9	9	9.00	Very Valid
3.	The learning objectives according to the indicators	9	9	9	9.00	Very Valid
4.	Time allocation is appropriate	9	8	8	8.33	Very Valid
5.	Learning materials according to learning achievement	9	9	9	9.00	Very Valid
6.	Relevant learning resources	9	9	8	8.67	Very Valid
7.	Assessment instruments according to aspects	9	9	9	9.00	Very Valid
Learning Activities						
8.	Learning activities according to ARICESA	9	9	9	9.00	Very Valid
9.	The learning step is clear	9	8	9	8.67	Very Valid
10.	Student-centered activities	9	9	10	9.33	Very Valid
11.	Learning activities generate motivation	8	9	9	8.67	Very Valid
12.	Learning activities facilitate conceptual comprehension	9	9	9	9.00	Very Valid
13.	Give students the opportunity to make inquiry	9	10	9	9.33	Very Valid
14.	Give students opportunities for material evaluation	8	8	9	8.33	Very Valid
Average value		8.93	8.86	9.00	8.93	**Very Valid**

Note: VD : Validator/Expert

The prototype appraisal step of learning materials got some suggestion of improvement given by expert appraisals. The cover must be drawn a picture to represent the content of learning tool. It also explains the relation concept with the application more coherent (concept, application of the concept, and discussion converted to example of application, concept, and discussion), adding a simple example of activity that relate to concepts and phenomena, use of language is pursued more communicative and uses terms that are easy to understand. Suggestions about the demands in explaining the concept and the addition of student activities are great for improving these learning materials. This discourse is expected to make it easier for students to understand the presented concept [37-38]. Indirectly, this also can increase the competence of pedagogical content knowledge of prospective teachers [39]&[40]. The validator also suggests that the drawing of the concept illustrations should be explained in detail and the explanation should contain all the components in the drawing entirely to avoid multiple interpretations of the image. It is intended that image visualization can foster students' comprehension of science concepts [24, 41, 42, 43]. In addition, some types need to be fixed to make it easier for users to understand the contents of the learning device.

Table 4. The validation result of student worksheets by experts.

No.	Components of Feasibility	Value			Average value	Category
		VD 1	VD 2	VD 3		
Didactic						
	Appropriate learning achievement	9	8	10	9.00	Very Valid
	Material flow is coherent	9	8	10	9.00	Very Valid
	Facilitating students to make inquiry	8	9	9	8.67	Very Valid
	Facilitating students to self-evaluate	9	9	9	9.00	Very Valid
Content						
	Complete component	9	10	9	9.33	Very Valid
	Relevant to the context of everyday life	9	8	9	8.67	Very Valid
	Examples of cases correspond to learning objectives	9	8	8	8.33	Valid
	Problem comprehension test in accordance with the achievement of learning	8	8	9	8.33	Valid
Presentation						
	Language according to correct rules	9	9	9	9.00	Very Valid
	The language is simple and easy to understand	9	9	9	9.00	Very Valid
	The font type and size are proportional	9	9	9	9.00	Very Valid
	Illustration / Image helps to understand	9	8	9	8.67	Very Valid
	The color combination is appropriate	9	8	10	9.00	Very Valid
Time Management		9	10	9	9.33	Very Valid
	The time to work on the worksheets is proportional	9	9	9	9.00	Very Valid
	Average value	**8.86**	**8.57**	**9.14**	**8.86**	**Very Valid**

Note: VD : Validator/Expert

User Responses

The learning materials of basic science concept were tested on some students and lecturers of primary school teacher education program of STKIP PGRI Tulungagung. This step in the form of a modeling class to simulates the learning process with three lecturers model and five students. Lecturers are asked to study the content of learning books, lesson plan, and student worksheet, while students study learning book, then asked to fill out a response questionnaire to the book. Their response becomes one part of the validity justification for learning materials. Table 5 presents a summary of user responses to learning books. Each lecturer gave a percentage score of 89.09%, 86.85%; and 85.95%, while each response of students are 84,18%, 88.17%, 88.79%, 87.05%, and 84.84%. Overall average percentage of user response is 86.86% with an excellent category.

Table 5. The results of lecturer and student responses.

Components of Feasibility	Respondents							
	L 1	L 2	L 3	S 1	S 2	S 3	S 4	S 5
Presentation of Material	88.50%	83.27%	84.69%	86.09%	83.50%	82.56%	86.42%	85.72%
Illustrations and Graphics	93.18%	91.34%	84.13%	81.11%	93.18%	93.18%	90.37%	84.13%
Retention of material	90.15%	88.56%	85.72%	85.37%	88.93%	88.56%	91.05%	81.04%
Motivation to learn	90.13%	88.93%	90.01%	84.92%	91.03%	91.13%	84.13%	83.13%
Ease of Use	83.49%	82.13%	85.22%	83.42%	84.22%	88.50%	83.27%	90.17%
Average	89.09%	86.85%	85.95%	84.18%	88.17%	88.79%	87.05%	84.84%
Total Average	86.86%	(Very Good)						

Note: L : Lectures, S : Students

This article only deals with the data results of the validation process on the prototype stage, especially the Focus Group Discussion (FGD) results, expert appraisals, and user responses on the modeling class. FGD and expert appraisals results are internal validity representations consisting of construct validity and content validity, whereas user's responses are representations of one part of the external validity. Based on both components of validity, the prototype of learning materials can be declared valid. The process should continue the effectiveness test and consistency test to produce a proper final learning material and able to increase the motivation and students comprehension of the science concepts. The next stage is the limited trial and field trial. During the validation process, there are some constraints that the lecturer model is still not expedited in using the simulation software and time management that is not following the lesson plan. This issue will be followed up before making a limited trial at a later stage.

IV. CONCLUSION

Based on the results and discussion on the above description, the validation scores for the learning book, lesson plan, and student worksheet are 9.17, 8.93, and 9.88, all of the learning materials belong to very good criteria. FGD results for this materials are also very good, while the response of students and lecturers is also very good with an average percentage of 86.86%. So this prototype has passed the validation process with valid status and continuous to the next stage of development process. The next stage is a limited trial to determine the effectiveness of prototypes and field trials to determine the consistency of the effectiveness of learning materials in improving the motivation and concepts comprehension. The stage of the modeling class needs to be fixed before the trial stage so that the model lecturer can be more fluent in implementing the learning process and adjust the time according to the lesson plan.

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