The integration of science and math

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Abstract. The research aims to produce teaching materials for improving the quality of science learning that integrated mathematics for students in Primary Teacher Education (PTE) department of Universitas Negeri Padang. The research method used is the ADDIE model. The research stages consist of five phases. Firstly, the analysis stages conducted on the curriculum, the needs of the students and the lecturers' demands. Secondly, the product designs stage in the form of lecturing module, which is analyzed by an expert team. Thirdly, product stages consist of several chapters that integrate science and mathematics. Fourthly, the implementation stages are test stages. Its phase performed if the expert team has finished validating the used teaching materials in the review process. Lastly, the evaluation stage has been appropriately implemented such as looking back on whether all the steps. The results showed that the teaching materials developed to improve the quality of learning with the average achievement of prices of 63.66 while the average posted the value of 75.10. Then the results of the observer assessment showed that 75% of students followed the course activities well.

1. Introduction

Recently, there are so many alternatives offered to develop science, one of which is through learning development practice, i.e., integrated learning [1-4]. The essential integration of two disciplines is that of between science and mathematics [3, 4]. In line with this idea, Hurley [5] argues that science and mathematics are highly interrelated to one another and inseparable. Based on the writer's experience studying in Primary Teacher Education (PTE) department of Universitas Negeri Padang (UNP), integrated learning materials were only applied to elementary school related subject but not to the happy ones while, in fact, there are several collaborative basic concepts of natural science and mathematics. It is true that integrated learning subject has already been offered, but it still combines several disciplines for elementary school learning. During the instructional process, students involved in learning task activities without being provided with the problems to be solved in advance [6, 7]. Through the provision of these problems, students can think more creatively. As the prospective educators, students need to have the ability to integrate various disciplines of science and mathematics [8]. Through the integrative ability that they already obtain in their undergraduate learning experience, it is much easier for students to implement it and their insights will also be developed and expanded due to the familiarity with two interrelated disciplines.

In reality, many students are not able to solve the problems related to natural science subject. One of the topics integrated for the disciplines of science and mathematics is planted classification and sets as it is already given in the curriculum for the syllabus *Konsep Dasar IPA SD 1* in PTE UNP. In those learning materials, the writer will integrate science with the basic concepts of sets. The article on plant classification

is highly related to basic concepts of sets. However, many elementary school teachers have not yet been able to design an assessment that develops creative thinking ability with problem-based.

Some researchers have already conducted studies related to this research [9, 10]. Science Technology Engineering Mathematics (STEM) is the currently favored interdisciplinary learning for the last few years [9]. Another research conducted by Merrit, et al. [10] reveals that PBL learning is the effective learning model to develop science and mathematics. Based on the above explanation, it is essential to conduct the research with the theme is how to developing integrated science learning problem based instructional documents on sets to improve PTE students' thinking skill.

2. Method

The research design employed is research and development. This type of study encompasses the systematic processes of planning, developing, and evaluating. This research uses ADDEI models covering analysis, design, development, implementation and evaluation stages [11]. This research performed on PTE students of UNP in the odd semester for the academic year of 2017/2018. The subjects of this research were PTE students who took *Konsep Dasar IPA SD 1* issue on the materials of plant classification and sets. The observation was conducted on the implementation of integrated mathematics and science learning problem based instructional document by students and lecturer, and it's out coming impact.

The type of data in this study is primary data, obtained from the validity result of instructional documents by the validator, practicality data from lecturers and students, and the effectiveness taken from the observation and students' evaluation [12]. The instruments of data collection in this research were practicality, validity, and the effectiveness sheet of instructional documents. The data were collected through test, process and product evaluation [13]. Besides, the questionnaire also distributed. Besides, the giving test also is done by giving a questionnaire. The type of data taken in this research is primary data from the validity result by validator and the implementation of the limited trial to the students of PTE UNP in the form of observation of the instructional documents use, and lecturer as well as students' response.

3. Results and discussions

3.1. Analysis phase

At this stage, the analysis is done on several aspects such as performance and students analysis. Performance analysis carried out by reviewing the RPS (semester lesson plan) for *Konsep Dasar IPA 2* subject. The concept of performance analysis is needed in studying material coverage, learning objectives and selection of strategies appropriate to the fundamentals of instructional documents development. It focuses on the review of the material classification of living things with the concept of sets.

Student analysis is a study of students' characteristics including age, background knowledge, cognitive development level, absorption rate and information processing as well as their talents and interests. The analysis of students' characteristics in this study focuses on the aspects of language development, intellectual, and other elements that can improve their motivation.

Analyzing the level of students' language development is necessary for considering the language of learning materials. Analyzing the intellectual development of the students is necessary for setting the level of difficulty of the problems in learning materials. Finally, learning motivation analysis is necessary for designing the presentation of the material and instructional documents appealing to students' interest and motivation [14].

3.2. Design phase

The designed RPS is that of mathematics and science integrated learning using problem-based on undergraduate students of PTE. The developed RPS shows the exposure of the learning stages on the topic of classification of living things combined with the concept of the sets. The characteristics derived from this RPS design are more detailed and easy to understand. It also helps to understand the classification of living things. The fundamental principle in RPS design is that the lesson material

presented has fulfilled the scientific truth; the order of the article adjusts to the level of student development, and the preparation of the RPS adapt to the established components.

The SAP is compiled entirely and systematically regarding the developed RPS. Based on the analysis of the material, the achievement of competency indicators is implemented in 3 lectures with the allocation of time for each lecture 6 x 35 minutes. Each address is conducted in a structured way by collaboration the stages of Problem Based Learning [15].

Learning materials are designed by the curriculum and presented using the learning steps of the PBL model. Its development adapts to the needs and characteristics of students' progress [16]. These materials develop regarding the results of material analysis and formulated indicators.

3.3. Development phase

This stage is to validate the instructional documents namely RPS, SAP, and learning material validation. Validity test is conducted through confirming the learning process by experts and practitioners followed by revisions and improvement. The data collection instrument is validated by three experts that can be seen in Table 1.

Table 1. The results of instrument assessment by expert validators

No	Instrument	Total Score		Mean (%)	Category
		V1	V2		
1	RPS validation	3,86	3,71	3,79	Very Valid
2	SAP validation	3,86	3,86	3,86	Very Valid
3	Learning material validation	3,86	3,71	3,79	Very Valid
4	SAP implementation sheet	3,86	3,71	3,79	Very Valid
5	Lecturer's response sheet on material practicality	3,86	3,86	3,86	Very Valid
6	Students' response sheet on material practicality	3,86	3,57	3,72	Very Valid
7	Learning observation sheet	3,86	3,71	3,79	Very Valid
8	Students' activities observation sheet	3,86	4,00	3,93	Very Valid

There are three aspects of this phase namely validity, practicality, and effectiveness. All aspects already validate with the expert validator and revision validator. Validity test on mathematics and science integrated learning instructional documents using PBL based model consist of three parts such as RPS, SAP, and Learning material [17]. All results can be seen in Table 2.

Table 2. Validity test result

No	Validation	Results	Category
1	RPS	3.79	Very valid
2	SAP	3.82	Very valid
3	Learning Material	3.76	Very valid

The done RPS validation is on several aspects including formulation of learning objectives, presentation of learning materials, learning activities, selection of learning resources, and assessment. The overall result of RPS validation from expert validators and practitioner validator is 3.79 which belong to the category of very valid.

The done SAP validation is on several aspects including identity, objective formulation, selection of learning materials, method and detail of learning steps, selection of learning resources, and assessment. The overall result of SAP validation from expert validator and practitioner validator is 3.82 which belong to the category of very valid.

Learning material validation focuses on several aspects including content appropriation, language, presentation, and graphics. The overall result of learning material evaluation from expert validator and practitioner validator is 3.76 which belong to the category of very valid.

Practicality test of mathematics and science integrated learning instructional documents using PBL model consist of four aspects such as the observation results of SAP implementation, students' response on instructional document practicality, lecturer's response of instructional document practicality, and observation results of learning material implementation. Instructional documents considered to be valid are then tested to see the level of practicality in its use. The practicality of the developed instructional documents is found out by observing the level of SAP implementation, the response of lecturers and students to the learning materials, and the observation of students' use of the learning materials. The recapitulation of practicality result can be seen in Table 3.

Table 3. Practicality result

No	Validation	Results	Category
1	SAP implementation	3.60	Very practical
2	Students' response	3.81	Very practical
3	Lecturer's response	3.78	Very practical

The observation SAP implementation focuses on seeing if the learning process is carried out in accordance with the SAP. The results of this observation are in the category of very practical with the overall score of 3.60. Furthermore, the assessment of student responses is conducted to know students' opinions about the practicality level of the learning process. The data on students' response data are obtained from student response instrument. Lastly, the assessment of the lecturer's response is conducted to their opinions on instructional documents that have been developed. This response is obtained by using a questionnaire.

The observation focuses on the level of practicality for students in using learning materials developed. The results of this observation indicate that it is generally practical and comfortable for students to understand every concept in the learning materials. In general, students can follow every step of PBL well. In the aspect of interest and motivation to use the learning materials, students, in general, are quite interested in the display of teaching materials. The next element is students' participation and enthusiasm to perform the tasks. Overall, the students are quite active and enthusiastic in doing every work in the learning materials. Based on the above description, it can be concluded that it is easy for students to understand the concept and do various tasks in the learning materials. Thus, students do not experience significant constraints in using the substance of the classification of living things integrated with sets.

Effectiveness test on instructional documents on the topic of classification of living things integrated with sets using PBL model consist of the students' activity. Students' activity is observed by using an observation sheet instrument. The observed student activities are: observing and listening to the lecturer's explanation, paying attention to learning materials, doing the activities in learning materials, asking questions, and giving a response. The result of this observation can be seen in Table 4.

Table 4. The observation results of students' activity

No	Meeting	Observed Activity					Mean	Category
		A1	A2	A3	A4	A5		
1.	Meeting I	81,3%	87,5%	89,6%	72,9%	70,8%	80,4%	High
2.	Meeting II	89,6%	95,8%	95,8%	81,3%	75%	87,5%	Very High
3.	Meeting III	93,8%	100%	100%	87,5 %	85,4%	93.3%	Very High
			Mean				87,06%	Very High

Explanation:
A1 (Activity 1) = observing and listening to lecturer's explanation
A2 (Activity 2) = paying attention to learning materials
A3 (Activity 3) = doing the activities in learning materials
A4 (Activity 4) = asking questions
A5 (Activity 5) = giving response

3.4. Implementation stage

The implementation stage is the use of instructional documents in the broader scope. This phase in this research is conducted in another school, i.e., *SDN 12 Bukit Cangang*. The purpose is to test the effectiveness of the use of advanced products on different objects, situations, and conditions. The implementation stage was done from November 25 to December 8, 2016 at V *SDN 12 Bukit Cangang*. The effectiveness test in the implementation stage is the same as effectiveness test in product trial at *SDN 04 Bukit Apit*. Three main aspects need to be considered in this stage, i.e., students' activity.

Students' activity is observed by using observation sheet instrument. The result of this observation shows that the mean for students' activity in general 89.37% which belongs to the category of very high (Table 5).

Table 5. The observation results of students' activity

No	Meeting	Observed Activities					Score	Category
		A1	A2	A3	A4	A5		
1.	Meeting I	82,7%	86,5%	92,3%	76,9%	78,9%	83,5%	Very High
2.	Meeting II	92,3%	94,2%	96,2%	82,7%	82,7%	89,6%	Very High
3.	Meeting III	96,2%	96,2%	100%	90,4 %	92,3%	95,0%	Very High
	Mean						89,37%	Very High

Explanation:
A1 (Activity 1) = observing and listening to lecturer's explanation
A2 (Activity 2) = paying attention to learning materials
A3 (Activity 3) = doing the activities in learning materials
A4 (Activity 4) = asking questions
A5 (Activity 5) = giving response

3.5. Evaluation stages

Assessment of evaluation questions on classification of living things integrated with sets using PBL model product evaluation can be seen in Table 6. It shows that the overall mean of students' test result is 86.54 which belong to the category of very good.

Table 6. Product evaluation

No.	Students' Number	Meeting 1		Meeting 2		Meeting 3	
		Pass	Fail	Pass	Fail	Pass	Fail
1	30	26	4	28	2	26	-
	Percentage	84,6%	15,4%	91,3	6,7%	100%	0%
	Average Score	83,27		86,15		90,19	
	Overall Mean			86,54			

4. Conclusion

The effectiveness of developed instructional documents on the classification of living things integrated with sets using PBL model has already been tested. The results of the trial stage reveal the observation of student activity in a very high category (87.06%), very high grade (15%) and the average score of student test result in the good class (83.05), with the percentage of passing exceeding the minimum limit. Also, the results of implementation stage reveal the observation of student activity in a very high category (89.4%), and students' test result with the average score of (87.22) in excellent grade, with the percentage of passing, also exceeding the minimum limit.

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