The Development of Problem-Based Learning Material for Integrated Science Subject in Primary Teacher Education Program

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Abstract. This research and development aim to develop a learning material for the learning improvement quality of Primary Teacher Education (PGSD) students in Integrated Science subject. The research method used is Borg and Gall model. The research stages are: (a) curriculum analysis, the students’ and teachers’ need analysis, (b) the learning material development stage which is analyzed by experts’ judgment, and (c) the pilot stage. The research instruments are observation sheets, interview guides, validation sheets, teachers and students’ response questionnaires, tests, performance assessment sheets, and attitude questionnaires. The results show that the learning material is valid, practical and effective to improve Integrated Science subject learning quality.

1. Introduction
People's lives are not only influenced by the economy sector but also the education sector. Changes in the field of education aiming to achieve prosperity have demanded the government to structure the education system in a whole and comprehensive manner, especially in the term of education quality. In addition, the arrangement of education should be tailored to the living environment and the needs of the learners [1].

The government has made various efforts to improve the learning quality in primary schools. One of them is requiring primary school level to conduct an integrated manner for natural science learning. The concept of integration is shown in the basic competence (KD) of science learning in which one KD has integrated to the science concepts from the field of chemistry, physics, biology, and space (IPBA) [2].

This means that natural science students are introduced to the problems that exist around them. The students are trained how to harmonize the natural environment that can contribute in supporting life. The science learning emphasizes the concept of life problems in which the students are trained to find their own concepts to be learned through direct experience. Thus, it can motivate the students to learn actively in trying and doing the activities, and also apply the concepts that have been learned. The students read and find the problem, find a solution to answer the problem [3].

Problem-based learning model (PBL) is a learning model that emphasizes the problem solving process that can challenge the students' abilities and provide satisfaction to determine new knowledge
for the students. Besides, problem solving can improve the students' learning activities, help the students' how to transfer their knowledge, understand the problem and be responsible in their learning. Therefore, the problem-based learning model is a good technique to better understand the content of the lesson. The students who graduate from problem-based learning programs have the same factual knowledge but better critical performance than those from traditional schools [4]. Thus, this learning model is more fun and enjoyable for the students.

Learning natural science that is oriented on applicative ability, development of thinking ability, reasoning, development of caring attitude, and responsible for social and natural environment, is a science-based learning which is integrated to problem-based learning. The application of varied learning models is expected to be more meaningful, authentic, enjoyable learning to make the students' holistic conceptual understanding [5].

Problem-based learning is a learning that begins with solving a problem, but the students need knowledge to solve it. Therefore, problem-based learning is a learning that involves the students in an active, collaborative learning process, and students-centered learning. Because learning has a motivational and emotional component, the PBL model can cultivate or inhibit this matter depending on the skill of its teachers [6]. In addition, PBL is able to develop the problem solving skills and self-learning capabilities that the students need to face the challenges in life and careers for today's complex environment [7].

PBL is a small group collaborative learning method that was first used in medical education at McMaster University in the late 1960s. The PBL scenario does not only increase the students' intrinsic motivation, but also facilitates the uptake of knowledge in the future through coding specificity as recalling future knowledge [8]. Learning should not be separated from practice, and the learning context should be as authentic as possible [6]. After this perspective, the instructional design focuses more on perception and action rather than on memory and retrieval.

The primary teacher education students must have motivational and emotional components that can be obtained when learning using PBL: whether it can grow or block, it depends on the teacher's skill [9]. The students need to learn and be introduced to this PBL model. This is in line with the view that the students graduating from PBL programs have the same factual knowledge but better critical performance than those from traditional schools. Although traditional schools may have little confidence in their knowledge [10].

2. Methods
This research used research and development model with the intention to produce new products through certain stages. Then, the product was tested at the level of validity, practicality, and effectiveness of teaching materials (modules). The study used the ADDIE model [11]. The use of the final model aimed to produce a specific product and test the effectiveness of the product in the form of Integrated Science module based on Problem-based learning for primary teacher education program.

This research was modified according to the purpose and time available. The research stages were: (a) curriculum analysis, the students’ and teachers’ need analysis, (b) the learning material development stage which was analysed by experts’ judgment, (c) the pilot stage, (d) the implementation stage, and (e) the evaluation stage.

The curriculum, needs, and student analysis were done in the analysis phase. At the design stage, the designed module was developed using Problem-based Learning [12]. The module was also made referring to the book-making guide in accordance with Permendiknas No 11 of 2005. The next stage was the development stage undertaken to produce valid, practical, and effective textbooks which involved expert practitioners here. After that, the implementation was conducted to test the module and practicality of the module was done in the pilot phase for the students of primary teacher education in Universitas Negeri Padang. The last stage was evaluation. It was conducted to evaluate and revise the module after it was tested in the first semester for the students of primary teacher education in
Universitas Negeri Padang. The assessment procedures should be tailored to the intended teaching objectives and the most important thing for the teacher was to get reliable and valid assessment.

Table 1. Data collection and instrumentation techniques

| No | Aspect | Data Collection          | Instrument                  |
|----|--------|--------------------------|-----------------------------|
| 1  | Validity | Validation phase, Experts judgment | Validation sheet            |
| 2  | Practicality | Observation, Questionnaire | Observation sheet, Questionnaire |
| 3  | Effectivity | Learning achievement     | Test, Questionnaire         |

The teaching materials developed in this study were module. Then, the generated modules were analysed for their validity, practicality, and effectiveness before being used in the integrated natural science learning activity for the students of primary teacher education in Universitas Negeri Padang.

3. Result and Discussion

3.1. The validity of the module

From tabel 1, it can be concluded based on the table 2 that the integrated science module developed using Problem-Based Learning model for the primary teacher education program students had valid with the level of achievement of 0.878. This was higher than the level of achievement of the validity (0.67) [13]. Thus, the assessment of the categorical module was valid. This result was no different from the study of integrated science using PBL through lesson study. It was obtained valid results (0.7 - 0.8) [14].

Table 2. The validity result of Integrated science module.

| Instrument | Validator Assessment | Average | Score  | Category |
|------------|----------------------|---------|--------|----------|
| Content    | 86 85 83             | 10.15   | 0.869  | valid    |
| Language   | 90 89 91             | 10.57   | 0.932  | valid    |
| Media      | 10 9 9               | 9.78    | 0.833  | valid    |
| Average    |                      |         | 0.878  | valid    |

3.2. The practicality of the module

The results of the lesson plan implementation were drawn using the observation sheet at each meeting. The highest observation result of lesson plan observation in this study was generated at the fourth meeting of 94.74% (very done) and the lowest assessment resulted at the first meeting with the value of 78.65% (implemented). Moreover, the modality of the generated module was also seen from the teacher's response questionnaire and the student's response. The data can be seen in table 3.

Table 3. The students’ and teachers’ perception toward the module.

| Responder  | Average | Criteria       |
|------------|---------|----------------|
| The teachers | 88.78   | Highly practical |
| The students | 85.55   | Highly practical |

The above results fit to the following view which states that PBL encapsulates the belief that the learning outcomes of cognitive and social interactions in the environment are problem-centred [15]. The students are active partners in learning and they are not passive recipients. The students’ involvement in PBL is essential to achieve learning objectives. Their involvement in the learning process will help them to learn from their experiences, filtering, sorting and refining ideas, consolidating what they know, also practicing their arguments well [16].
3.3. The effectivity of the module

The effectiveness can be assessed in terms of process (the students’ activities) and product (the learning outcomes). The graduates that using PBL demonstrate the ability to work more efficiently [8]. The key to achieving educational goals is that the students and teachers understand the learning process and actively participate in helping the students [17].

3.3.1. The Activities. It shows from table 5 that the average has increased in the student activity with the very good category that reaches 83.6%, good category reaches 4.8%, fairly good category reaches 9.5%, and not good does not exist. The average increase per cycle has increased from previous meetings. PBL helps the students to develop themselves into competent reflective practitioners [5]. The teachers need to consider a learning environment that supports the students developing lifelong learning habits, skills, and attitudes that will help them become competent practitioners [18]. Each of the elements that make up the PBL places responsibility not only for the students, but also for their teachers, schools, and learning communities [19].

| Table 4. The students’ activity engagement |
|-------------------------------------------|
| Aspect                             | 1st meeting | 2nd meeting |
|                                   | 1st meeting | 2nd meeting |
| Mental activity                     | 16          | 18          |
| Oral activity                       | 16          | 18          |
| Visual activity                     | 66.7        | 85.4        |
| Average                            | 66.7        | 85.4        |

3.3.2. The Learning Achievement. The products obtained in addition to modules are learning outcomes. PBL exhibit a positive effect on physician competence, particularly in the social and cognitive fields, especially with regard to cultural and ethical issues [20]. The learning grading of the integrated science using Problem-based Learning for the students of primary teacher education in Universitas Negeri Padang in academic year 2017/2018 can be seen in table 5.

| Table 5. The validity scoring assessment. |
|------------------------------------------|
| Instrument                 | Validator’ assessment | Average | Scoring | Category |
| Knowledge                  | a. Content            | 17      | 19      | 17      | 10.00  | 0.89  | Valid |
|                           | b. Media              | 21      | 18      | 22      | 9.50   | 0.86  | Valid |
|                           | c. Language           | 11      | 13      | 15      | 9.88   | 0.88  | Valid |
| Skill                     | a. Content            | 17      | 16      | 13      | 9.20   | 0.83  | Valid |
|                           | b. Media              | 18      | 20      | 16      | 9.64   | 0.87  | Valid |
|                           | c. Language           | 12      | 11      | 11      | 9.80   | 0.88  | Valid |
| Attitude                  | a. Content            | 19      | 18      | 18      | 9.32   | 0.84  | Valid |
|                           | b. Media              | 23      | 21      | 20      | 9.60   | 0.87  | Valid |
|                           | c. Language           | 11      | 10      | 11      | 9.24   | 0.84  | Valid |
|                           | Average               | 0.853   |          |         |         | Valid |
It appears based on table 5 that all validation assessment components including feasibility of content, media, and languages are in valid categories. The assessment validity analysis also shows that the knowledge domain has the highest average score, while the attitude aspect has the lowest average rating among other domains.

In the cognitive domain, PBL graduates are considered as better problem solvers. PBL cognitive effects on student learning; increased retention of knowledge, integration of basic science concepts into clinical problems, development of self-learning ability and increased intrinsic interest of students in the subject matter [21,22].

4. Conclusion
From the above description, it can be concluded that the problem-based learning strategy must begin with awareness of the problem to be solved. At this stage, the teacher guides the students to the awareness of gaps or gaps perceived by humans and the social environment. The ability to be achieved by the students at this stage is the students can determine or capture the gap that occurs from various phenomena existed.

Problem-based learning model is a learning model that emphasizes the process in which the students are involved in making problems, find solutions, and how to solve problems actively, collaboratively, and based on the student-centre. Therefore, integrated problem-based for natural science learning can develop problem solving skills and self-learning capability of the students. This model is also needed to face challenges in life in the future.

5. References
[1] J Rende 2016 Initial Research of Cross-Level Thematic Task Implementation to Build Learning Initiatives and Democratization outside School. International Journal of Scientific Research and Education 4
[2] B Freudenberg, M Brimble, V Vyvyan 2010 The Penny Drops: Can Work Integrated Learning Improve Students’ Learning? e-Journal of Business Education & Scholarship of Teaching 4 1
[3] C Tosun and Y Tapkesenlygyl 2012 The Effect of Problem Based Learning on student motivation toward chemistry classes and on Learning strategies Journal of Turkish science education 9 1
[4] Watmough SD, Taylor DCM, Garden AS, Ryland I 2006 Educational supervisors’ views on the competencies of preregistration house officers Britain Journal Hosp. Med. London 67
[5] B Akcay 2009 Problem-based Learning in Science Education Journal of Turkish science education 6 1
[6] E Bate, H Juliette, D Robbert and David C M Taylor. 2014. Problem-based learning (PBL): Getting the most out of your students – Their roles and responsibilities Journal Medical Teacher 36
[7] Sudarman 2007 Problem Based Learning: Suatu Model Pembelajaran Untuk Mengembangkan dan Meningkatkan Kemampuan Memecahkan Masalah. Jurnal Pendidikan Inovatif 22 68-73
[8] Schmidt HG, Vermeulen L, Van Der Molen HT 2006 Longterm effects of problem-based learning: A comparison of competencies acquired by graduates of a problem-based and a conventional medical school Med Educ 40 562–567.
[9] G Tuncer, C Tekkaya, S Sungur, J Cakiroglu, H Ertepinar and M Kaplowitz 2009 Assessing pre-service teachers environmental literacy in turkey as a mean to develop teacher education programs. International Journal of educational development 29 4
[10] Koh G C, Khoo HE, Wong ML, Koh D 2008 The effects of problem-based learning during medical school on physician competency: A systematic review. Can Med Assoc Journal 178
[11] Molenda, M 2003 In Search of the Elusive ADDIE Model Performance Improvement 42 5
[12] JR Mergendoller, NL Maxwell and Y Bellisimo 2006 The effectiveness of PBL: a comparative study of instructional methods and student characteristics. Interdisciplinary journal of PBL 1 2
[13] R I Arends 2004 Learning to Teach. 5th Ed Boston: McGraw Hill
[14] M M Cooper and S Sandi-Urena 2009 Design and validation of an instrument to assess meta-cognitive skillfulness in chemistry problem solving *Journal Chemistry education* **86** 2

[15] P Rahayu, S Mulyani, and S S Miswadi 2012 Pengembangan pembelajaran IPA Terpadu menggunakan model pembelajaran Problem-Based Learning melalui lesson study *Jurnal Pendidikan IPA Indonesia* **1** 1

[16] DH Jonassen and W Hung 2008 All problems are not equal: implications for PBL *Interdisciplinary Journal of PBL* **2** 2

[17] Taylor DCM and Hamdy H 2013 Adult learning theories *Med Teach* **35** 11

[18] J Strobel and Van Barneveld A 2009 When is PBL more effective? A meta-synthesis of Meta analyses comparing PBL to conventional classrooms *Interdisciplinary Journal of PBL* **3** 1

[19] O Burg 2010 *The Interdisciplinary Journal of Problem-based Learning, Spring* **4** 2

[20] Norman G 2008 Problem-based learning makes a difference. But why? *Can Med Assoc Journal* **178**

[21] Dolmans DHJM and Schmidt HG 1996 The advantages of problem-based curricula *Postgrad Med Journal* **72**

[22] Goh, K 2014 What good teachers do to promote effective student learning in a problem based learning environment *Australian Journal of Educational & Development Psychology* **14**