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Takin as Indigenous based Experiment Activity Topic in Mathematics and Physics

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Abstract. Our study addresses the development a novel topic in learning math and physics by using Dayak's tribe indigenous knowledge. Limited educational facilities in remote, marginalized and isolated (3T) areas have triggered us to adopted the local wisdom in learning activities. We had adopted Takin, an indigenous woven "back pack" from Dayak tribe, West Kalimantan, to be used in learning series in math and elasticity in physics. Through this Research and Design study, we developed the experiment kit design and equipped with student worksheet. This learning activity has been piloted on first year pre-service teacher student whose taking basic physics course in year 2019 odd semester. The problem identification and student needs analysis shown the requirement of learning and experiment/laboratory activity based on local wisdom in math and physics lesson. The result showed that student worksheet is valid and the experiment kit design was practicable. The experiment kit and student worksheet are feasible to be used in learning activities.

Keywords: *Elasticity, Series, Indigenous Knowledge Based learning, Dayak.*

A. Introduction

Kalimantan as the largest island in Indonesia, but this large coverage area did not match by the developments, including the education sector. This very wide island has numerous remote, marginalized and isolated areas (*Terluar Tertinggal Terdepan*, 3T) especially in rural, remote, and border areas. The education obstacle encountered generally in this area were lack of classroom, teachers, and learning facilities (Brata, 2020) (Anwar et al., 2020), such as internet (Irfan et al., 2020) (Rahmadi et al., 2010), electricity supply (Anwar et al., 2020), and public infrastructure (Putra & Rhussary, 2018). The education's quality will impact nation's competitiveness, so that the education funding must be well distributed throughout all province in Indonesia, so the gap and lack of human development could be reduce (Sulisworo, 2016). This limited situation must be addressed with innovation in learning process that utilize indigenous knowledge.

Indigenous knowledge or local wisdom or ethnoscience based learning is an learning approach which use the local wisdom, or local culture in learning activity. This learning approach implementation signed by the using of specifically local or "endemic" or "unique" term, used only in that area. Indigenous knowledge based learning had reported in boosted students motivation, it is easy, interesting, helps students in learning independently (Ramdiah et al., 2020), effective to improve math problem solving ability (Parwati et al., 2018). This is essentials, but still rare in implementation (Hartini et al., 2017), which had affected the lack of attention to socio-cultural environment (Dewi et al., 2019). By learning according to their indigenous knowledge, learning activity will be more contextual (Dewi et al., 2019) and vanishing the gap between learning and daily life.

Takin is a woven basket, a heritage of Dayak Tribe from Bengkayang Regency, West Kalimantan. This woven basket made by weaving the natural fibre of rattan, bamboo, pandanus or tree bark, which harvested from forest. The similar woven basket

found in all Dayak's Tribe in another local area, but in different name, such as "Katoro" or "Bakul" in Landak Regency (Linda et al., 2017) in West Kalimantan and "Bakul" and "Lanjung" in Central Kalimantan (Larasati Zaini, 2014) (Hafizianor, 2018), "Lulung" and "Bakul" in South Kalimantan (Hartatik, 2018) and "Anjat" in East Kalimantan (Suteja, 2020). Takin is a cylindrical container, with coverless top. As a container or a bag, it can load any kind of stuffs, from light to heavy, also for any purposes.

Takin is strong and durable, it's capable to carry very heavy load and last for decades, therefore it's still widely used as household in each Dayak's family. This severe mechanical strength due to strength of natural fibre which reinforced again by weaving. Weaving activity produce meeting point of along the fibre body, so thar the load's weight is divided evenly through all Takin's body. Hence this weave pattern determines it's mechanical strength. The mechanical strength of a body has been learned in elasticity subject (physics). The weave pattern which showing harmonic repetition denotes to series subject in Math. Therefore, we used Takin as a novel topic in studying elasticity and series.

B. Method

This is a Research and Discussion (R&D) study to developed Takin as noble topic to learn Series (Math) and Elasticity (Physics) by using Plomp Model (Plomp et al., 2013)(Egok et al., 2020), which consist of three phases, they are: (1) Problem Identification and needs analysis; (2) Design development and implementation; and (3) Evaluation. Problem identification and student needs data collected by using questionnaire sheet, which distributed to randomly selection of 20 high school students in Kalimantan. The field test (try out) in this R&D research type was conducted by first year student of pre-service teacher in Faculty of Education and Teacher Training Universitas Kristen Indonesia. This study had used purposive sampling, students whose become participants are students who come from West Kalimantan, Indonesia. First year student picked up because they just graduated from senior high school, so they can still represent the high school students. The instrument had used in this research were learning materials, which consist of experiment kit and student worksheet. The validity of learning material has been analysed in this R&D study.

Takin learning material is valid if there is a suitability between student worksheet and constructed instructional material, with four validator that consist of one physics education lecturer, one mathematics education lecturer, one physics senior high school teacher in West Kalimantan and one math high school teacher also from West Kalimantan. This suitability had calculated using this percentage equation (Hartini et al., 2017):

$$Validation\ percentage = \frac{x}{x_{max}} \times 100\%$$

Where x is total obtained scores and x_{max} is maximum score. Then, validation percentage compares with validation criteria (Table 1) (Hartini et al., 2017).

Table 1 Validity Criteria of Learning Materials

Average Value	Validity Criteria
80% - 100%	Highly Valid
65% - 79%	Valid
55% - 64%	Less Valid
< 55%	Not Valid

C. Results and Discussion

1. Product of Research and Development

Phase 1- Problem Identification and Needs Analysis

This study developed a noble learning material by using takin in math and physics lessons. The product development started by the first phase that is problem identification and needs analysis. This phase aims to set the product framework, which held analysed from student's questioner answer. The questioner has been arranged from previous research results. Problem identification (Table 2) consisted of four part, which are learning materials, student motivation and student satisfaction, teacher learning materials and experiment / lab activity in learning process (Dewi et al., 2019; Egok et al., 2020; Hartini et al., 2017; Ramdiah et al., 2020). The analyse component from learning materials were contextual aspect, help student in understanding the lessons, local wisdom and learning source. The student motivation that we analyse were in math and physics learning. Meanwhile the experiment/laboratory activity that we analyse in frequency, local wisdom base learning and availability of equipment.

Table 2 Problem Identification of Learning Materials

Statement	Percentage (%)
Learning materials has been contextual	30
Learning materials has been accordance with local wisdom	5
Learning materials only from textbooks	50
The available learning materials has been helped student to understanding the lessons	30
Student was satisfied with the learning materials	20
Student was demotivated in physics learning	65
Student was demotivated in math learning	65
Teacher prepare their own learning materials	30
Learning activities still lack of experiment / lab activity	70
Experiment / lab activity has been used local wisdom equipment	20
Experiment / lab activity still lack of equipment	75

Problem identification result showing the learning obstacle in learning materials, student motivation and satisfaction, teacher and experiment / lab activity. The learning materials is less of contextual with student daily life, less suitable with local wisdom and still limited in text book source. Teacher's role in design effective and attractive learning

materials has not been done optimally. Lack of experiment / lab activity in math and physics learning might be due to the incompleteness of experiment / lab equipment, considered the participant are in marginal or remote area. Experiment / lab activity learning method actually have to do because it conforms the scientific learning. Student learn not only by reading or listening, but the most important is they doing and experience their knowledge personally. Those factors could be affected the student's satisfaction as of student demotivated, especially in math and physics. To deal with those problems above, an act of innovation in design teaching material must be done by using local wisdom that available on that area. The scientific learning still can be done by the modest, creative and contextual with student life.

In order to provide appropriate treatment, the need analysis (Table 3) was carried out by using questioner. There are two components has been analysed, student's needs of learning materials and student needs the experiment / lab activity in the class. The learning materials that student required were in formed an easy and based on their local wisdom worksheet and example. Basically, students need topics that close to their daily life so that they are not alienated from learning and hopefully could increase student learning motivation. The interesting finding were student needs to have experiment / lab activity in math subject with almost close percentage with physics subject. The experiment learning method / lab activity help student learning by their psychomotor ability, which required by all students. Scientific learning is a learning approach that activated hands-on and minds-on learning. It makes classroom atmosphere more enjoyable, enhancing student opportunity and student's role in learning activity, and also can improve student's learning outcome specially in science learning (Hukmah & Puspitawati, 2020; Parsons, 2019; Rohaenah et al., 2019).

Table 3 Student Needs of Learning Materials

Statement	Percentage (%)
Student need an ease worksheet to help understanding in learning activity	75
Worksheet based on their local wisdom will help student to understanding in learning activity	85
Student need a local's wisdom base learning materials.	85
Student need local's wisdom base example in learning materials	90
Experiment / lab activity help student to understanding in math lessons.	75
Experiment / lab activity in help student to understanding physics lessons	85
Experiment / lab activity based on their local culture will help their understanding in math learning	65
Experiment / lab activity based on their local culture will help their understanding in physics learning	85

The percentage of student's need in local wisdom base learning materials should also be taken into account. Local wisdom base learning and scientific were tied up, the scientific learning must be very contextual. This contextual learning help student to reducing anxiety and perplexity in student. The student's self-confidence can be lifted-

up in local wisdom base learning because they had the preliminary knowledge, which can help student to construct their scientific knowledge. Every region in Indonesia has local wisdom that has not been optimized in learning activity. Even though with creativity, teachers can adopt it to design more interesting, contextual and easy to understand learning activity. It is a solution to deal with the limited education facilities problem, it is more accessible than just waiting for the government policy.

Phase 2- Design development and implementation

Takin learning materials that has been developed in this study were the experiment kit and student worksheet. The experiment kit of Takin employed tensile test experiment by analogue Takin as the spring or object, to evaluate the modulus elasticity. The basic procedure in this experiment / lab activity is pulled the takin and observed the length deformation by variable force of wight load. The teacher must facilitate quantized load, stative or stand stick, and ruller, which accessible and easy to find. Takin roles like a spring or rubber that student want to investigate the nature of it's elasticity. The elasticity will be evaluated from Young Modulus or Elasticity Modulus. The stiffness or spring constant can be held from Hooke's Law as the gradient between force and length deformation. We can also ask student to construct elasticity modulus and length deformation curve to analyse the elasticity region, from hookes law region to fracture.

This experiment involved at least 3 (three) takin into experiment / lab activity, so that student can make comparation between those. For each takin elasticity data then connected with its's own weave pattern, in this section we learn about series in math learning. To facilitate this series learning, we provide three takin with the same size in diameter and height also in the same basic weave materials, but different in weave pattern. The student was begun this experiment / lab activity by drawing 3 (three) takin weave pattern and measure the geometries then they also asked to investigate the weave pattern into series. This weave pattern converted into numbers, so that teacher can ask student to determine the n^{th} term and the summation result. The weave pattern then can be correlated with the elasticity modulus. The student asked to observe and investigate which weave pattern of takin has the higher elasticity and find out what causes it.

Phase 3- Evaluation

The experiment / lab activity by using Takin has been done and the student answer has been collected. The experiment has been progressed smoothly because the student worksheet has been arranged systematically and completely guiding student, from assembled the experiment kit, doing the tensile test and collected the useful data. To perform data analysis, the student worksheet also completed with guiding questions. All of student are able to assembly the experiment kit, doing the tensile test and collected the elasticity data. All student are able to measure the length deformation, enter the data into observation table, calculate the elasticity modulus and create the relation curve between elasticity modulus and length deformation.

In math section, the student are able to drawing the weave pattern. The student difficulties have seen when they convert it into geometric series pattern. The student difficulties also seen in the determination of n^{th} and summation result of series. The teacher has provided some extra direction in this section. This can happen due to the lack of math abilities. But with a little encouragement and guidance, student can still do it.

The higher difficulty seemed when student correlated the elasticity modulus with the weave pattern. This is natural because this section requires a higher degree, that is evaluated (C5) in revised Bloom Taxonomy. To explain this, give student the scaffolding question, in order to understand that the highest modulus elasticity achieved by a weave pattern that distributes the centre of weight more evenly.

2. Validation of Learning Material

The validity of this learning material assessed by expert validation based on Table 1. The validity percentage achieved 92,5 %, which is in highly valid category. This achievement denote to the learning materials development were correlated with problem identification and student needs and feasible used in learning activities. This noble learning material has involve hand-on and mind-on learning, suitable with scientific learning and very contextual. Activities that are included in hands on activities are when students assembling the experiment kit, doing tensile test and collected data. Whereas minds on activities are when students exploring their thinking ability to analyse for their descriptions of elasticity and converted the weave into series, and also linking the concept of series (math) into elasticity modulus (physics).

D. Conclusion

The validity of this learning material assessed by expert validation based on Table 1. The validity percentage achieved 92,5 %, which is in highly valid category. So that, this noble learning materials in students worksheet developed proved to be worthy used in learning process. It can be used as a solution to held experiment / lab activity by using local wisdom.

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