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The Development of Student Worksheet and Test Instrument for Statistical Thinking Skill Based on Local Culture and Accordance with Curriculum 2013 in Indonesia: Design Research Stage

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***Abstract*—This research aimed to developed of student worksheet and statistical thinking ability test instrument for Senior High School's student based on local culture and accordance with the provisions of Curriculum 2013 in North Sumatera, Indonesia. The special purpose of this research was to analyze and to formula the purpose of mathematics lesson in statistical thinking ability and also to develop to try out the students worksheets based on local culture developed. Subjects in this study were eleventh grade students of Senior High School. This research was a development research using 4D type created by Thiagarajan, Semmel and Semmel. The development process of these research consists of four phases: define phase, design phase, development phase, and disseminate phase. From the preliminary reserach results, we obtain that student worksheet and test instruments of statistical thinking ability based on local culture and accordande with Curriculum 2013 were valid, practice and effective to be use in mathematics learning at Senior High School**

Keywords—student worksheet, local culture, instrument test, statstical thinking

I. INTRODUCTION

Statistical thinking ability is a part of the mathematical ability that students must possess especially for high school students. It was stated in the guarantor of education quality of mathematics subjects [1] in accordance with the Curriculum 2013 by saying that one of the goals of learning mathematics is "...using reasoning on traits, performing mathematical manipulations both in simplification, as well as analyzing existing components in problem solving in the context of mathematics as well as outside mathematics (real life, science and technology) which includes the ability to understand problems, build mathematical models, complete the model and interpret the solutions obtained including in order to solve problems in everyday life (real world)". In accordance with the objectives of mathematics learning 2013 Curriculum above, it was found that the ability of statistical thinking required good reasoning ability, especially about statistical data to be analyzed.

This was in accordance with the opinion of [2] that one of the steps in statistical thinking is to have good reasoning on how to select data, so it can be used in answering the existing problems. From the two descriptions above, it could be concluded that the ability to think statistically had a specific relationship with students' mathematical reasoning abilities. Before students do the process of statistical thinking, then students had to go through a good reasoning process, so that the process of statistical thinking could be done to answer the existing problems in accordance with the expected results. According as told [3] also provided the same statement that the ability to think statistically was part of the means of scientific thinking in which there was a part of logical and systematic thinking. In studying statistics, the mastery of competence was very important, it was because learning statistics became the main prerequisite of students to know the ability of statistical thinking. By mastering the concept of statistical thinking, it would help students in understanding mathematics.

Through mathematics learning, students were expected to have logical, analytical, critical and creative thinking skills [4]. The ability to think statistically could be found in all areas of mathematics and important in everyday life, as [3], that someday think statistics would be a necessity for humans like reading and writing. Therefore, through the ability of statistical thinking in learning mathematics was expected to stimulate students to use the ability to think logically, analytically, systematically and creatively, and use the ability to draw conclusions and simplify the problems of a problem. From the above description, it was very important for teachers to develop statistical thinking skills in the learning process and the development of a data-oriented learning curriculum in the learning process of statistics is necessary for students [5], [6].

Details of the learning curriculum that needed to be developed were preparing research statements, designing investigative designs, collecting data for use in the

process of observation, data, experimentation, presenting and defining data findings as well as formulating and proving conclusions and predictions that fitted the data. While developing the ability of statistical thinking in the curriculum of learning in the United States schools had been done long enough. The reason why statistical learning is included in secondary school learning is due to the use of statistics found in solving everyday problems [7]. Apart from that, the importance of learning statistics was to develop critical thinking skills and the ability to arrange statistical data in accordance with the rules, so that it could have an impact on the character of the students themselves. Through the study of statistics with strong rules, students develop the character of discipline that will be useful for the future in various fields of profession [8]–[10]. Furthermore, the above statement had also been alluded to by Principles and Standards for Schools Mathematics (National Council Teacher of Mathematics*)* and the Guidelines for Assessment and Instruction in Statistics Education (GAISE) in its research findings [11] which found that there was a significant increase in the development of statistical education applied to school curricula in the United States and some other countries [6].

From some of the above statements, the authors concluded that the ability of statistical thinking was very important for students in developing high-order thinking skills. However, the difficulties of students in solving problems related to statistical data indicated that the learning process built by teachers was not appropriate in improving and facilitating students to realize the objectives of learning mathematics. The learning process required a method that could realize the above goals, one of which was a student-centered learning method. Problem-based learning was one of the student-centered learning methods recommended by the Curriculum 2013. Changes in the learning curriculum that took place in Indonesia forced teachers to hone the ability to choose the right method and should be in accordance with the 2013 curriculum. One of its demands was active learning, as well as closed to everyday problems, which made the learning experience of students more varied and interesting. In addition to the selection of appropriate learning methods, the use of teaching materials also needed to be adjusted to the demands of the Curriculum 2013. Teaching materials that had been used by students were still far from what was expected by the Curriculum 2013. Student Worksheet (LKS) was still not in accordance with hierarchy from LKS itself.

Student work sheet was a student manual used to conduct investigation or problem-solving activities. Student worksheet can be a guide for cognitive aspect development exercises as well as guides for the development of all aspects of learning in the form of experimental or demonstration guides. It can be concluded that the student worksheet was a sheet that presented a series of student learning activities [12]. The use of student worksheet was expected to increase students' independence in learning, confidence, discipline, responsibility and decision making [13].

However, in fact, the use of LKS in learning in some schools was still limited. This was shown from the observations made, in the learning of mathematics, the teacher did not use the student worksheet. This was because teachers had not designed their own student worksheets that could accommodate the students' need to learn more actively, so they only used the students' handbook. Meanwhile, the use of student worksheets could improve the effectiveness of mathematics learning in the classroom. This was in line with the opinion of the Teacher Work Structure Instructor Team (PKG) stating that "one of the ways to make students active is by using LKS" [14]. It is also in line with Government Regulation No. 41 of 2007 on standard processes in which students must be actively involved in learning.

Referring to the above facts, the development of student worksheets in accordance with the Curriculum 2013 and appropriate in developing the students' statistical thinking skills needed to be done. Student worksheets to be developed also needed to be integrated in the environmental context as a part of the student's life. The integration of local cultural contexts was one of the environmental factors that could be linked to real and non-routine problems. This is in line with Frudental's [15] suggesting that mathematical learning should be related to existing realities, remained close to the students and relevant to the life of society. This viewpoint involved learning mathematics not only as a subject of learning but also as a human activity, which was closely related to the local culture. The same opinion was expressed by Bishop [16] that mathematics is part of a culture, which has integration in all aspects of human life. Thus, the implementation of problem-based learning models with local cultural contexts could be developed through student worksheets that met the demands of the 2013 Curriculum in Indonesia.

II. Materials and Method

The population of this study was all students at eleventh grade students in Senior High School, North Sumatra, Indonesia. The sample was selected by proportional random sampling, and two classes were selected as the design trial class. Thus, the number of samples in this study was 60 students.

Data were collected through various data collection techniques, including tests, questionnaires and observation sheets. The test was used to analyze and validate the level of mastery of statistical thinking ability. Questionnaires were used to determine student responses related to the learning process in the classroom. While the observation sheet was used to determine the level of implementation of the learning model used in the classroom, namely the activities of teachers and students in the learning process in this case. The tests had been validated by educational experts for use in the legibility testing classes, then analyzed to calculate the value of validity and reliability. Calculation of validity is done by

using product moment correlation formula [17], while the calculation of the coefficient of reliability was done by using the formula Alpha [18].

This research was a development research oriented to product development. Development of student worksheets was based on local culture using Thiagarajan, Semmel and Semmel development model called 4-D model consisting of 4 stages, including define stage, design stage, development stage and dissemination stage.

III. FINDINGS AND DISCUSSION

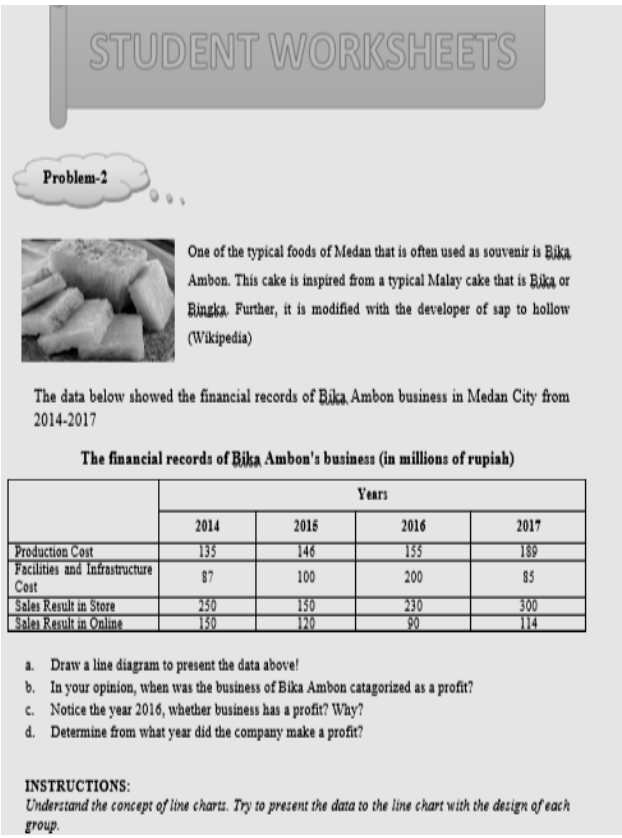
Local cultured student worksheets and statistical thinking test instruments had been declared valid by the validators. From the legibility test, the validity test of static ability was significant at the 0.01 level. Meanwhile, the test calculation of four tests of statistical thinking ability is at the value of 0.831. Four tests of statistical thinking ability were presented based on local culture. Table 1 presented a summary of the validity and reliability tests for all four statistical thinking skills tests.

TABLE I. THE VALIDITY OF STATISTICAL THINKING TEST

Correlations		*Test 1*	*Test 2*	*Test 3*	*Test 4*	*Total Score*
Test 1	Pearson Correlation	1	.790**	.657**	.616**	.881**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	30	30	30	30	30
Test 2	Pearson Correlation	.790**	1	.708**	.608**	.888**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	30	30	30	30	30
Test 3	Pearson Correlation	657**	708**	1	780**	889**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	30	30	30	30	30
Test 4	Pearson Correlation	616**	.608**	.780**	1	851**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	30	30	30	30	30
Total Score	Pearson Correlation	881**	888**	889**	851**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	30	30	30	30	30
Cronbach's Alpha Reliability Statistics (R)=0.831						

***. Correlation is significant at the 0.01 level (2-tailed).*

From the aspect of validity, it was found that all tests of statistical thinking ability met valid criteria with a high level of significance. This showed that the test was precisely measuring what should be measured in accordance with the material being taught. While on the calculation of reliability, a high significance value obtained. This meant that the test got the same result (consistent) if it was done repeatedly at different times and classes. Thus, it could be concluded that all four tests of statistical thinking ability that had been designed were eligible to be used in field trial classes. These findings were supported by research conducted by Ramadhani [19] earlier and in accordance with a statement from [18]. One of the test items about statistical thinking ability that had been designed was shown in Figure 1 below:


STUDENT WORKSHEETS

Problem-2

One of the typical foods of Medan that is often used as souvenir is Bika Ambon. This cake is inspired from a typical Malay cake that is Bika or Bingka. Further, it is modified with the developer of sap to hollow (Wikipedia)

The data below showed the financial records of Bika Ambon business in Medan City from 2014-2017

The financial records of Bika Ambon's business (in millions of rupiah)

	Years			
	2014	2015	2016	2017
Production Cost	135	146	155	189
Facilities and Infrastructure Cost	87	100	200	85
Sales Result in Store	250	150	230	300
Sales Result in Online	150	120	90	114

a. Draw a line diagram to present the data above!
b. In your opinion, when was the business of Bika Ambon catagorized as a profit?
c. Notice the year 2016, whether business has a profit? Why?
d. Determine from what year did the company make a profit?

INSTRUCTIONS:
Understand the concept of line charts. Try to present the data to the line chart with the design of each group.

Fig 1. One display of statistical ability test based on local culture

Some students were able to present data from the table to the diagram. Some students presented the data in the form of line diagrams, bar charts and pie charts. Some students also had been able to deduce data from the diagram presented and determine the most sales that occurred during the year of 2017. It showed a positive change in students' statistical thinking skills. Based on the observation sheet, the results obtained in field trial I that the application of student worksheets based on local culture provided an increase in student activity. It could be seen in the learning activities that took place, many students were enthusiastic in solving the problems presented. Some student discussion groups looked very active, both when discussing the issues presented, debating the graphical display or table to be presented. The same was also obtained from student questionnaire results; most students gave a positive impression to the students' work sheet presentation and test of local culture-based statistical thinking ability. Students felt easy to solve the problems presented because the problem was close to the culture and traditions in their area. They did not feel bored when following the learning process. Enthusiasm and positive responses were obtained from

the application of student worksheets and tests of local culture-based statistical thinking skills.

However, although the results of observations and student questionnaires showed a positive value, there were some minor revisions to the student worksheet and the statistical thinking test. The special revision lied in the less obvious image display, the use of sentences both on the narrative of the problem and the submission of questions until the use of local cultural context were still minimal either on the student worksheet or on the test.

After re-revision of the student worksheet and the test based on local culture, researcher tested back to different test classes, but still in one level of education. In field trial II, the results obtained indicated that both student worksheets as well as local culture-based tests met the practical and effective product criteria in the classroom learning process. On practical criteria, student worksheets and local culture-based tests had been researched and analyzed by education practitioners, and practical criteria had been obtained. While on the effective criteria, student activity observation sheets, teacher observation sheets to manage the learning until the student's response to learning in the classroom had been obtained. In the effective criteria, both categories were obtained in the three effective criteria. The results obtained were included in the design stage in the 4D model development stage. In the last stage, the disseminate stage was the dissemination of the student worksheets and the test of local culture-based statistical thinking ability that had been developed and tested to the Mathematics Teacher Subject (MGMP) group at the research school.

Learning tools, especially student worksheets were very important in the learning process in the classroom. The student worksheet should contain the concept of teaching materials that were taught and able to be completed either individually or in groups. The context changes in the presentation of the problem in the student worksheet by using the local culture were aiming to facilitate students in understanding the concept of learning materials learned, connecting teaching materials with real problems, until the integration of local culture in the learning process was expected to make learning more fun. The learning process will be meaningful if the concept learned is adjusted to the actual conditions [12], [20]. The applying integrated learning to local cultures provided new experiences for students in learning math, especially if the presentation of the problem was presented in Sundanese and Javanese which were the colloquial language of the students [21].

The presence of local cultural contexts in mathematics learning was suggested on the agenda of a mathematics teacher. This was in line with Bishop's [16] assertion that mathematics is part of a culture, which has integration in all aspects of human life. Thus, mathematics for a person would have an impact on the person's cultural background, because the whole thing they do was based on what they see and feel. Pannen [22] also said that a culture-based learning strategy creates an environment and learning experience that integrates culture as part of the learning process.

Further research that supported the integration of local culture in the learning process in the classroom, also found in research conducted by Sinaga. He undertook the development of a learning strategy based on Batak culture and his research provided an improvement to students' mathematical abilities [23]. Similar findings were also founded that the development of problem-based learning models with problems based on Bugis local culture, the developed a joyful learning model designed based on Malay culture; and also the developed a guided-discovery learning model based on Batak Toba culture [24]–[26].

Teachers as facilitators in the learning process were expected to explore information, to prepare teaching materials that support students' ability in solving non-routine mathematical problems, to choose teaching methods that can provide a fun learning experience for students. Giving student worksheets and tests that supported the ability to solve mathematical problems were expected to help students and to provide a new atmosphere in the process of learning in the classroom. While in classroom management, students working in groups needed to be done so that students could interact positively in building mathematical concepts. This is in line with Vygotsky [27], [28] that knowledge built by applying a social environment called social constructivism could shape the personal and social students, so that group learning could be developed. Thus, it could be concluded that the application of student worksheets and tests of statistical thinking ability could increase student activity especially in group learning, until it could improve the ability of other students' high-level thinking.

IV. CONCLUSION

Based on the findings of the research, it was found that the results of trial legibility on the student worksheet and the test of local culture-based statistical thinking ability showed significant reliability value at the 0.01 level namely 0.831. While the significant validity value at the 0.01 level on the four tests of statistical thinking ability was 0.877. Trial of student worksheets and tests of local cultural-based statistical thinking skills indicated that the application of student worksheets and local culture-based tests was valid, practical and effective to be used in teaching and learning mathematics at High School level in accordance with the applicable 2013 Curriculum in Indonesia.

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