The Development of Constructivist-Based Junior High School Mathematic Worksheet (LKS) on the Polyhedron

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Abstract. The LKS(worksheets) that are used in schools generally only contain questions, so they have not helped the students in constructing mathematical knowledge. Therefore, constructivist-based LKS is developed for learning mathematical knowledge. This study aimed to develop constructivist-based LKS on the subject of Polyhedron and to see the validity of the produced worksheets. This research was a research development using a 4-D model. This model consists of the stages of define, design, and disseminate. Data collection was carried out through validation and trial of the developed LKS. Validation was carried out by 3 validators who are experienced in their fields and the trials were conducted on grade seventh of SMP Negeri (Public Junior High School) 1 Kubung to determine the practicality and effectiveness of the LKS. This study produced constructivist-based LKS on the subject of Polyhedron. The validity of the LKS was categorized as very valid. Validity test that was carried out consisted of several aspects, namely aspects of content / material, form / presentation and language / legibility. The validation results showed that the LKS was very valid with an average value of 3.42. The practicality test results in aspects of the attractiveness of the LKS to student interest, ease of use and content, and the efficiency of time showed this constructivist-based LKS was very practical for students and teachers with an average value of 89.14% and 79.25%.

1. Introduction

One of the goals of mathematics learning in the school-level-based curriculum (KTSP) is to develop creative activities that involve imagination, intuition and discovery by developing divergent, original thinking, curiosity, making predictions and guesses, and experimenting. In the fact, the achievement of these goals is still far from what was expected. This indication can be seen from the attitude of junior high school students towards mathematics itself. There is a tendency for students to consider that mathematics is an unattractive, boring, complicated and abstract science, and that mathematics is only memorizing formulas.

One example of the learning tools that is often used by the teachers is the student worksheet (LKS). In learning mathematics, the LKS is widely used to provoke the student learning activities. Through the LKS, the students will feel the moral responsibility to complete an assignment and feel compelled to do it, especially if the teacher gives full attention to the results of student work in the LKS. This is in line with what was stated by Suyitno (1997: 40) that "Student worksheets (LKS) are one of the appropriate learning alternatives for the students because the LKS helps students to add information about the learned concepts through systematic learning activities."

Based on the results of interviews with several junior high school mathematics teachers, in learning mathematics in junior high schools the teachers generally use the LKS and textbooks. However in
reality, the LKS that has been owned by students so far has not been able to help to find the concepts, because it only contains short material and questions. Besides, sometimes the presented material is also not in accordance with the applicable curriculum, and in terms of presentation it is also less interesting.

The LKS that is used generally contains verbal information about mathematical concepts and is equipped with practice questions. The used LKS tends to make the students directly work on the questions. If the students cannot answer the questions, students will look for the answers in the summary of the material in the LKS. In the use of language, the sentence structure and dictions are also less simple and sometimes do not match the level of maturity of the students, so that the students have difficulty in understanding both the statements and questions in the LKS. In fact, often, the LKS that students should do at school is forced to work at home because there is no match between the materials contained in the LKS with the available time. If this condition is allowed to continue, the function of the LKS as a teaching material that can improve the ability to think critically and creatively will not be achieved.

The polyhedron is one of the subjects in Mathematics taught in grade seventh of Junior High School. In this subject there are a variety of important concepts and principles. Based on interviews with several students, it was found that in general students had difficulty in mastering this material because it was full of concepts, principles and application of concepts.

One of the roles that can be done by the teacher is by developing learning instrument such as worksheets using the constructivism approach. With the constructivism approach the teacher is not the giver of the final answer, but only directs to form (construct) mathematical knowledge so that a mathematical structure is obtained. In the LKS is presented the questions that can guide the students in finding concepts, so that the given LKS can direct students to find the concepts. Most worksheets only present a summary of material in the form of key points, not a complete reading. With this model, the students are likened to being crammed with the facts and information only without being given the opportunity to evaluate and conclude the subject matter themselves. This summary model might be good for the students who have already read the lesson material in a textbook. This reading only teaches the students to memorize the facts without giving them an opportunity to think further.

The constructivism approach emphasizes the importance of the students reexamining the concepts which have already in their heads, then repairing them if they are not in accordance with the cognitive structure they already have in order that concept errors do not continue. In the constructivism approach, knowledge is found, formed and developed by the students, while the teacher only acts as a mediator and facilitator to form and develop knowledge itself, not to transfer knowledge [1].

This approach is used to help the students learn by connecting new experiences and information with existing knowledge into new knowledge. Changes in transformation occur through new understanding as a result of the emergence of new cognitive structures. The constructivism approach in learning mathematics is thought to motivate students to learn because the learning process is student-centered. In the learning process, the students are encouraged to be able to think critically. Therefore, learning the subject matter of Surface Area and Volume of Polyhedron is carried out using tools / media in the form of LKS.

Constructivism learning is a learning that was produced from the ideas of Piaget and Vigotsky which emphasizes more on students to actively participate in building their own knowledge. So, in this study the educator has more role as a facilitator and mediator of learning. Because the emphasis is on the active students, the learning strategy is often called student-centered teaching.

In [2] says that in the constructivism approach the students are empowered by different knowledge in themselves. Most of the time the learning process takes place based on student activities. The students are considered to have knowledge and concepts about something based on their experiences in daily life. So that, with constructivism learning, the students actively try to develop their own concepts or
knowledge gradually, perhaps by asking the teacher, discussing with friends, or reading books so that the students find the concepts that are true or almost true based on the concepts they already have.

The characteristics of constructivism learning versus traditional learning according to [3] are as follows:

Table 1. The difference between constructivism learning and traditional learning

| No. | Constructivism Learning                                      | Traditional Learning                        |
|-----|-------------------------------------------------------------|--------------------------------------------|
| 1   | Focus on in-depth learning with relevant experience         | Focus on efficiency                        |
| 2   | Demands the full involvement and active learning of students | The main approach to memorizing            |
| 3   | Skills are developed in relevant learning activities        | Skills are taught sequentially            |
| 4   | Integrated learning material, must be used and compiled by students | Learning materials are taught in logical order |

In the view of constructivism, the teacher is no longer the only presenter of information in the classroom whose purpose is to teach students to know, but as a human resource who plays an active role in preparing learning facilities and building a conducive learning atmosphere. Besides, in the learning process the teacher does not only deliver the information, but helps the students build their knowledge by using the knowledge that is already owned by the students. The results of knowledge that have been obtained by students can be evaluated by the teacher by asking questions related to the student's knowledge.

The student worksheets are sheets containing assignments that must be done by the students. The worksheet is usually in the form of instructions, steps to complete a task. [4].

According to [5] there are two LKS functions in the teaching and learning process, namely: (1) in terms of students: the LKS function is a means of learning both in the classroom, in the practice room and outside the classroom so that the students have a great opportunity to develop abilities, apply knowledge, practice skills, process itself to get its acquisition, (2) in terms of teachers: through LKS, teachers in organizing teaching and learning activities have implemented the method of "students learning" with high levels of SAL (Student Active learning). The intervention given by the teacher is in the form of answers to student questions, but in the form of a guide for students to solve problems.

Physically the LKS is in the form of worksheets that become learning facilities that must be read, understood, and done by the students to carry out a programmed activity. Based on its function, the worksheet can be used as a means of optimizing the achievement of learning outcomes and increasing student involvement in the learning process.

To produce a good LKS, it is necessary to know the techniques / requirements for drafting LKS. According to [6] there are several conditions that must be considered. The first, the didactic requirement is as one of the means for the learning process to take place, then the LKS that is compiled must follow the principles of effective learning that is the pressure on the process of finding the concepts so that the LKS serves as a guide for students to find out and show the existence of individual actions, so that a good LKS can be used to measure students' abilities. The second, the construction requirements which include the use of language that matches the level of student maturity, sentence structure, simplicity of words, learning sequence and identity to make administration easier. Third, the technical requirements which include writing, pictures and appearance of the LKS.

According to [6] to compile LKS it is necessary to consider the following criteria: 1) Referring to the curriculum 2) Materials in LKS are easy to understand 3) Can encourage students to learn and do activities 4) The suitability of the material and time available 5) Used to perform tasks or solve problems and draw conclusions 6) Used to find concepts.
The LKS with the constructivism approach is a developed LKS by using the constructivism approach in which the use of this LKS makes the students to be encouraged to learn mostly through their own active involvement with concepts and principles. LKS in learning mathematics plays an important role in presenting mathematical material that requires understanding, application, analysis, synthesis, evaluation or high-level thinking. Analysis of mathematical problems, important images in mathematics that are abstract can be assisted in the presentation through LKS. In addition, LKS can help student’s independence, save time, and stimulate the students' thinking abilities.

A self-developed LKS using the constructivism approach can be a systematic guide in learning process. Through this LKS the students can build new concepts, develop their knowledge and build student creativity and activity which can later shape the students' attitudes and responsibilities towards their learning outcomes. In addition, LKS with constructivism approach can make the students build their own meaning, not transfer meaning or knowledge, so that it can help students connect mathematical concepts with facts in everyday life.

2. Research method
This type of research was research and development. In this research, the developed product was constructivist-based LKS for the subject matter of polyhedron. To find out the effectiveness of the LKS that has been designed, a pre-experimental study with the "The One-Shot Case Study" research design was used (Sumadi, 2002: 40). In this study were observed student learning activities after participating in learning using constructivist-based LKS.

This constructivist-based LKS was developed by using the Four-Door (4-D) model. This model consists of 4 stages of development, namely the stage of defining, designing, developing, and disseminating. This research was conducted until the develop stage because of limited time and money. The procedure for developing LKS is illustrated in the diagram as Figure 1.

The data in this study were analyzed by descriptive analysis. The data on the result of the validity of LKS by experts were through validation sheets that were given very good, good, less good, and not good. Then, to determine the score and average value given by the validator for each statement item was calculated using the formula:

$$\bar{X}_i = \frac{\sum_{i=1}^{n} x_i}{n}$$

Explanation : $\bar{X}_i$ = mean of every item

$x_i$ = score given by validator-i

$n$ = number of validator

To determine mean of every aspect was assessed by

$$\bar{X}_A = \frac{\sum_{i=1}^{m} \bar{x}_i}{m}$$

Explanation: $\bar{X}_A$ = mean of every assessed item

$\bar{x}_i$ = mean of every item-i

$m$ = number of validator

The validity of the validated LKS was given a value of 1-4 with the criteria as follows:

0 – 1,00 = not valid
1,01 – 2,00 = less valid
2,01 – 3,00 = valid
3,01 - 4,00 = very valid

(adapted from [7])
The practicality analysis of the LKS was obtained from the data of the responses of the teacher and students to the LKS and observation sheet of the learning implementation. The questionnaire responses from teachers and students were arranged in the form of a Likert scale. This Likert scale was modified and arranged in a positive category so that the positive statement got the highest weight with the details as follows:

a. 4 point for statement strongly agree
b. 3 point for statement agree
c. 2 point for statement strongly disagree
d. 1 point for statement strongly disagree

![Flowchart Diagram]

**Figure 1.** The procedure for developing LKS
The practicality questionnaires were described by the technique of frequency data analysis with the formula:

\[
\text{Practicality} = \frac{\text{mean score}}{\text{maximum score}} \times 100\%
\]

The percentage data obtained were grouped according to the criteria as follows:

- 0 – 39.9% = impractical
- 40 – 54.9% = less practical
- 55 – 69.9% = quite practical
- 70 – 84.9% = practical
- 85 – 100% = very practical

(adapted from [8])

The data on the practicality of the implementation of learning with the constructivist-based LKS was processed using descriptive techniques.

3. Finding and Discussion

The significance of this study was to produce constructivist-based mathematics LKS that was valid, practical and effective. The following steps of the research were carried out based on the 4D model.

3.1 Define

Curriculum analysis was focused on SK (standard competence) and KD (basic competence) for the material of polyhedron as listed in the content standards (SI). In the material, the aims which are contained in the SK is that the students can understand the properties of the cube, cuboid, pyramid, and its parts and determine its size. The KD in this material is to calculate the surface area and volume of cubes, cuboid, prisms, and pyramid.

In this study, the subject of the trials were junior high school students, aged 12-14 years old, and were at the formal operational stage. At the formal operational stage the students are systematic and cover the complex processes. The operations were no longer limited to the things that are concrete, but can also be done on other operations. According to [9] children at the age of 12-14 years old have been able to predict a variety of possibilities. They have been able to distinguish between what happened and what should occur and can construct hypotheses. Based on the age of the cognitive level of the trial students, namely junior high school students, who are in the formal operational stage, so all forms of the student activity are in the form of activities that are in accordance with their development. The students’ activities are guided by the theory of the constructivism in which this process the knowledge is obtained by the students through experiences.

3.2 Design

The content of the LKS that is designed and developed refers to the characteristics of constructivism. The design of constructivist-based mathematics LKS includes: an introduction, an exploration activity called "Let’s Find!", a discussion activity called "Mini Laboratory" and an evaluation called "Let’s practice!"

This constructivist-based LKS design was created using Microsoft Word and Corel Draw. Constructivist-based LKS was designed in blue because the use of blue in graphic design is better and blue is easier to remember by the brain and increases work productivity. Psychologically, the blue color represents virtue and trust. Letters in constructivist-based LKS was typed using Comic sans MS type letters, because these type letters seem more relaxed, familiar, not rigid and in accordance with the age level of eighth grade students.

The constructivist-based LKS cover was created with the help of Corel Draw. The LKS cover was blue with a color display from faded blue to deep. This is so as not to show the impression of monotony. Next, there were some examples of images of geometry found in everyday life in accordance with the theme of the LKS. The writing of the LKS is curved so that it does not look blank on the top cover. The display of constructivist-based LKS was shown in Figure 2.
Figure 2. LKS Cover

The next page contains material that begins with a discourse/case and pictures of examples of objects in geometry in daily life so students can know that the material they are learning is close to daily life, then the students are asked to look for the other examples of geometry and write it at the provided points as shown in Figure 3.

Figure 3. Introduction Section

In the exploration section, it was given the short questions related to the concept of geometry that makes the students recalled the concepts that have been studied previously, so that it became new knowledge that was a temporary guessing knowledge that later they explore and investigate again at the next stage. Then, the students were asked to conclude their findings in their own language before they discussed the findings later in groups as in Figure 4.
In the discussion section, the questions were given that required the students to cooperate and practice directly, for example by taking measurements through direct manipulation of objects. In this section the students communicated the results of the investigation and findings, then presented and agreed together whether to agree or not with the opinions or results of the discussions from other groups by expressing the reasons through question and answer activities guided by the teacher as shown in Figure 5.

In the evaluation section, several questions related to the material were given, ranging from simple to difficult levels. The evaluation section could be seen in Figure 6.
3.3 Development

The LKS that has been designed was validated by experts and educational practitioners in accordance with their field of study, consisting of 3 validators, two are lecturers and one is teacher. Based on the assessing instrument of the expert validity on constructivist-based LKS, there were analyzed three aspects. The three aspects assessed by the validator are the feasibility of the content / material of the LKS, the form / presentation of the LKS, and language / readability. The results of LKS validation could be seen in Table 2.

Table 2. The Result of LKS Validation by Expert

| No. | Aspect                        | Validator 1 | Validator 2 | Validator 3 | Mean | Criteria   |
|-----|-------------------------------|-------------|-------------|-------------|------|------------|
| 1   | Content and Material          | 3.5         | 3.5         | 3.25        | 3.42 | Very valid |
| 2   | Form and presentation         | 3.6         | 3.6         | 3.6         | 3.6  | Very valid |
| 3   | Language and legibility       | 3.5         | 3         | 3.25        | 3.25 | Very valid |
|     |                               |             |             |             | 3.42 |            |

The results of the LKS validation shown in Table 2 were very valid. This was indicated by the average value of the validator at the LKS of 3.42. The validity of LKS could be seen from three aspects, namely in terms of content / material, presentation / form, and language / legibility. The validity of the LKS developed was 3.42, which meant that the LKS was valid in terms of content. The validity of presentation / form of LKS developed obtained an average value of 3.6, this showed a valid LKS in terms of presentation / form. The validity in terms of language / legibility obtained an average value of 3.25 which meant that the LKS was valid.

The constructivist-based LKS for the sub-subject of polyhedron was valid based on the results of the validator's assessment as follows: The learning indicators formulated very clearly. A good indicator has the following characteristics: (1) Contains the measured basic abilities, (2) Contains operational verbs that can be measured, (3) Relates to the material being taught, and (4) Can be made into a specific form of problems [10].

The contents of the LKS were in accordance with the material of mathematics subject in the textbooks and syllabus of grade VIII. The contents of the LKS, both theories and questions used, could facilitate the students to learn them. As stated by [11] namely (1) subject matter must be relevant to the learning objectives to be achieved, (2) subject matter must be in accordance with the level of difficulty with the
ability of students to receive and process the material, (3) subject matter must be able to support student’s motivation, (4) learning material must be able to help the students to involve themselves actively, both by thinking alone and by doing various activities, (5) subject matter must be in accordance with learning procedures, and (6) learning material must be appropriate with the available learning media.

LKS was also in accordance with the characteristics of constructivism, namely the activation of existing knowledge, learning experiences and the acquisition of new knowledge. The summary of material in the LKS could be used as initial knowledge for students. Practice helped the students gain their own learning experiences so they could construct new knowledge. The use of language in LKS could be seen in simple and clear sentences. The sentences on the LKS have used enhanced spelling (EYD). Finally, in terms of the physical form, the LKS was very interesting in terms of presentation and design.

From the observations made were obtained the data on the implementation of the LKS, teacher responses, students’ responses and students’ activities. The results of the practicality questionnaire given to the teachers were obtained from the data in Table 3 as follows.

| No. | Aspect                              | Percentage (%) | Criteria      |
|-----|------------------------------------|----------------|---------------|
| 1   | The attractiveness of the device to the student | 80,57          | Practical     |
| 2   | Ease of use and content            | 80,57          | Practical     |
| 3   | Increased student activity         | 75,03          | Practical     |
| 4   | Time efficiency                    | 78,15          | Practical     |
| Mean|                                   | 79,25          | Practical     |

According to Table 3, it could be seen that the teachers argued that constructivist-based LKS was practical in use with an average value of all aspect 79.57%.

The results of the practicality questionnaire given to the students were obtained from the data in Table 4.

| No. | Aspect                              | Percentage (%) | Criteria      |
|-----|------------------------------------|----------------|---------------|
| (1) |                                    | (2)            | (3)           | (4)           |
| 1   | The attractiveness of the device to the student | 92,40          | Very Practical |
| 2   | Ease of use and content            | 87,35          | Very Practical |
| 3   | Increased student liveliness       | 84,86          | Practical     |
| Mean|                                   | 89,14          | Very Practical |

The practicality of LKS was seen from 3 aspects, namely the attractiveness of the device to students, ease of use and content as well as increased student activity. Based on Table 4, the average score of overall practicality from the 3 aspects was 89.14% which showed that LKS was very practical to use.

Based on the results of giving questionnaires to the teachers and students about the practicality of constructivist-based LKS obtained the following description 1) the Students understood the fulfillment in the constructivist-based LKS because the instructions and steps given in the LKS quite clear. The language used is also easy to understand. 2) The design of LKS was attractive to students, seen from the way the material and pictures were presented. 3) The time provided for students to do LKS was sufficient.

The obstacle faced by the students when working on constructivist-based LKS was that the students had difficulty working on questions in the form of applications and even though there was enough available time but there were still questions that could not be worked on by the students, namely high difficulty problems. Based on the results of giving questionnaires to the students, the use of
constructivist-based LKS was already practical. This could be seen in the clarity of the LKS, language, and design.

4. Conclusion
Based on the results of data analysis, it could be concluded as follows: The first, constructivist-based LKS developed for Surface Area and polyhedron were valid with very valid criteria. The second, the constructivist-based LKS developed had practical categories according to the teacher and was very practical according to students. Furthermore, the researcher suggested several things for similar research, namely: the first, the constructivist-based LKS that has been made is expected to be used in the learning process so that it can be seen its effect on the learning outcomes. The second, repeated simulations need to be carried out to make time management more effective. The third, in learning, the teacher needs to emphasize the instructions that must be done in completing the LKS, so that the LKS can be done effectively.

References
[1] Fani Prima Ardiana, "Keefektifan Penerapan Pendekatan Kontruksivisme Terhadap Hasil Belajar Siswa Materi Pokok Trigonometri di SMA Negeri 15 Semarang Kelas X Semester 2 Tahun Pelajaran 2006/2007", Semarang: Unnes.
[2] Erman Suherman, "Strategi Pembelajaran Matematika Kontemporer", Bandung: Universitas Pendidikan Indonesia, 2003.
[3] Lufri Arlis Yuslidar Yunus Sudirman, "Strategi Pembelajaran Biologi", Padang: Jurusan Biologi, FMIPA, UNP, 2006.
[4] Depdiknas, "Panduan Pengembangan Bahan Ajar. Jakarta: Direktorat Jenderal Manajemen Pendidikan Dasar dan Menengah", 2008.
[5] Anonim, "Meningkatkan Motivasi Siswa", (online), (http://www radar semarang.com/community/artikel-untukmuguruku/2259-merangsang-kreatifitas-guru-menyusun-bahan-ajar.htm. com/2007/11/isi/-/sk Jakarta : Raja Grafindo Persada, 2007.
[6] Nita Anggaryani, "Pengembangan LKS Pesawat Sederhana yang disesuaikan dengan KBK untuk Kelas VII", Makalah komprehensi tidak diterbitkan. Surabaya: Program Pasca Sarjana Universitas Negeri Surabaya, 2006.
[7] Nana Sudjana, "Penilaian Hasil Proses Belajar Mengajar", Bandung: PT. Remaja Rosdakarya, 2005.
[8] Ngalim Purwanto, "Prinsip- prinsip dan Teknik Evaluasi Pengajaran", Bandung: Rosdakarya, 2004.
[9] Sanjaya, "Perencanaan dan Desain Sistem Pembelajaran", Jakarta : Kencana, 2008.
[10] Isra Nurmai Yenti, “Pengembangan Buku Kerja Berbasis Konstruktivisme pada Perkuliahan Kalkulus 1 di STAIN Batusangkar” (Tesis), Padang : Program Pascasarjana UNP Padang, 2008.
[11] W. S. Winkel, "Psikologi Pengajaran". Jakarta: Grasindo.sstudio, 1996.
[12] Suryabrita, Sumadi, “Metodologi Penelitian”, Jakarta: Rajawali Pers, 2002.
[13] Suyitno, Amin dkk, “Dasar dan Proses Pembelajaran Matematika, Semarang: FMIPA UNNES, 1997.