Journal of Physics: Conference Series

PAPER • **OPEN ACCESS**

Development Of *Blcs* Learning Devices Based On Traditional Or Computer Explorative Media To Improve Mathematical Problem-Solving Skills

To cite this article: Ni Wayan Ina Sukma Dewi *et al* 2020 *J. Phys.: Conf. Ser.* **1503** 012011

Journal of Physics: Conference Series **1503** (2020) 012011 doi:10.1088/1742-6596/1503/1/012011

Development Of *Blcs* Learning Devices Based On Traditional Or Computer Explorative Media To Improve Mathematical Problem-Solving Skills

Ni Wayan Ina Sukma Dewi[1], I Made Ardana[2], Gede Suweken[2]

[1]SMP Negeri 11 Denpasar, Jl. Tukad Punggawa No. 14 Denpasar, Bali, Indonesia-80229
[2]Ganesha University of Education, Jl. Udayana No. 11 Singaraja, Bali, Indonesia-81116

E-mail: sukma_ina@yahoo.com

Abstract. This study aimed to develop a valid, practical and effective BLCS learning devices to improve problem solving skills. The BLCS (Bruner's theory, Local Culture, and Scaffolding) learning devices were computer or traditional explorative media supported by lesson plans, worksheets and formative tests. This development research was based on Plomp's procedure and used research instruments in the form of observation sheets, questionnaires, interview guidelines, and description tests. In the preliminary research stage, several learning problems were found, mainly learning did not lead the students to find mathematical concepts and the exercises given were not mathematical problems. Furthermore, the prototyping phase carried out several stages such as (1) the development of initial learning devices as a solution to the problem, (2) conducting validation tests by three validators, (3) the trial limited to 12 students to obtain practicality data, and (4) the field trial I on 40 students to get practicality and effectiveness data. In the final stage, was carried out a semi-summative assessment called field trials II on 40 students and provided results in the form of a final BLCS learning devices that was valid, practical and effective. The discovery of mathematical concepts was facilitated by computer or traditional explorative media which contain real problems based on local culture and was supported by lesson plans, worksheets, and formative tests with each of their characteristics so that problem solving abilities could also be well honed.

1. Introduction

Studies by the Program for International Students Assessment (PISA) focus on students' basic level abilities in identifying, understanding and using basic mathematics in everyday life. Basic mathematics is one of them is the ability to solve mathematical problems. The first study was conducted in 2000 where Indonesia was ranked 39 out of 41 countries, in 2003 at 38 out of 40 countries, in 2006 at 50 out of 57 countries, in 2009 at 61 out of 65 countries, in 2012 at 64 out of 41 countries 65 countries, and in 2015 in 63 out of 70 countries [1]. This shows the weaknesses of students in linking formal mathematical concepts with real-world problems, so that students' mathematical problem solving abilities cannot be developed properly. In anticipation of this problem, the Indonesian government has made several changes to the curriculum, which to date has used the revised 2013 curriculum. However, this curriculum change has not been able to raise the mathematical achievements of Indonesian students in general at the international level. Preliminary observations show that the role and function of teachers in planning and implementing mathematics learning is not in line with changes in the curriculum. In fact, one important factor that can improve students' mathematical abilities is to carry out quality learning by making appropriate learning devices [2].

The development and application of realistic mathematics education (RME) based learning devices have been carried out and have given results in the moderate category, namely increasing students' problem solving abilities from an average of 69.067 to 74.5. This condition is found because of some obstacles faced by students such as lack of understanding of the problems expressed in the learning devices and lack of motivation and good direction so that some students are not focused on learning [3]. In addition, to create quality learning also requires an innovative learning, such as the use of media in learning. From the results of research that has been done, only 33.67% of teachers do problem-based learning and only 38.77% of teachers apply computers to learning [4]. In line with these conditions, related to classroom management there are 47% of elementary school teachers do not understand it well, while for secondary school teachers there are 67% of teachers do not understand it. Therefore, especially high school teachers need to pay special attention to self-evaluation [5]. This self-evaluation can be facilitated by formative tests that are used to reflect on the learning that has been done and complete the usual summative tests. This is because the use of formative-summative evaluation models provides effective results in measuring the effectiveness of teacher success in transferring knowledge [6]. Based on the problems found in the literature study, researchers are interested in directly observing in the field and interviewing several mathematics teachers and some students in secondary schools.

In the initial stages of this study found several mathematics learning problems that cause students to not be able to follow the learning well. Mathematics learning in class does not pay attention to students' initial abilities and directly direct students to abstract mathematical formulas. In addition, monotonous learning from year to year is the same without the self-evaluation by the teacher even though many changes in the conditions of students in the field, one of which is the development of the times and technology. To facilitate the problems that occur in the field as well as the problems revealed from some of the studies above, it is necessary to have a solution.

The solution to the learning problem can be done by facilitating students to find the concept of a mathematical formula independently through the given real problems. To make it easier for students to find concepts and understand given problems, problems must be presented more concretely. This facility can be designed through a local culture-based explorative learning media that is familiar with the environment and is linked to students' initial abilities. This condition is supported by the results of Jamaan's research which states that mathematical critical thinking abilities from students with high entry behavior and scientific approaches is better than direct instructional [7]. The integration of explorative media in mathematics learning has a positive influence on students' mathematics learning achievement [8]. Geogebra is a quality dynamic mathematics software that is very popular today to support media-based learning technology. The new generation of children are now ready to use technology in learning to gain cognitive knowledge, so technology must be integrated in future curricula [9]. One thing that has been done is the development of reading comprehension software programs that can help students in solving initial problems when conceptual and procedural understanding. However, it did not succeed in increasing students' mathematical achievement because it was not balanced with adequate facilities such as teachers using their own methods [10].

On the other hand, the implementation of Aceh's local culture-based learning devices can also arouse student interest so that learning becomes effective [11]. Integration of local culture to train the scientific process skills and scientific attitude are feasible to be used in the learning process [12]. Integration of local culture leads students to make analyzes in making conclusions from the knowledge found. In this process, students naturally have difficulty in solving a given problem. Scaffolding can be provided by the teacher as assistance or direction by linking student difficulties to the zone of proximal development to enhance the development of potential abilities [13]. In this case the role of the teacher or other person is needed to be the facilitator and motivator. Learning can be designed by forming heterogeneous groups based on cognitive abilities and gender to facilitate students helping each other exchange ideas in finding mathematical concepts. Furthermore, the existence of the teacher as a facilitator also provides an important role when discussions between students have not given maximum results. The decisive factors in improving the performance of mathematics teachers maximally when they combine teacher competence, mathematical talent and motivation to teach [14].

The learning model that supports this learning devices is a learning model that is oriented towards Bruner theory, local culture, and scaffolding, hereinafter abbreviated as BLCS learning model. Ardana and Gita developed a learning model of BLCS based on Bruner's theory (active, iconic, and symbolic) and local culture that caused students to be familiar with the mathematical problems faced so as to foster confidence in students [15] High confidence in the success of this learning combined with the help in the form of scaffolding so as to cause maximum effort to achieve success or lead to achievement motivation in students. With the growth of achievement motivation, students can be more persistent in learning until the goals can be achieved as planned. The use of a combination of local culture "*jengah*" concept is very effective to be used in mathematics learning. This humble conception is the foundation of the BLCS model, in addition to other Balinese conceptions of local culture in cooperative activities [16]. This conception of "embarrassment" is a Balinese local culture supported by the presentation of Mantra where it states that there are several main conceptions of Balinese culture that are used to foster cultural resilience and a foundation for the development of various aspects of community life, such as the concept of *skala-niskala*; *desa-kala-patra*; *yang lalu-kini-akan datang; tri-hita-karana; taksu* dan *jengah* [17]. The concept of ignorance in a cultural context has the connotation of enthusiasm. The concept of ignorance can be a motivator for each activity to be carried out, giving direction to the activity towards the goal to be achieved, and able to guide students to determine the actions that must be taken to align with the objectives to be achieved. Students with high motivation also consider the problem as an interesting thing, so they tend to work harder in solving problems [18]. Based on these descriptions, researchers are interested in developing valid, practical, and effective BLCS model learning devices to improve students' mathematical problem solving abilities.

2. Method

This development research aimed to develop a *BLCS* learning model. This *BLCS* learning devices was in the form of computer or traditional exploratory media supported by lesson plans, worksheets, and formative tests. This learning devices was developed so that it fits the valid, practical and effective criteria stated by Nieveen. The developed learning devices can be said to be valid if the product is of good quality, namely to focus on the material and learning approach used. The learning devices must be based on material or knowledge (content validity) and all components must be consistently linked to each other (construct validity). Furthermore, learning devices that have been developed are said to be practical if users (students and teachers) state that learning devices are easy to use in learning and there is consistency between the curriculum and the learning process. Meanwhile, learning devices are said to be effective if students succeed in the learning process and there is consistency between the curriculum, student learning experiences, and achievement of the learning process [19]. In this study, the learning devices were said to be effective if they could improve students' mathematical problem solving abilities.

The process of developing this learning devices was based on the development procedure according to Plomp (2013), namely (1) preliminary research, (2) prototyping phase, and (3) assessment phase [19]. In the preliminary research stage, an analyzing the learning problems in classroom and riviewing the literature were conducted. Furthermore, the prototyping phase carried out several stages such as (1) the development of initial learning devices as a solution to the problem, (2) conducting validation tests by three expert validator with mathematics and technology background, (3) the trial limited to 12 students of VIII B class SMP Negeri 12 Denpasar to obtain practicality data, and (4) the field trial I on 40 students of VIII E class SMP Negeri 12 Denpasar to get practicality and effectiveness data. In the final stage, was carried out a semi-summative assessment called field trials II on 40 students of VIII D class SMP Negeri 12 Denpasar and provided results in the form of a final

Journal of Physics: Conference Series **1503** (2020) 012011 doi:10.1088/1742-6596/1503/1/012011

BLCS learning devices that was valid, practical and effective. The discovery of mathematical concepts was facilitated by computer or traditional explorative media which contain real problems based on local culture and was supported by lesson plans, worksheets, and formative tests with each of their characteristics so that problem solving abilities could also be well honed.

This development research was used research instruments in the form of observation sheets, questionnaires, interview guidelines, and description tests. Interviews were used to improve the validity of the data (data triangulation) obtained from the results of questionnaires and observation sheets related to the practicality of the learning devices developed. Triangulation is a data validity checking technique that utilizes something else outside the data for checking or comparison purposes [20]. Interview questions were arranged based on needs and according to the results of questionnaires and observation sheets obtained during the implementation of learning. To collect effectiveness data in the form of students' mathematical problem solving abilities, the teacher used a description test to find out how students solved mathematical problems and expressed their thoughts in writing to the answers to the problems given. So, in this study three types of quantitative data (validity, practicality and effectiveness) were produced which were then analysed descriptively with criteria 1) minimal validation results in the valid category; 2) practicality results with minimal practical criteria; and (3) the effectiveness results seen from the score of students' mathematical problem solving abilities where at least in the good category.

3. Results and Discussion

In the preliminary research stage, it was found several learning problems that occurred in the field so that the development of the *BLCS* model of learning devices was developed as explained in the introduction. The initial design of the *BLCS* learning devices was carried out in the prototyping phase. The design of early learning devices in the form of computer or traditional exploratory media supported by lesson plans, worksheets, and formative tests. In this study, learning devices are made for learning circle material that is learned in eight meetings. *BLCS* Explorative Media facilitates students to explore using their initial knowledge. This exploration was to solve real problems based on local culture that was displayed so as to find the mathematical concepts learned. This explorative media was designed in accordance with the characteristics of learning materials where there were those using real objects based on local culture which are called traditional exploratory media like the example in Figure 1 below.

Figure 1. Examples of Traditional Explorative Media

The introduction of the combined flat area concept can be facilitated by using *pis bolong*. *Pis bolong* means hollow money in which the money is usually used as a means of payment by the people of ancient Bali. However, *Pis Bolong* is still only used as a means of cultural ceremonial equipment in Bali and is very familiar to children in Bali. In addition, there are also a number of explorative media designed with the help of geogebra software called computer exploratory media. This computer explorative media is made to facilitate the presentation of the concept of the reader, because the concept is abstract and requires high imagination. *Pengider-ider* is a Balinese cultural concept of the position of the guardian deity in every direction of the compass that forms a circle. For example, with the help of these media students are asked to connect the position of the gods in the north, middle, and northeast directions, so as to obtain the central angle of the circle, as in the example in Figure 2 below.

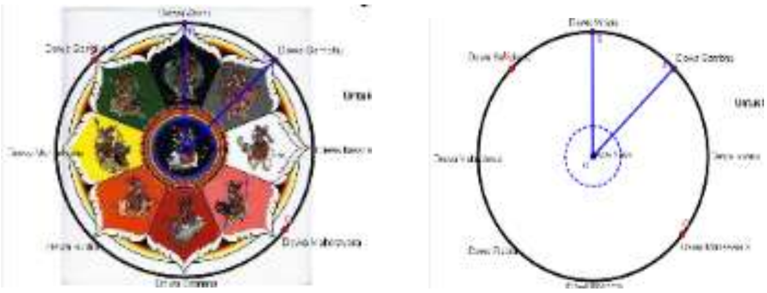

Figure 2. Examples of Computer Explorative Media

The learning devices that have been developed have met the valid, practical, and effective qualities with several advantages compared to the learning devices commonly used. The advantages of this learning device were (1) helping the students easily to find mathematical concepts as a basis for solving mathematical problems through independent and local culture-based activities that have been designed in explorative media and worksheets; (2) directing experience experienced by students in solving a problem in the form of a circle concept will have an effect on students' long-term memory, (3) making it easy for teachers to carry out effective learning because it has been guided through lesson plans combined with explorative media and worksheets; (4) explorative media based on local culture and familiar with students presented in traditional or computer form can further motivate students to find solutions; (5) this learning device can also arouse students' embarrassing conceptions. High embarrassment makes students feel more challenged to find concepts and solve problems better; (6) scaffolding in the form of assistance to the obstacles found by students during learning can facilitate students in solving problems found; and (7) formative tests make it easy for teachers to reflect on the learning that has been done through so that later learning can facilitate students to solve problems better. Besides having the advantages mentioned earlier, this learning device also has limitations, namely the material developed is limited to the circle material included in the geometry section. Therefore, the results explained in this study are still limited from one point of view, so that further development and research is needed. This is considered necessary because mathematics learning material has various characteristics. Based on the constraints and limitations of the research that has been done, as for the advice that the author can convey, namely to get results from various characteristics of mathematical material needed further development and research for other mathematical material, such as algebra.

4. Conclusions

Based on the discussion above, it can be concluded that the learning devices developed have met the valid, practical, and effective qualities with their respective characteristics, as follows. (a) the lesson plan emphasizes on checking students' initial abilities, directing learning based on Bruner's theory, arousing students' misconceptions, and facilitating teachers' scaffolding; (b) the worksheet facilitates students finding concepts and honing students' mathematical problem solving skills; (c) explorative media designed in a computer or traditional form containing real problems based on local culture to facilitate students finding concepts as the basis of solving students' mathematical problems; (d) Formative tests can release teachers from the shackles of comfort in monotonous learning so that later learning can facilitate students' better problem solving. These characteristics distinguish learning devices developed from existing learning devices.

References

[1] PISA Indonesia. (2016). Hasil PISA 2015 Membaik. *https://pisaindonesia.wordpress.com/2016/12/06/hasil-pisa-2015-membaik/* Accessed April 10 th , 2019.

[2] Fahradina, N., Ansari, B.I., & Saiman. (2014). Peningkatan Kemampuan Komunikasi Matematis dan Kemandirian Belajar Siswa SMP dengan Menggunakan Model Investigasi Kelompok. *Jurnal Didaktik Matematika.* 1(1), 54 – 64.

[3] Maulydia, S. S., Surya, E., & Syahputra, E. (2017). The Development of Mathematic Teaching Material Through the Development of Mathematic Teaching Material Through Realistic Mathematics Education To Increase Mathematical Problem Solving. *International Journal of Advance Research and Innovative Ideas In Education*, *3*(2), 2965–2971.

[4] Cvetković, B. N., & Stanojević, D. (2017). Educational Needs of Teacher for Introduction and Application Of Innovative Models In Educational Work To Improve Teaching. *International Journal of Cognitive Research in Science, Engineering and Education*, *5*(1), 49–56. https://doi.org/10.5937/IJCRSEE1701049N

[5] Delceva, J. (2014). Classroom Management. *International Journal of Cognitive Research in Science, Engineering and Education*, *2*(1), 51–56. https://doi.org/10.26417/ejms.v1i1.p201-210

[6] Divayana, D. G. H., Ardana, I. M., & Ariawan, I. P. W. (2017). Measurement of Effectiveness of a Lecturer in Transferring Algebra Knowledge Through of Multimedia Facilities By Using Certainty Factor-Formative-Summative Model. *Journal of Theoretical and Applied Information Technology*, *95*(9), 1963–1973.

[7] Jamaan, E.Z., (2017). The Effect of Scientific Approach and Prior Knowledge to Mathematical Critical Thinking Abilities Students' in Junior High School at SMPN 8 Padang. *Proceedings International Conference on Mathematics and Natural Sciences*, 93 – 97.

[8] Suweken, G. (2012). Pengembangan Mathlet Matematika Eksploratif untuk Meningkatkan Kompetensi Matematika Siswa SMP Kelas VIII di Singaraja. *Jurnal Sains dan Teknologi.* 1(2), 97 – 106.

[9] Stošić, L. (2015). The Importance of Educational Technology in Teaching. *International Journal of Cognitive Research in Science, Engineering and Education*, *3*(1), 111–114.

[10] Proudfoot, D. E. (2016). The Effect of a Reading Comprehension Software Program On Student Achievement in Mathematics. *International Journal of Cognitive Research in Science, Engineering and Education*, *4*(1), 39–48. https://doi.org/10.5937/IJCRSEE1601039P

[11] Aufa, M., Saragih, S., & Minarni, A. (2016). Development of Learning Devices through Problem Based Learning Model Based on the Context of Aceh Cultural to Improve Mathematical Communication Skills and Social Skills of SMPN 1 Muara Batu Students. *Journal of Education and Practice*, 7(24), 232 – 248. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ1112888&site=ehost-live

[12] An'nur, S., Rachmawati, L., & Misbah (2017). Development of Student Worksheets Integrated Local Wisdom to Train Scientific Process Skill and Scientific Attitude, *Proceedings International Conference on Mathematics and Natural Sciences*, 42 – 50.

[13] Chairani, Z. (2015). Scaffolding dalam Pembelajaran Matematika. *Math Didactic: Jurnal Pendidikan Matematika*, *1*(1), 39–44. https://doi.org/10.33654/math.v1i1.93

[14] Widiartana, I.P.H., Ardana, I.M., & Sariyasa (2017). The Contributions of Teacher's Competences, Mathematical Talent, and Teaching Motivation Toward Mathematic Teachers' Performance in The Implementation of Curriculum 2013 at The Elementary School of Buleleng Sub-District. *Proceedings International Conference on Mathematics and Natural Sciences*, 105 – 112.

[15] Ardana, I.M., & Gita, I.N. (2015). Pengembangan Model dan Perangkat Pembelajaran Matematika Berorientasi Teori Bruner, Budaya Lokal, dan Scaffolding untuk Siswa Sekolah Dasar di Singaraja. Singaraja: Universitas Pendidikan Ganesha.

[16] Ardana, I. M., Wisna Ariawan, I. P., & Hendra Divayana, D. G. (2017). Measuring the Effectiveness of BLCS Model (Bruner, Local Culture, Scaffolding) in Mathematics

Teaching by using Expert System-Based CSE-UCLA. *International Journal of Education and Management Engineering*, *7*(4), 1–12. https://doi.org/10.5815/ijeme.2017.04.01

[17] Ardhana. I.G.G., & Sudharta, R.T. (1990). Keserasian Transformasi Nilai dan Pembangunan Berwawasan Budaya Dalam Masyarakat Bali. Makalah Disajikan Dalam Seminar Nasional Keserasian Transformasi Nilai dan Pembangunan Berwawasan Budaya. Denpasar: Fakultas Sastra.

[18] Grajcevci, A., & Shala, A. (2017). Exploring the Link Between Achievement Goals, Motivation, and Parental Expectations among University Students in Kosovo. *Center for Educational Policy Studies Journal*, *7*(4), 147–164.

[19] Plomp, T., & Nieveen, N. (2013). Educational Design Research, Part A: An Introduction. Enschede: The Netherlands (SLO).

[20] Moleong, L. (2006). Metode Kualitatif. Bandung: PT. Remaja Rosda Karya.