Developing HOTS-Based Computer Assisted Instruction Media for Linear Program Learning Material in Senior High School

A. Najla
Mathematics Education Department
Universitas Sriwijaya
Palembang, South Sumatera, Indonesia
nys_aisyah@yahoo.co.id

N Aisyah
Mathematics Education Department
Universitas Sriwijaya
Palembang, South Sumatera, Indonesia.

Meryansumayeka
Mathematics Education Department
Universitas Sriwijaya
Palembang, South Sumatera, Indonesia.

Abstract— **The existing curriculum emphasizes learning process on higher order thinking skills and to use ICT in learning. Therefore, it is necessary to develop CAI media HOTS-based in learning. This study is kind of development research that aims to produce a valid and practical CAI media based on Higher Order Thinking Skills (HOTS) criteria for linear program learning material, and has a potential effects for Senior High School students' mathematical learning process. The method consists of two stages, preliminary and formative evaluation consisting of expert reviews, one to one, small group, and field test. Subjects involved in this research were 33 students from Srijaya Negara Palembang Senior High School. The results showed that CAI media developed based on HOTS for linear program material has a power point integrated with Geogebra. It was categorized into a valid and practical media and has a potential effects. It is used for four meeting sessions, in which the media consisting of HOTS question for each meeting.**

Keywords: CAI media, HOTS, linear program

I. INTRODUCTION

The 21st century skills require higher order thinking skills [1-3]. In Indonesia, this higher order thinking ability is one of curriculum demands that have to be applied into the learning process [1]. The other, curriculum demand to use ICT in learning process, which requires students to know the importance of information, media, and communication information technology [4-7]. Using ICT media in learning can take the form of Computer Assisted Instruction (CAI) [8].

Prior studies stated that Indonesia students' higher order thinking skills are still low [9, 10]. It is seen from the results of PISA and TIMMS, the average value of Indonesia is unsatisfied. The results of PISA in 2015 [11] showed that Indonesia was at 63 in the mathematics field. Whereas based on the 2011 TIMSS results [12], Indonesia was ranked 38 out of 42 countries by obtaining an average score of 386 below the average international score of 500. The percentage of correct answers on aspects of content that had the lowest score was algebra at 22% [13].

Judging from the low content of algebra in PISA, it shows that algebra is one of the most difficult material, especially linear program material. Based on the problems, researchers are interested in developing HOTS-based CAI media for linear program learning material in senior high school.

II. METHOD

The research method in this study used the development research that purposed to produce CAI media that is valid, practical, and have potential effects. Data were analyzed qualitatively. This research focuses on two stages, namely the preliminary stage and the formative evaluation stage.
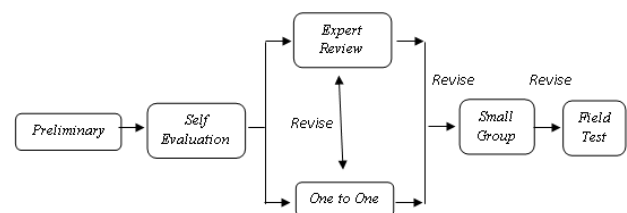

Fig. 1. Flowchart of development studies [14].

In the preliminary stage, researchers plan, collect, and prepare all the things that will be done at each stages. Preliminary consists of two stages, namely the analysis stage and the design stage. At the analysis stage, researchers conduct student analysis, curriculum analysis, core competencies, basic competencies, and learning objectives that are in line with the 2013 revised high school curriculum 2013. Next, the researcher designs the problem to be presented, learning objectives, learning model, and determination of the right media to use.

Formative evaluation consists of five stages, namely self-evaluation, expert review, one to one, small groups, and field

tests. Formative evaluations have their respective goals at each stage. In the first stage, self-evaluation aims to conduct analysis and design of the media to be developed so as to produce prototype 1. After that the product is validated by 3 validators named M, EK, and B, then tested on 3 students who are not the subjects of the study named R, D, and A from XII IPA 1 of 13 Senior High School Palembang, which aims to obtain a prototype 2 is a valid product. The next stage of the prototype 2 product was tested on 2 small groups XII IPA 2 of 13 Senior High School Palembang to obtain prototype 3 in the form of a practical product. So after doing the four stages the product is applied to learning in the classroom. CAI media that have been developed are applied in XI IPS 2 Srijaya Negara Senior High School Palembang. Data collection techniques used were interviews and tests.

III. RESULTS AND DISCUSSION

Analysis of the results in this study is preliminary stage and formative evaluation stage.

A. *Preliminary*

Preliminary consist of two stages, analysis and design.

B. *Analysis*

In this study, the first stage carried out was the analysis which included student analysis, curriculum analysis, and material analysis. Researchers conducted research in XI IPS 1 of Srijaya Negara Senior High School Palembang, in this case the mathematics lesson was taught by Mrs. STN. That class numbered 33 students, consisting of 13 men and 20 women. Mathematical material was be taught every 2 times a week with each meeting as many as 2 meetings. In learning, teachers usually use the expository method and very rarely use ICT media. The curriculum used is 2013 curriculum. In this study, Linear program material was used by researchers to be tested on students so that the core competencies and basic competencies of the linear program material for XI senior high school were adjusted to the 2013 curriculum.

C. *Design*

Researcher designed CAI media, problems, and activities questions. CAI media developed are in the form of power points that are integrated with Geogebra. Power points are developed interactively so students can operate on their own while learning in the class. The media that will be developed consists of four meetings. Problems developed based on HOTS indicators, namely analysis, evaluation, and creation. In presenting problems, researchers also design problem solving questions that become student activity sheets, so it is expected that students can be helped in solving the problems presented. The designed CAI media is called prototype 1.

D. *Formative Evaluation*

Formative evaluation consist of five stages, Self Evaluation, Expert Review, One to One, Small Group and Field Test.

1) *Self Evaluation*

Researchers review the suitability of basic competencies, indicators, and learning objectives. The suitability of the questions that have been developed is based on the HOTS indicator, and then suitability of the problem solving steps that are presented with the stages of problem solving.

2) *Expert Review*

Researcher validated to 3 validators so generate several comments, such as presentation of problems made in the form of images, the media were exported in a stand-alone form so that students could not see the next slides, at the meeting there should be C4, C5, C6, for example meetings-1 consists of C4, C5, meeting-2 consists of C5, C6, and so on, then use video's instructions.

3) *One to One*

Result from validator revised then tested to 3 students, which generates some comments which can be seen in the table below.

TABLE I. COMMENT AND DECISION ON REVISION AT ONE TO ONE STAGE

Comment/Suggestion	Revision Decision
Slide total on the "animal feed" problem, which is 2 slides makes students difficult to understanding the problems	Slide total is changed to one slide
Numbers at the animal feeds problem generate final results with decimal values and numbers that used are considerable	Numbers are changed into round value. But the numbers are not reduced because will not be corresponding with the context of "animal feed"
-	Based on observation when the process of using CAI media, students need a tutorial to shading the settlement area on the geogebra.

Table 1 shows experts opinion about HOTS problem in CAI media developed. They suggested to considered students' view in understanding problem given. They also criticized about numbers used. They argued that HOTS problems are not always difficult problems that make students difficult to understand problem or difficult in doing calculation. Their opinions were used as base to revise CAI media. The revised media become the second prototype of HOTS- based CAI media.

TABLE II.   REVISED CAI MEDIA FROM PROTOTYPE 1 TO PROTOTYPE 2

Prototype 1	Prototype 2
Rules of activities use	
Presentation of setting line form tutorial	
Presentation of each problems	

After validating at the expert review stage and testing at the one to one stage, the researchers revised the CAI media so as to produce a prototype 2 that would be tested at the small group stage.

4) Small Group

This trial was conducted to 2 groups, each consisting of 2 students. The results of this trial produce some comments or suggestions given by students which can be seen in the table below.

TABLE III.   COMMENT AND DECISION REVISE AT SMALL GROUP STAGE

Comment / Suggestion	Revision Decision
In the problem of the android context, researcher observes that the students feel confused because the final result of the students answers is decimal numbers	Numbers are changed

After conducting a trial at the small group stage, researchers revised the CAI media so as to produce a prototype 3 that the researchers would use in classroom learning to see the potential effects of the HOTS-based CAI media that had been developed on student learning result.

5) Field Test

Field test were carried out to trials the product to a larger scope which was useful to see the potential effects of CAI media. Field test conducted in 4 meetings, for 3 meetings students study in the computer laboratory, so that each student

can use the CAI media by themselves. In addition, at each meeting students were given linear program HOTS problems to train them in higher-order thinking. At the last meeting a test is conducted. The results of these tests indicate that the most dominant ability to appear in linear program material using HOTS-based CAI media is the ability to analyze.
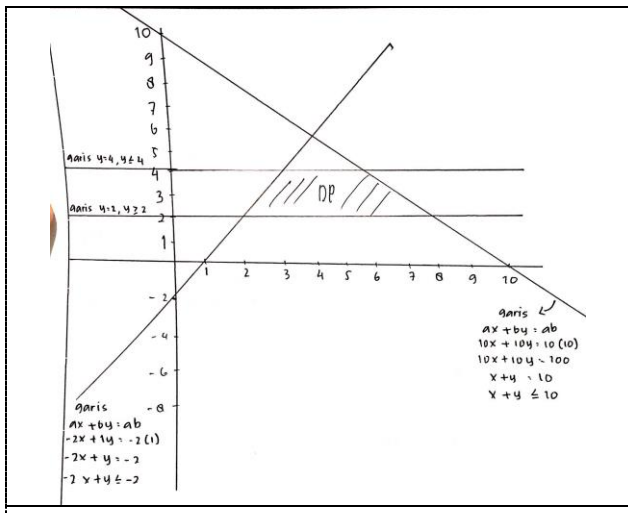

Fig. 2. Student answers that create a new problem from previous experience

Figure 2 shows that students are able to create a new problem because students are able to make a system of inequality correctly from the pictures that have been made before.
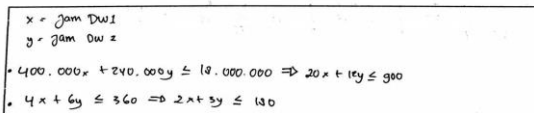

Fig. 3. students' answers who make mathematical models of contextual problems

Figure 3 shows that students are able to analyze the problems in the question and are able to make mathematical models from the information provided
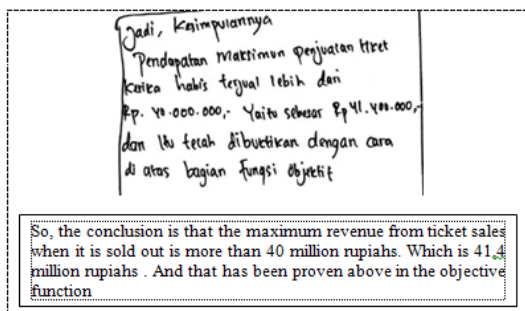

Fig. 4. students' argument who are able to give opinions about the truth

Figure 3 shows that students are able to provide arguments for the truth of their opinions based on the calculation of the answers they have made before.

Figure 1-3 is the answer of one student from each indicator. Based on the results of expert review, one to one, and small groups, HOTS-based CAI media is valid and practical for learning mathematics in class. CAI media that is applied to mathematics learning can improve students' ability to think at a higher level. In addition, improve the effectiveness of students in understanding classroom learning. This is corresponding with some research results which state that the media can improve the effectiveness of learning mathematics and science in the classroom [15-18]. Meanwhile, based on Bhatti's research result [19], the developed CAI media can produce diverse products for different levels of student ability to improve abilities in the learning process and facilitate in the classroom. Correspondingly, another opinion states that CAI media can improve learning on a variety of materials in the field of education [20] and can improve student learning outcomes and students' assessments [21].

IV. CONCLUSION

Based on the research results, CAI media that have been developed are declared into a valid media by the validator in terms of content, constructs, and language and based on the results of the one-to-one stage. In addition, CAI media have been considered into practice media based on the results of small group stage and have potential effect that seen from the appearance of students' ability to think at a high level in solving problems using the CAI media.

REFERENCES

[1] Pratama G S & Retnawati H 2018 Journal of Physics: Conference Series vol 1097 p 012147

[2] Fakhomah D N & Utami M S 2019 International Journal of Indonesian Education and Teaching (IJIET) vol 3 41-49

[3] Nofrion N & Wijayanto B 2018 Geosfera Indonesia vol 3 122-130

[4] Dube S 2017 International Robotics & Automation Journal vol 3 1

[5] Yen T S & Halili S H 2015 The Online Journal of Distance Education and e-Learning vol 3 41-47

[6] Ball A J H D & Butcher A D 2016 International Journal of School Social Work vol 1 1

[7] Wahyuni, S 2016 International Journal of Learning and Teaching vol 2 117-120

[8] Sahid 2010 Pengembangan Media Pembelajaran Berbasis ICT

[9] Asma N 2018 Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Higher Order Thinking Skill (HOTS) Pada Pembelajaran Matematika Kelas V SD Negeri 2

[10] Kusuma M D 2017 IOSR Journal of Research & Method in Education (IOSR-JRME) vol 7 26-32

[11] OECD 2018 PISA 2015 Results

[12] Mullis M O 2012 TIMSS 2011 International Results In Mathematics

[13] Shodiq L J Dafik & Tirta, I M 2015 Analisis Soal Matematika TIMSS 2011 dengan Indeks Kesukaran Tinggi Bagi Siswa SMP

[14] Tessmer M 1993 Planning and Conducting Formative Evaluations: Improving The Quality of Education and Training. (London: Kogan Page)

[15] Brophy K A 1999 Is computer-assisted instruction effective in the science classroom? pp 1-54

[16] Carter M B 2004 An analysis and comparison of the effects of computer-assisted instruction versus traditional lecture instruction on student attitudes and achievement in a college remedial mathematics course (Doctoral dissertation, Temple University).

[17] Yesilyurt M 2010 Turkish Online Journal of Educational Technology-TOJET vol 9 123-131

[18] Ahiatrogah P D Madjoub M B & Bervell B 2013 Academic journal of interdisciplinary studies vol 2 77

[19] Bhatti Nirupma Pareek Sarla & Dhamija Neelam 2014 Journal of International Academic Research for Multidisciplinary vol 2 159-164

[20] Ranade M D 2006 International Journal of Science and Mathematics Education vol 4 763-789

[21] Berman N B Fall L H Maloney C G & Levine D A 2008 Advances in Health Sciences Education vol 13 373-383