HOTS Android-Based student worksheets to practice creative thinking ability of vocational school students

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Abstract. This study aims to describe the development of an Android-based HOTS Student Worksheet to train the creative thinking skills of vocational students. The type of research used is Research and Development (R & D) using the ADDIE model which consists of five stages: 1) analyze, 2) design, 3) development, 4) implementation, and 5) evaluation. The research subjects were class XI students in Online and Marketing Business (BDP) majoring in SMK Negeri 1 SekarBojonegoro, totaling 33 students. The research instruments used were learning media validation sheets, test questions, and student response questionnaires. The results of this study are HOTS-based Android LKS learning media that meet very valid criteria with an average of 90.22%, practically with an average student response questionnaire of 80.30% and effective to train creative thinking skills of class XI students of linear program material. Keywords: HOTS, Android, Creative Thinking Ability

1. Introduction
Creativity is one component that contributes to life in the future [1]. Therefore the ability to think creatively is most needed competencies in the 21st century. Creative thinking is the ability to produce new perspectives, mindsets, ways or ideas in solving problems. The ability to think creatively is needed in the development of the process learning mathematics. The ability to think creatively can support and develop problem-solving abilities[2]. The formation of a creative pattern attitude is the most important thing from the goal of mathematics learning. The 2013 curriculum requires students to think creatively in solving mathematical problems[2], [3]. Students who have the ability to think creatively will feel free to issue ideas that are owned and easily solve existing problems.

Based on TIMSS (2015), Indonesia is ranked 45th out of 50 participating countries with a math score of 397 points. Most students still experience difficulties when solving problems that require high-order thinking, especially relate with linear programs. Often linear program questions are presented in the form of stories in the long language so that students difficult for understanding the intent of the questions[4]. This statement was strengthened by the results of observations at SMK Negeri 1 Sekar in class XI students who showed as many as 25 students or 76.00% of students could not reach the KKM. This is due to the lack of training in solving linear program problems so that students' creative thinking abilities are less developed[5].

One way to improve students' creative thinking skills is by using learning media[6]–[8]. Learning media functions and is used to carry messages to students that contain lesson concept material that makes it easy to understand the subject matter in realtime[9]. Learning media can attract students' attention to
their appearance[10], and can foster emotional awareness and attitudes towards learning and teaching material.

Learning media can be presented in various forms such as applications, teaching aids, textbooks, and so on. In this study, the media developed in the form of student worksheets oriented Higher Order Thinking Skills (HOTS) which can be operated on an Android smartphone. The use of smartphones is recommended in learning to facilitate and encourage the creative process[11]. Media development is intended to train students' creative thinking skills.

The development of android-based learning media has been widely carried out both for school students and students[12]–[17]. However, the development of android-based learning media for mathematics that is focused on increasing the creative thinking of students, especially vocational students, is still not widely done.

Android-based learning media is intended so that students can learn wherever and whenever, and can study harder. Thus students can train their creative thinking skills intensively. The ability to think creatively is not easily possessed by students without perseverance and continuous practice[6]. In line with the research[18] which said that the development of android-based learning media using the inventor app can improve student learning outcomes. However, the use of the application still has a number of weaknesses, including (1) the learning video must be opened online, (2) unable to display the score, and (3) the selection of answers must be typed on. Therefore, it is necessary to develop similar learning media by paying attention to and correcting these weaknesses.

Therefore, there need to be a learning media that can support students in training their creative thinking skills and can make students more enthusiastic in participating in mathematics learning especially in linear program material. Researchers try to develop learning media that can be run offline so that it can be used anytime and anywhere without depending on internet connection. In addition, android-based electronic worksheets can display the results of student learning tests.

1.1. Higher Order Thinking Skill (HOTS)
HOTS is a method of thinking someone who is higher than just memorizing and expressing facts, or simply applying a procedure, regulation, or formula but requires someone to think analytically, creatively, critically about information and data in solving the problem[19]–[21]. High-level thinking skills need to be trained to students in order to solve problems well. One of the high-level thinking skills is the ability to think creatively.

1.2. Android-Based Media
Android is a platform open-source designed for devices mobile, android provides all the tools and frameworks for developing applications mobile quickly and easily[22]. Android is an operating system for devices mobile Linux-based that includes operating systems, middleware, and applications. Android-based media is a media in the form of applications that are extension *.apk and can be run or operated on android devices[23].

1.3. Creative Thinking
The ability to think creatively is a person's capacity to foster original ideas and expand the knowledge gained to create new things[24]. The ability to think creatively in solving math problems includes fluency (ability to give many answers or many statements to solving problems), flexibility (ability to use a variety of resolution strategies), novelty (ability to use new strategies), detail.

2. Research Method
This is research and development aims to develop android-based learning media. Learning media developed are HOTS based Android LKS for students of class XI Vocational linear program material. The study was conducted at SMK Negeri 1 Sekar in class XI Online and Marketing Business (BDP).

The development model used is ADDIE (analysis, design, development, implementation, and evaluation) developed by Reisser and Mollenda (1990). The analysis phase aims to determine the need
for the development of learning media, includes observation of the conditions of learning facilities, teachers and students. Design is the planning framework of instructional media that aims to prepare prototype learning device. Development phase is the stage of development of instructional HOTS android based student worksheet which further validated the design and study about the test results, and revised in accordance with suggestions validator. At the implementation phase of HOTS Android-Based Student Worksheet applied to the BDP class XI student of SMK Negeri 1 Sekar number of 33 students, followed by an achievement test. Before the application of the HOTS Android-Based Student Worksheet, learning was done conventionally and continued with the learning outcomes test to determine the students' initial abilities. Phase evaluation is done by the analysis of the feasibility of media.

2.1 Validity Analysis of HOTS Android-Based Student Worksheet.

The reference used to determine the level of validity HOTS Android-Based Student Worksheet adopts the data analysis formula proposed by Akbar (2013) as follows.

\[ V = \frac{TSh}{TSe} \times 100\% \]

Description:
- \( V \): Percentage of validity
- \( TSh \): Total empirical score (maximum number of scores)
- \( TSe \): Total expectation score (number of assessment scores by validator)

This research and development involve 3 experts as validators. So to find out the overall percentage, the researcher calculates the combined validity with the following formula:

\[ V = \frac{V_1 + V_2 + V_3}{3} = \ldots \% \]

The criteria validity is shown in Table 1 below:

| Criteria Validity | Level Validity |
|-------------------|----------------|
| 85.01% - 100.00%  | Very valid, or can be used without revision |
| 70.01% - 85.00%   | Quite valid, or can be used but needs to be revised small |
| 50.01% - 70.00%   | Less valid, it is recommended not to use because it needs a large revision |
| 01.00% - 50.00%   | Invalid, or may not be used |

In this study, the validity criteria in the range of 70.01% - 85.00% as the minimum validity limit.

2.2 Practical Analysis of HOTS Android-based Student Worksheet.

The practicality test of learning media is done by giving questionnaires to students. Questionnaire for the practicality of learning media consists of a range of scores between 1 and 4. Scores consist of 4 types of options namely Strongly Disagree (STS), Disagree (TS), Agree (S), and Strongly Agree (SS). Scoring the answer option takes into account the statements in the questionnaire. The statement in the questionnaire consists of 2 forms, namely positive and negative statements. The number of scores which are the result of assessment by students is then held to determine the level of practicality. The formula used is as follows.

\[ P = \frac{\sum X}{N} \times 100\%, \quad NA = \frac{\sum P}{n} \]

Description:
- \( P \): Percentage score
- \( \sum X \): Number of scores
- \( N \): Maximum score
- \( NA \): Final score
- \( n \): Multiple points of the statement

Practicality tests were carried out using student response questionnaires and analyzed using Hobri practicality criteria, which are shown in Table 2 below:
Table 2. Practicality Criteria

| Percentage (%) | Practicality Criteria |
|----------------|----------------------|
| 75 ≤ P < 100   | Practical            |
| 50 ≤ P < 75    | Practical Enough     |
| 26 ≤ P < 50    | Less Practical       |
| P < 26         | Not Practical        |

In this study, practicality criteria ≥ 75% as a practical limit.

2.3. Analysis of the effectiveness of HOTS Android-based Student Worksheet.

The effectiveness of HOTS Android-based Student worksheet can be seen from the increase in the level of Creative Thinking Ability (TKBK) before and after the application of learning media. This learning media is effective if there is an increase in student TKBK. TKBK is obtained from the analysis of learning outcomes tests before and after students use HOTS based Android worksheets in learning. The TKBK classification of students is based on the following criteria.

Table 3. Level of Creative Thinking Ability (TKBK)

| Level                  | Description                                                                 |
|------------------------|-----------------------------------------------------------------------------|
| Level 0 (Not Creative) | Students cannot show all aspects of creative thinking in solving            |
| Level 1 (Less Creative)| Students are able to show one aspect of creative thinking in solving        |
| Level 2 (Quite Creative)| Students are able to show two aspects of creative thinking in solving       |
| Level 3 (Creative)     | Students are able to show three aspects of creative thinking in solving      |
| Level 4 (Very Creative)| Students are able to show all aspects of creative thinking in solving       |

Source: [25]

3. Results and Discussion

Android-based HOTS student worksheet learning media are feasible and can be used if they meet the three development criteria, that are validity, practicality, and effectiveness.

3.1 Analysis

The results of the observations found several reasons for the need for the development of an HOTS Android-based student worksheets. Based on the observations, there were several reasons for the need for the development of an Android-based HOTS LKS, including 1) students did not have a handbook, 2) did not have a library, 3) students not having much reference, so that lack of training in solving HOTS-based problems, 4) and found all students of class XI BDP have smartphones that are often used to send messages and play android-based games.

3.2 Design

Based on the analysis, HOTS android-based student worksheet is based on linear program material as developed. The following is design of HOTS Android-based student worksheet.

Table 4 HOTS-based Student Worksheet design based on Android

| No. | Figure | Description                                                                 | No. | Figure | Description                                                                                                                                 |
|-----|--------|-----------------------------------------------------------------------------|-----|--------|---------------------------------------------------------------------------------------------------------------------------------------------|
| 1.  | ![Image](initialview.png) | InitialView The initial display contains the competency button, you know, teaching materials, examples of questions, evaluations, and about which are integrated with the next menu display. | 2.  | ![Image](displayofcompetencies.png) | Display of Competencies Display competencies containing core competencies, basic competencies, indicators, and learning objectives. |
3. Display of Teaching Materials
The display of teaching materials contains linear program material and accompanied by video examples of work on linear program problems.

4. Pen
Display The pen display contains a blank page that has 5 pen color options. This page is intended as a medium for students to draw graphics.

5. Display of Sample Questions
The display of the sample questions contains examples of linear program problems that are accompanied by an explanation of the steps in writing.

6. Evaluation view after filling in the name and pressing the button start training. There are 10 questions and 5 choices of answers on each question.

HOTS based-android student worksheet can be run online or offline with a minimum of a smartphone Android version 4.1 (Jelly Bean). When running online, this learning media can send the evaluation results to a predetermined e-mail. In addition, the Android-based HOTS student worksheet can go to the previous page just by shaking the smartphone that the student has, except on the "Pen" page.

3.3 Development
In the development stage, HOTS-based student worksheet learning media was validated by experts and practitioners. It aims to determine whether or not the HOTS-based LKS is based on Android so that it can be determined whether or not revisions. In addition, validation is used to conclude that an Android-based HOTS LKS can be used or not.

3.3.1 The validity of HOTS Android-based student worksheet. HOTS student worksheet media is valid if the average validation aspect shows a percentage of more than 70.00%. The following are the results of validation from media experts and practitioners.

| No. | Validator | Total expectation score (TSh) | Total empirical score (TSe) | Percentage of Validity | Percentage of Validity Combined |
|-----|-----------|-------------------------------|-----------------------------|-------------------------|--------------------------------|
| 1.  | I         | 68                            | 75                          | 90,67%                  | 90,22%                        |
| 2.  | II        | 69                            |                             | 92,00%                  |                                |
| 3.  | III       | 66                            |                             | 88,00%                  |                                |

Based on Table 5. It can be concluded that Android-based HOTS worksheets was stated to be very valid. However, still there are suggestions for improvement by practitioners. This aspect of improvement shown in Table 6 below.

3.4 Implementation
HOTS based Android student worksheet was used as a learning media in the XI class of BDP. First, learning using HOTS based Android worksheets and followed by learning outcomes tests. The second, HOTS Android-based student worksheet was used as a learning media and continued with tests. After using HOTS Android-based worksheet, students were asked to respond through a questionnaire.
3.5 Evaluation

The evaluation is done to assess HOTS student worksheet based on android. The assessment includes the practicality, and effectiveness of media. The following is a more complete description.

3.5.1 The practicality of HOTS Android-based Worksheet can be used if it meets the practical criteria of ≥ 75%. The results of the questionnaire responses of 6 students were obtained = 73.98% or stated as quite practical. The results of the 27 student responses questionnaire were obtained = 82.01% or stated practically. Overall, it can be concluded that HOTS-based Android LKS meet criteria Practical.

3.5.2 The effectiveness of Android-based HOTS LKS on HOTS based Android. LKS is declared effective if students' thinking abilities increase with a percentage> 50% of the total. Learning outcomes tests are carried out before and after students learn linear program material using learning media HOTS based Android.

The test results, there are 76% of students at TKBK Level 0, and 24% at TKBK Level 1. It can be concluded that the ability to think creatively is not owned by students. Then a repeat test was carried out after students were treated with HOTS Android-based student worksheet media. The written test was conducted twice to determine the improvement of students' creative thinking skills before and after the application of Android-based HOTS student worksheet. The results of the written test after the application of the HOTS Android-based student worksheet55% of students at TKBK 0, 24% TKBK 1, 15% TKBK 2, 6% TKBK 3, and 0% TKBK 4. Increasing students' creative thinking skills can be known by comparing TKBK before and after the application of HOTS Android-based student worksheet. The increase of student creative thinking after applied ofHOTS Android-based student worksheet amount 11 students. Thus, there is an increase in creative thinking skills of 33.33% of the total number of students.

The Android-based HOTS LKS received a very valid assessment from media experts, material experts, and practitioners. This shows that HOTS-based Android student worksheet can be applied in mathematics learning. This media designed in the form of an application so that can be accessed from an Android smartphone. This allows students to easily access this application. Students can easily learn linear program material in this HOTS worksheet. Content in media allows students to learn material easily and can repeat freely until students can understand the material. Thus students are accustomed to working on HOTS problems using this media. The results of the analysis showed a positive response to the application of HOTS worksheets.

In general, HOTS-based Android LKS learning media can train students' creative thinking skills. As for the factors that lead to creative thinking students can be trained, among others: 1) student learning hours increase, because HOTS-based Android worksheet practically brought along and can be used wherever and whenever, 2) HOTS based Android worksheet there are examples of contextual questions both written and in video form, so students are interested in learning it, 3) on HOTS-based Android LKS there are practice questions accompanied by scores, so students can find out their abilities in solving linear program problems, 4) Android-based HOTS LKS can send scores to subject teachers through google document without the knowledge of students when working online, so the teacher can follow up on the scores that have been obtained.

The results of this study in line with[18], [26] that android learning media is effective for increasing HOTS, wherein HOTS there are several aspects, one of which is the ability to think creatively. HOTS student worksheet has a positive influence on improving student learning outcomes[27]. Analysis of students' creative thinking skills shows that aspects of fluency, flexibility, and detail have been fulfilled by students, although not many students have fulfilled these aspects. This shows that HOTS-based Android LKS learning media have been able to train students' ability to think creatively. However, in the novelty aspect, no student has been able to bring up newness in solving problems related to linear programs. The HOTS Android-based HOTS LKS developed has not been able to bring up new ideas for students related to the completion of HOTS questions. Examples of questions presented in the media are still very limited. It is necessary to present examples of HOTS problem solving which give rise to a variety of resolution strategies. Course activities such as seeing examples of professional work, lectures, student presentations, discussions, and reading help to identify a body of work within a creative discipline. Students frequently cited these features as facilitating their own creative process skills[28].
Students' experience of problem-solving with various methods of settlement can inspire and open up students' insights to find diverse solutions. Thus the ability to think creatively especially in the novelty aspect can be honed.

4. Conclusions and Suggestions

Based on the results of the study it can be concluded that the HOTS-based Android student worksheet very valid according to media experts, material experts and practitioners with a combined average value of 90.22%, practical according to students with an average value of 80.30% and can improve creative thinking skills of class XI students of Vocational School. An increase in students' creative thinking skills is optimal i.e. 33.33% of students whose Creative Thinking Rate (TKBK) has increased. Therefore further research is recommended to develop similar media by paying attention to the weaknesses in this HOTS Android-based student worksheets. The recommendation for future research is by adding the exercise on the media, give the open-ended problems in order to the creative thinking students ability can be improved on the novelty aspect.

References

[1] J. Voogt, O. Erstad, C. Dede, and P. Mishra, “Challenges to learning and schooling in the digital networked world of the 21st century,” J. Comput. Assist. Learn., vol. 29, no. 5, pp. 403–413, 2013.

[2] S. M. Wechsler et al., “Creative and critical thinking: Independent or overlapping components?,” Think. Ski. Creat., vol. 27, no. November 2017, pp. 114–122, 2018.

[3] S. Maharani, T. Nusantara, A. Rahman, and A. Qohar, “Analyticity and Systematicity Students of Mathematics on Solving Non-routine Problems,” Math. Stat., vol. 7, no. 2, pp. 50–55, 2019.

[4] H. Ahmad, Nurhidayah, and Nurdin, “Analisis Kemampuan Siswa Dalam Menyelesaikan Soal Cerita Pokok Bahasan Program Linear,” J. MathEducation Nusant., vol. 1, no. 1, pp. 20–24, 2018.

[5] Amidi and M. Z. Zahid, “Membangun Kemampuan Berpikir Kreatif Matematis Dengan Model Pembelajaran Berbasis Masalah Berbantuan E-Learning,” Semin. Nas. Mat. X Univ. Negeri Semarang 2016, pp. 586–594, 2016.

[6] R. Hu, Y. Y. Wu, and C. J. Shieh, “Effects of virtual reality integrated creative thinking instruction on students’ creative thinking abilities,” Eurasia J. Math. Sci. Technol. Educ., vol. 12, no. 3, pp. 477–486, 2016.

[7] H. W. H. Eny, U. E. Rizky, and R. R. Maya, “Pengembangan Media Pembelajaran Puzzle Card untuk Meningkatkan Kemampuan Berpikir Kreatif Siswa,” Semin. Nas. Pendidik. Sains V, no. November, pp. 30–34, 2015.

[8] D. Sudiantini and N. D. Shinta, “Pengaruh Media Pembelajaran Terhadap Kemampuan Berpikir Kreatif Dan Penalaran Matematis Siswa,” J. Penelit. dan Pembelajaran Mat., vol. 11, no. 1, pp. 177–186, 2018.

[9] Rozak, Darmadi, and Wasilatul, “Pengembangan Media Pembelajaran Sasa-Aura untuk Meningkatkan Prestasi Peserta Didik SMK Cendekia Madiun Tahun Ajaran 2017/2018,” Didakt. J. Pendidik. dan Ilmu Pengetah., vol. 18, no. 1, pp. 31–50, 2018.

[10] W. R. Widjayanti, T. Masfingatin, and R. K. Setyansah, “Media Pembelajaran Interaktif Berbasis Animasi Pada Materi Statistika Untuk Siswa Kelas 7 Smp.,” J. Pendidik. Mat., vol. 13, no. 1, pp. 101–112, 2018.

[11] N. McGreen and I. Arnedillo-Sánchez, “Mobile Phones: Creative Learning Tools,” in LA DIS International Conference Mobile Learning 2005, 2005, pp. 241–245.

[12] R. Yektyastuti and J. Ikhsan, “Pengembangan Media Pembelajaran Berbasis Android pada Materi Kelarutan untuk Meningkatkan Performa Akademik Peserta Didik SMA Developing Android-Based Instructional Media of Solubility to Improve Academic Performance of High
School Students,” *J. Inov. Pendidik. IPA*, vol. 2, no. 1, pp. 88–99, 2016.

[13] S. Fatimah and Y. Mufti, “Pengembangan Media Pembelajaran IPA-Fisika Smartphone Berbasis Android Sebagai Penguat Karakter Sains Siswa,” *J. Kaunia*, vol. X, no. 1, pp. 59–64, 2014.

[14] M. A. Zaus, R. E. Wulansari, S. Islami, and D. Pernanda, “Perancangan Media Pembelajaran Listrik Statis dan Dinamis Berbasis Android,” *INTECOMS J. Inf. Technol. Comput. Sci.*, vol. 1, no. 1, pp. 1–7, 2018.

[15] H. H. Batubara, “Pengembangan Media Pembelajaran Matematika berbasis Android untuk Siswa SD/MI,” *Muallimuna J. Madrasah Ibtidaiyah*, vol. 3, no. 1, pp. 12–27, 2017.

[16] D. Setyadi, “Pengembangan Mobile Learning Berbasis Android Sebagai Sarana Berlatih Mengerjakan Soal Matematika,” *Satya Widyat*, vol. 33, no. 2, pp. 87–92, 2017.

[17] T. N. H. Yunianta, A. Putri, and D. Kusuma, “Development and Comparison of Mathematical Mobile Learning By Using Exelearning 2.0 Program and Mit Inventor 2,” *Infin. J.*, vol. 8, no. 1, p. 43, 2019.

[18] F. Mobarok, “Pengembangan Media Pembelajaran Berbasis Mobile Application Menggunakan App Inventor Pada Mata Pelajaran Mekanika Teknik Untuk Siswa Kelas X Studi Keahlian Tgb Smk Negeri 3 Yogyakarta,” 2015.

[19] S. M. Brookhart, *Assess HOTS In Your Classroom*. 2007.

[20] A. Fanani and D. Kusmaharti, “Pengembangan Pembelajaran Berbasis Hots (Higher Order Thinking Skill) Di Sekolah Dasar Kelas V,” *JPDJurnal Pendidik. Dasar*, vol. 9, no. 1, pp. 1–11, 2018.

[21] R. K. A. Singh, C. K. S. Singh, T. M. T. M., N. A. Mostafa, and T. S. M. Singh, “A Review of Research on the Use of Higher Order Thinking Skills to Teach Writing,” *Int. J. English Linguist.*, vol. 8, no. 1, p. 86, 2017.

[22] C. Agustina and T. Wahyudi, “Aplikasi Game Pendidikan Berbasis Android Untuk Memperkenalkan Pakaian Adat Indonesia,” *IJSE – Indones. J. Softw. Eng.*, vol. 1, no. 1, pp. 33–39, 2015.

[23] C. L. I. S. Fonseka, “A Smart App for Mobile Phones to Top-Up User Accounts for Any Network Service Provider in SriLanka,” *Int. J. Comput. Trends Technol.*, vol. 60, no. 2, pp. 99–105, 2018.

[24] L. Puspitasari, A. In’am, and M. Syaifuddin, “Analysis of Students’ Creative Thinking in Solving Arithmetic Problems,” *Int. Electron. J. Math. Educ.*, vol. 14, no. 1, pp. 49–60, 2018.

[25] P. Dwi Herdani and N. Ratu, “Analisis Tingkat Kemampuan Berpikir Kreatif Matematis Siswa SMP Dalam Menyelesaikan Open – Ended Problem Pada Materi Bangun Datar Segi Empat,” *JTAM | J. Teor. dan Apl. Mat.*, vol. 2, no. 1, p. 9, 2018.

[26] A. Nugroho Prasetya and K. Yohanes, “Meningkatkan Higher Order Thinking Skill dan Sikap Terbuka Melalui Media Pembelajaran Android,” *J. Komodo Sci. Educ.*, vol. 01, no. 01, pp. 79–94, 2018.

[27] K. Karsono, “Pengaruh penggunaan LKS berbasis hots terhadap motivasi dan hasil belajar IPA siswa SMP,” *J. Pendidik. Mat. dan Sains*, vol. 5, no. 1, pp. 50–57, 2017.

[28] S. R. Daly, E. A. Mosyjowski, S. L. Oprea, A. Huang-Saad, and C. M. Seifert, “College students’ views of creative process instruction across disciplines,” *Think. Ski. Creat.*, vol. 22, pp. 1–13, 2016.