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ICT-Based Statistical Learning Design to Train Middle School Students Higher Order Thinking Skills

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Abstract: This research aims to develop a statistical learning design for ICT-based data presentation material to train HOTS skills for junior high school students using the Successive Approximation Model (SAM) development method. The research was conducted at a junior high school in the city of Surabaya with 33 class VIII students as research subjects. The assessment of the feasibility of the learning design was validated by 2 lecturers and 1 mathematics teacher. The validation results for the HOTS questions obtained an assessment result of 80.4% (feasible), the material received 80.9% (feasible), and the media 83.7% (very feasible) so that the design instrument could be declared suitable for use. The learning design used in the learning process got a result of 97.7% (very practical) in observing the implementation of learning and a result of 95.8% (very practical) in observing student activities. Based on these results, the learning design was practical to use. The learning process obtained student responses to learning tools showing 94% of students agreed that learning tools helped in the learning process, and student responses to ongoing learning activities showed 89.8% of students agreed that learning activities helped in understanding the material. The students' posttest results of 84.84% met the minimum standard score, because the results of student responses were positive and above 80% of students met the minimum standard score, learning was effective to use. Based on these results, it can be concluded that the learning design is valid, practical and effective to use.

Keywords: high order thinking skill, information and communication technology, learning design.

Abstrak: *Penelitian ini bertujuan untuk mengembangkan desain pembelajaran statistika materi penyajian data berbasis ICT untuk melatih keterampilan HOTS siswa SMP dengan metode pengembangan Successive Approximation Model (SAM). Penelitian dilakukan di SMP yang ada di Kota Surabaya dengan subjek penelitian siswa kelas VIII sebanyak 33 siswa. Penilaian kelayakan desain pembelajaran divalidasi oleh 2 dosen dan 1 guru matematika. Hasil validasi soal HOTS mendapatkan hasil penilaian 80,4% (layak), materi mendapatkan 80,9% (layak), dan media 83,7% (sangat layak) sehingga instrument desain dapat dinyatakan layak untuk digunakan. Desain pembelajaran digunakan dalam proses belajar mendapatkan hasil 97,7% (sangat praktis) pada pengamatan keterlaksanaan pembelajaran dan hasil 95,8% (sangat praktis) pada pengamatan aktivitas siswa, berdasarkan hasil tersebut desain pembelajaran praktis untuk digunakan. Proses pembelajaran mendapatkan respon siswa terhadap perangkat pembelajaran menunjukkan 94% siswa setuju bahwa perangkat pembelajaran membantu dalam proses pembelajaran, serta respon siswa terhadap kegiatan pembelajaran yang berlangsung menunjukkan 89,8% siswa setuju bahwa kegiatan pembelajaran membantu dalam memahamkan materi. Hasil posttest siswa 84,84% memenuhi standart nilai minimum, karena hasil respon siswa prositif dan diatas 80% siswa memenuhi standart nilai minimum maka pembelajaran efektif untuk digunakan. Berdasarkan hasil tersebut dapat disimpulkan bahwa desain pembelajaran valid, praktis, dan efektif untuk digunakan.*

Kata kunci: *keterampilan berpikir tingkat tinggi, teknologi informasi dan komunikasi, desain pembelajaran.*

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▪ INTRODUCTION

Education is a process intended to gain knowledge, skills, values, friends of the same age, customs, and development for each individual (Almuhaimeed, 2022). The previous statement is in line with the 21st ccentury's demands on the fast moving education reformation, human resources were expected to have an impeccable skill. These were then supported by the constitution on Peraturan Menteri Pendidikan Nomor 5 Tahun 2022 regarding the competency standard of the graduates, through process of education it is hoped that the students will have a skill in identifying information or problem on hand by analyzing, prioritise most relevant information or most appropriate solution of a problem, while also have a numeration skills in reasoning a solution on a problem related to oneself, the environment, also the surrounding people by using concept, procedure, fact, and mathematical tool. Numeration skills in reasoning while analysing problem, built through a process of math studies (Permendikbud, 2022). Education also encourages the start of a young generation with creative and innovative skill which then function as the catalys of the economic growth (Hamdan, et al., 2019).

World Economic Forum just release the Top 10 skill of 2023 which is most needed in work forces on this era up until the year 2025, regarding about the tenth most needed skills in work force, five of which where the charateristic of an advanced thingking skill which more commonly known as Higher Order Thinking Skill (WEF,2020). Five skills are analytical thinking, innovation, critical thinking, complex problem solving, and creativity. These were then supported by the opinion of Setiawan et al., 2018 that the HOTS were detrimental to students to reach the 21st centuries competency which consist of the ability to think creatively and critically. HOTS were not only useful to face the challenges of the 21st centuries but also to help shape students to be a human with a higher level of thinking skills. In line with this argument is Raiyn (2015) stating that Higher Order of Thinking Skill (HOTS) is a collaborative skills required to solve a problem. HOTS skills refer to Anderson's (2001) revision of Bloom's taxonomy which states three levels of high-level thinking skills, namely analyzing (C4), evaluating (C5), and creating (C6). Adapted from Anderson (2001), Brookhart (2010), Syafryadin (2022), and Nawawi (2023), the HOTS cognitive level indicators are presented in Table 1.

Table 1. Indikator and level cognitive of higher order thinking skills

Indikator and Level Cognitive	Definition
Analyze (C4)	Draw connetions among ideas (Differentiate, organize, relate, compare, contrast, distinguish, examine, expritment, question, test)
Evaluate (C5)	Justify a stand or decision (Apprise, argue, defend, judge, select, support, value, critique, weigh)
Create (C6)	Produce new or original work (Design, assemble, construct, develop, formulate, investigate)

A higher level of thinking skills is required aspect in solving the PISA test made by the Organization for Economic Cooperation and Development (OECD). OECD is the organizer for student assessment on international scale on 2018 which have done assessment on mathematic, science, and literary known as the Program for International

Student Assessment (PISA). The Ministry of Education then release on their website regarding the result of PISA on 2018. Indonesia on the mathematic assessment scored 379 out of the average of 489. The result shows that Indonesia ranked is on the 72 out of 78 countries, or it can be said that we ranked 7th of the lowest. Based on the result on PISA that is being released by the Ministry of Education, the result of Indonesia student are pretty low, and it shows the skills of student in higher order of thinking (Kemendikbud,2019) . The result then pushed the Indonesian Government in stepping up the HOTS (Arriyana et al., 2018).

Learning mathematics by practicing HOTS requires the teacher's role to apply high-level thinking concepts (Acharya, 2021). High-level thinking skills are quite useful in everyday life, one of which is selecting, reading and presenting data (Kim How, 2022). The skills were detrimental to develop to middle schooler (Maryati, 2018). Statistical Learning is best use the daily lives problem, or real data that the students encounters with many times. The use of real data on statistic learning is hoped to train the HOTS on students. But on its practise on students result on contextual learning on the statistic matter has not been optimal, although contextual learning has shown better result on the statistic learning process (Kurniati, 2015) and (Pangemanan, 2020). Statistic learning process on its own needed a way or method to help the process of teaching that can be understood by both the teacher and the students.

Factors that can support the training of the students thinking ability in class, is the use of instructional media. The process of study with the right media will create an appropriate output suitable with the purpose of the study including the behaviour of the students. Based on several opinions from Priyadi (2021), Hsu (2022), Priyono (2018), conventional learning has not been effective in helping students, especially in training high-level thinking skills, so contextual learning is needed which can be meaningful for students. One solution is with the help of appropriate learning media in packaging and delivering the material so that it will produce results that meet expectations. One of the instructional media is Information and Communication Technology (ICT) which is a device, or technic of a certain technology design to help the teacher convey to the students in hope that the students are able to understand the material in a better way. This education devices is a way to improve the skills, ability, and the competency of the students, aimed to reached a more interactive learning (Artal-Sevil, et al., 2020:107). It is hoped with the help of the media in the learning process that it can build a more effective study process in which the students can work individually or collectively (Hasan, et al., 2021). The purpose of this research is to train students to train their higher order of thinking skill with ICT based learning designs.

▪ METHOD

Participants

The subjects in this research were class VIII students because they had received statistical material on data presentation in class VII second semester so that HOTS skills could be trained in students. The subjects in this study consisted of 33 students in class VIII E at SMPN 12 Surabaya for the 2023/2024 academic year. The subject selection was based on recommendations given by the mathematics teacher at the school.

Research Design and Procedures

This kinds of research is the development with the development procedure called the Successive Approximation Model (SAM) to develop the studying design. SAM is a design development model and an interactive multimedia studying app (Essel et al., 2016).

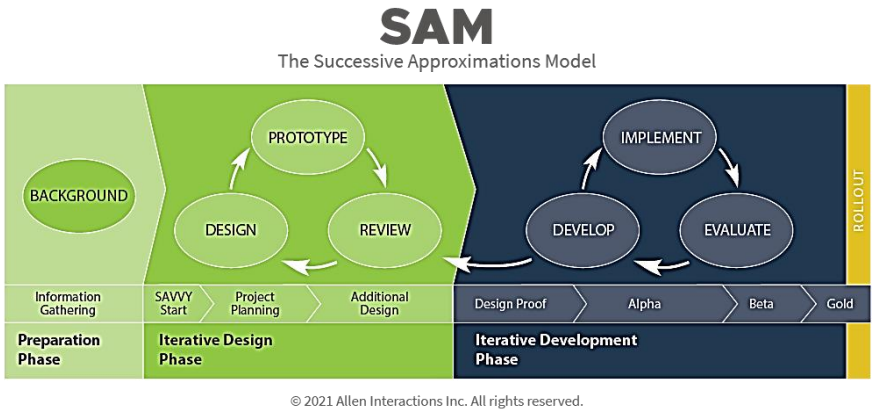

Figure 2. Chart on the development of successive approximation model (sam)

The procedural stages with the development model on successive approximation model (SAM) requires 3 phases which is the preparation phase, interactive design phase, and interactive development phase (Allen, 2012).

Instrument

The instruments developed in this research were lesson plans, validation sheets, sheets observing student activities, sheets observing learning implementation, student response questionnaires, HOTS question packages (pretest and posttest), and ICT-based learning media in the form of Android applications. Validation sheet to measure the validity of learning design products. Observation sheet of student activities and implementation of learning to measure practicality of learning. Student response questionnaire and posttest results to measure the effectiveness of learning design. The instruments HOTS question package to measure students' HOTS abilities takes the form of a posttest and pretest which have been validated as follows.

Table 2. Details HOTS question

Question Number	Cognitive Level	Topic
1	Evaluate (C5)	Solve daily problems related to mean and mode
2	Analyze (C4)	Solve daily problems related to data presentation
3	Create (C6)	Solve daily problems related to median

Data Analysis

The effectiveness criteria of statistical learning design on data presentation material in accordance with Nieveen (1999: 160), by measuring relevancy (validity), practicality, and affectivity learning design. The analysis of the data processing validation results for ICT-based learning media, the matter as well as HOTS questions were analyzed with the

Likert Scale. The result of the validation percentage was counted with the following equation.

$$P = \frac{\sum v}{\sum v1} \times 100\%$$

P stands for the percentage searched, $\sum v$ represent the total of respondent answer score in entirety. $\sum v\,1$ is the number of maximal scores in whole, and 100% is the identifier. The benchmark to represent the validation score result is as below.

Table 3. Validation criteria

Percentage	Criteria	Interpretation
81% - 100%	Very Decent	The product can be used immediately without repair
61% - 80%	Decent	The product can be used with minor improvements
41% - 60%	Decent Enough	The product can be used with many improvements
21% - 40%	Not Yet Decent	The product can be used with many improvements
0% - 20%	Not Decent At All	The product cannot be used

Analysis of the practicality of the design will be measured by observation sheets on the implementation of learning in class and student activity sheets. The benchmarks for presenting practicality results scores are as follows.

Table 4. Practicality criteria

Intervals	Criteria
$85\% \leq x \leq 100\%$	Very Practical
$70\% \leq x \leq 85\%$	Practical
$50\% \leq x \leq 70\%$	Less Practical
$0\% \leq x \leq 50\%$	Not Practical

Effectiveness analysis based on student questionnaire results as well as student posttest and pretest results. The processing procedure regarding the student respond data were analyzed using descriptive statistic with percentage, using the formula below.

$$\%\, respons = \frac{Total\ number\ of\ the\ postive\ respond\ each\ aspect}{The\ total\ number\ of\ respondent} \times 100\ \%$$

The success of the learning design in training students' HOT skills who have gone through an ICT-based learning process is analyzed by calculating the average N-Gain from the pretest and posttest results using N-Gain with the following formula:

$$N - Gain = \frac{S_{posttest} - S_{pretest}}{S_{max} - S_{pretest}}$$

Information $S_{pretest}$ is the pretest result value, $S_{posttest}$ is the posttest result and value, S_{max} is the maximum value. Student passing grade is measured individually from the

result posttest and declared as passed with a score ≥ 75 according to the standard of minimum completeness at school and classical passing grade if 80% of students achieve the criteria ≥ 75.

Table 5. Classification of n-gain values

Intervals	Criteria
$g \geq 0.7$	High
$0.3 \leq g \leq 0.7$	Medium
$g < 0.3$	Low

▪ RESULT AND DISSCUSSION

The results of the preparation phase are the collective information from teachers regarding students' conditions during the statistics learning process in the data serving material, which often experience difficulties when faced with discussions related to real data according daily life problems in line with opinions (Utomo, 2021). For example, the students have difficulty understanding online assessment ratings such as customer satisfaction ratings for online stores in e-commerce , location ratings on Google Maps , etc. That kinds of information in line with what was conveyed Widjayanti (2019) dan Pangemanan (2020) about learning statistic by using a real data approach which is expected to build students' statistical abilities . Learning outcomes in statistics material using a conventional learning process are not yet in line with what the teacher expects, but learning using a contextual as well as interactive media assistance to train students' abilities approach shows better results, especially in statistics material mean, median, mode (Das, 2019).

Other information obtained from students , namely that they have never received learning with the help of ICT media which contains explanatory videos and can be accessed on mobile phones via the Android application. The most frequent learning used is in a more conventional way which the teacher explains in front of regular white board . Meanwhile, the only ICT based learning form that they ever received is with the help of Google Classroom. Learning with only oral method often feels not interesting enough to attract the students and so it is less desired by student in trying to understand the material conveyed (Puspitarini & Hanif, 2019) . Zaripova (2020) said that the learning process in modern education must take into account the trend of progress in science and technology, which is one of the demands for quality services in education. In line with the opinions of Jeong (2014) and Kachakova (2020), Android-based learning can be a solution, filled with interesting and interactive content so that it is hoped that it can train students' high-level thinking skills. The information and background of learning that has taken place at the school are used as provisions for creating learning designs to train high-level thinking skills that can be applied at school.

Interactive design phase , information is obtained from teachers and students will then be put into project planning in consideration of media which we will be developing is an Android application about data presentation. At this stage, material and content are prepared to be published in ICT-based media will then be selected by considering the aspect efficiency so that the media is easy to used and interesting for students to be able to enjoy while understanding the material conveyed . The use of media in the learning process can help students to understand abstract mathematic material, and it is hoped that

students will get meaningful learning that is tailored to students' cognitive development (Widodo & Wahyudin, 2018: 154) . Through ICT-based learning, it is hoped that the messages regarding learning material can be conveyed to students well. Interesting content contained in learning media can create effective learning for students. In accordance with the opinion of Das (2019), interesting content contained in learning media can create effective learning for students.

The ICT-based media design that will be used is as follows. Create a menu page that has several options for accessing competency features, learning video materials, and exercises. Create a competency page that contains the basic competencies that students will gain after learning. Create a material page that contains an explanatory video and written material on mean, median and mode and also their application. Create a practice page that contains HOTS practice questions related to everyday problems.

Figure 3. ICT-based learning media development design

The media that was successfully created was then carried out in a validation process for the material, media and HOTS questions (posttest & pretest) which were validated by experts consisting of 2 lecturers and 1 mathematics teacher. Iterative Development Phase, obtained results from validation of materials, media and HOTS questions to measure validity, results of learning implementation and student activities in learning for practicality, and questionnaires for student assessment and learning outcomes measured by pretest HOTS questions before getting learning design and posttest HOTS questions after getting an ICT-based data presentation learning design to measure effectiveness.The validation results assessed by 3 validators regarding HOTS presentation, material, and media are as follows.

Table 5. Validation results of hots questions, materials, and media

Validation	Validation Results	Criteria
HOTS Question Test	80.4%	Decent
Material	80.9%	Decent
Media	83.7%	Very Decent

The result of the validator assessment on the HOTS question which then used to test the before and after the students received the ICT based learning obtained a total

assessment percentage of 80,4% which shows that the HOTS questions are very suitable to be used to test the effectiveness of ICT-based learning designs. The result on the validators assessment on the material used in the study of ICT based data serving manages to obtain a total percentage of 80,9 %, which shows that the material is very suitable to be used in the learning process. Results of the validator's assessment of learning media form The ICT-based Android application that will be used in presenting study received a total percentage of 83,75%, which shows that the media is very suitable to be used in the learning process that will be carried out in class. Based on these results the HOTS questions, materials and media can be declared valid for use in the ICT-based learning process.

The results of the practical include observing the implementation of learning and observing student activities during ICT-based learning to train HOTS which are observed by observers. Observations of learning implementation including preliminary activities, core activities, closing activities received an assessment of 97.78% indicating the very practical category. The results of observing the activities of 33 students, things observed included activities doing exercises in ICT-based learning media, activities operating ICT-based learning, activities paying attention to the teacher's explanation during learning, activities carrying out activities in accordance with ongoing learning which received an assessment of 95.8% indicating the very category. practical. Based on the results of these observations, practical learning designs can be stated to be used in the teaching and learning process to practice HOTS skills.

The results of learning effectiveness were measured from the results of student questionnaires and the results of working on HOTS questions (pretest and posttest) taken from 33 students. After the ICT-based learning process of presenting data regarding design, the following learning results were obtained. The results of the student response questionnaire to learning tools showed that 94% of students agreed that learning tools helped in the learning process and 6% of students disagreed. The results of the student response questionnaire to ongoing learning activities showed that 89.8% of students agreed that learning activities helped them understand the material and 10.55% disagreed. The results of the student questionnaire showed positive results that ICT-based data presentation learning tools and activities helped them in learning data presentation material.

Student learning outcomes are in the form of a pretest which is carried out before the ICT-based data presentation learning process and a posttest which is carried out after being given the ICT-based data presentation learning process to measure the effectiveness of the ICT-based learning design. The result was that 84.84% of students successfully completed the KKM in the posttest. The results of the analysis between students' pretest and posttest results showed that 84.84% had a high criteria classification and 15.16% had a medium criteria classification, based on calculations using the N-Gain value classification. Based on the results of the student assessment questionnaire and the results of the student pretest and posttest, it can be said that ICT-based learning design is effective for training HOTS skills. Based on research results, ICT-based learning can help to train students' HOTS. In line with Dhillon's (2022) research, integrating ICT-based learning in the curriculum can help optimize student learning outcomes, and can help encourage and provide students with flexibility in accessing learning. ICT-assisted learning challenges students not only to memorize, but to think independently and

critically (Mahlo & Waghid, 2023). This ICT-based statistics learning design for training high-level thinking skills is a good design, in accordance with Nieveen's (1999) criteria for use in the learning process because it meets the criteria of being valid, practical and effective.

▪ CONCLUSION

The conclusion of this research which is the development of an ICT based statistic learning design to train the high order of thinking skills on middle school student by using the method development Successive Approximation Model (SAM) for middle school students which fulfill the decent criteria to be used used in the learning process based on results validation material, media and test. It can be used practically which has been reviewed from results learning implementation on ongoing learning process. The level of effectiveness can be reviewed from the student questionnaire result and the students study result which is passed in a classical way . Suggestions for the next researcher is that this can be developed in ICT based learning design for other materials that can help the students learning process.

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