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Research Article

The development of HOTS-based assessment instruments on educational statistics

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ABSTRACT

The 21st century demanded that humans have various life skills. HOTS (High Order Thinking Skills) was a competency that leads to the formation of various 21st century life skills. Achieving HOTS on educational process was the basis. This study aimed to produce a HOTS-based assess-ment instrument in educational statistics that was valid and reliable. This research and develop-ment consisted of 8 steps, namely (1) determining the specifications of the instrument, (2) writing the instrument, (3) making a measurement scale, (4) selecting a rating system, (5) reviewing the instrument, (6) testing the instrument, (7) analyze the instrument, (8) compose the instrument. The research subjects were students of Tarbiyah and Teacher Training Faculty, State Islamic Universi-ty Professor K.H. Saifuddin Zuhri in the fourth and sixth semesters as many as 194 people for the 2020-2021 academic years. Data collected by tests. Data analyzed was in the form of validation (content and construct) and reliability tests. The research produced a valid and reliable HOTS-based test as many as 32 items with Cronbach's Alpha of 0.658 in the high category.

Keywords: Instruments; HOTS; Statistics; Education

1. INTRODUCTION

The use of technology in almost all fields became the momentum of the 21st century. People are also required to have life skills such as thinking critically, creatively, solving problems, and making decisions. HOTS (High Order Thinking Skills) is a bridge to the possession of these skills (Crossland, 2015). HOTS became one of the educational goals in the 21st century (21 (Jerome et al., 2017). HOTS is a level of thinking that emphasizes the applica-tion of received knowledge, reflection examination, problem solving, decision making, and formulating new things (Seman et al., 2017). A person's mind can affect the ability, speed and effectiveness of learning, so HOTS is very important in edu-cation (Ramdiah et al., 2019). A person capable of critical thinking, he can apply the acquired knowledge and skills to new contexts (Baguma et al., 2019). That is, HOTS is very important to be applied to the environment through positive things. (Heong et al., 2012) added that a person should be directed to obtain HOTS in order for them to be able to answer challenges in competence of critical thinking skills. By having HOTS, this opens the opportunity to have various life skills suitable for the 21st century.

The importance of achieving HOTS is a simultaneous step for all educational processes, ranging from elementary level to universities to carry out various efforts for the achievement of HOTS. (Suyatna et al., 2020) create STEM-based e-modules for high school students, (Dasilva et al., 2019) create learning media in the form of HP to learn physics interactively for high school students, (Lestari et al., 2021) compile HOTS-based worksheets in elementary school, (Setyarini et al., 2018) use storytelling, (Sidiq et al., 2021) carry out science learning through a series of HOTS-based questions, (Rahman et al., 2020) developed the PBL-Reathnomath model to train HOTS elementary students in an effort to achieve HOTS. Studies in the form of surveys of teachers and prospective teachers related to understanding HOTS are also conducted. (Kuntarto et al., 2019) examines students' ability to design HOTS-based learning. (Seman et al., 2017) examines the ability of elementary teachers to teach HOTS-based learning. (Ramdiah et al., 2019) examined the employment of teachers, especially high school biology teachers.

Despite the many efforts made to achieve HOTS, knowing the achievements of HOTS is also very important. For this reason, a standard instrument is needed to measure it. Non-standard instrument can result in measurement errors. Various instruments are arranged to measure HOTS according to the subject of the material being tested. (Hartono & Pahlevi, 2020) developed the HOTS assessment instrument of General Administration subjects. (Agustihana & Suparno, 2019) de-veloped a HOTS-based cognitive assessment for thermody-namic materials. (Mulyani et al., 2021) developed a HOTS-based religious assessment book. This research aims to develop HOTS-based assessment instruments on educational statistics courses. Education sta-tistics are one of the mandatory materials for undergraduate students of the Faculty of Tarbiyah and Teacher Science (FTIK), UIN Saizu. Hopefully, HOTS-based assessment instruments will be produced for valid and reliable educational statistics courses. This research is important to produce a standard HOTS-based assessment instrument.

Hopefully, the achieve-ment of student HOTS on the subject of educational statistics can be measured well.

2. RESEARCH METHOD

Research and development consists of 8 steps, namely (1) determining the specifications of the instrument, (2) writing the instrument, (3) determining the scale of measurement, (4) determining the scoring system, (5) reviewing the instrument, (6) conducting trials, (7) analyzing the instrument, (8) assem-bling the instrument. The study subjects were students of The State Islamic University Professor K. H. Saifuddin Zuhri (UIN Saizu) for the fourth and sixth semesters of 194 people, namely 39 male students and 155 female students. The research sub-jects came from 3 (three) study programs, namely Madrasah Ibtidaiyah Teacher Education, English Language Tadris, and Arabic Language Education. UIN Saizu is an Islamic state university located in Purwokerto, Central Java, Indonesia. Data collection techniques are tests. Data analyze in the form of validation and reliability tests. Validity tests are carried out on all instruments including content validity and construct validity. Validation of the contents produces a grid of instru-ments from the results of theoretical studies developed into indicators. The validity of the contract results from the results of the study of instruments by experts (expert judgment). Empirical validation is carried out by piloting instruments on the subject, namely students who take educational statistics courses in the even semester of the 2022/2021 academic year. Analysis of empirical validation tests is obtained by factor analysis techniques to see the correlation between one factor and another factor that forms variables. If a strong enough correlation is found, then the factor is expressed as a variable forming. Reliability tests are conducted on questionnaire items that have met the validation aspect through Cronbach's Alpha with conditions, very high (0.80 - 1.00), high (0.60-0.80), medium (0.40 - 0.60), and low (0.20 - 0.40) (Santyasa, 2014).

3. RESULTS AND DISCUSSION

The study consisted of 8 steps, namely (1) determining the specifications of the instrument, (2) writing the instrument, (3) determining the measurement scale, (4) determining the scoring system, (5) reviewing the instrument, (6) conducting a trial, (7) analyze the instrument, (8) assemble the instrument. The following are the research steps.

Step 1. Determining the instrument specifications

(Seman et al., 2017) defines HOTS as a level of thinking that emphasizes the application of knowledge that has been received, examination of reflection, problem solving, decision making, and formulating new things. This means that HOTS research is included in cognitive domain research. For this reason, the study used a test instrument. The test material is in the form of educational statistics for undergraduate students at FTIK, UIN Saizu, Purwokerto.

Step 2. Writing the instrument

The test questions are arranged based on the HOTS indicators, namely analysis, evaluation, and creation. Based on the HOTS indicators and educational statistics material, 50 items were compiled using a framework as shown in Table 1.

Table 1. The framework of HOTS questions

HOTS Indicators	Questions	Item number
Analyzing	Distinguishing descriptive statistics and inferential statistics	1,2,3,4,5,6,11,12, 15,16,17,25,26, 27,41,44
	Asserting data types based on traits	
	Analyzing the content of the graph of the research results	
	Analyzing research data	
	Analyzing prerequisite tests before using a certain statistical test	
Evaluating	Choosing a research design that uses statistical tests	7,8,9,10,13,14,18, 19,20,21,22,23,24, 28,29,30,31,32,33, 34,35,36,37,38, 39,40,42,43,48,50
	Assessing research data	
	Interpreting the results of research data processing	
Creating	Creating a statistical test design to answer the problem formulation	45, 46, 47, 49
	TOTAL	50

Step 3. Determining the measurement scale

The assessment test to measure HOTS is in the form of multiple choice as many as 50 questions. The number of obtions is 4 (four).

Step 4. Defining the scoring system

Based on the 50 questions, each question will be given a score of 2 if the respondent answers correctly. On the other hand, a score of 0 (zero) if the respondent answers incorrectly. That is, if the respondent answers correctly all will get a maximum score, which is 100.

Step 5. Reviewing the instrument

The activity of reviewing the instrument is to examine the quality of the instrument. The study was carried out by the coordinator of the course cluster lecturers who have expertise according to the fields that have been appointed by the LPM (quality assurance institution), UIN Saizu. The results of the study are contained in a validation sheet which has been signed by the coordinator of the lecturers of the course group. The validation test by the expert stated that the instrument had met the required aspects, such as the identity of the course, the construction of the questions, the suitability of the questions with the lesson plan, to the suitability of the questions with the expected competencies, namely HOTS. The results of the recitation of questions can be seen in Figure 1.

FORMULIR
***PEER REVIEW* SOAL UJIAN**

A. IDENTITAS MATAKULIAH YANG DI REVIEW
1. Nama Mata kuliah : Statistik Pendidikan
2. Dosen Pengampu : Dr. Siti Sarah, M.Pd.
3. Prodi : PGMI/TBI/PBA
4. Semester : Genap
5. Periode Ujian : UAS Genap T.A. 2020/2021

B. FORMAT LEMBARAN SOAL
1. Nama mata kuliah : (a) Ada b. Tidak ada
2. SKS/Semester : (a) Ada b. Tidak ada
3. Prodi : (a) Ada b. Tidak ada
4. Lama pelaksanaan ujian : (a) Ada b. Tidak ada
5. Nama Dosen pengampu : (a) Ada b. Tidak ada
6. Penggunaan Kertas :
   a. Menggunakan kertas kop Fakultas
   (b) Tidak menggunakan kertas kop Fakultas
7. Petunjuk mengerjakan soal berisi:
   a. Bentuk ujian(terbuka/tertutup) (a) Ada b. Tidak ada
   b. Cara mengerjakan soal (a) Ada b. Tidak ada
      (boleh tidak urut nomer atau tidak)
   c. Sanksi a. Ada (b) Tidak ada
   d. Larangan menggunakan *HP* a. Ada (b) Tidak ada
      selama ujian berlangsung.
8. Dalam penutup, mencantumkan himbauan moral untuk memberi semangat, tidak berbuat curang
   Kepada peserta ujian.
   a. Mencantumkan (b) Tidak

C. MATERI SOAL
1. Kesesuaian materi soal dengan RPS:
   (a) Sesuai ~~SAP~~ RPS b. Kurang sesuai c. Tidak sesuai
2. Nomor urut soal:
   (a) Nomor urut soal disusun berdasarkan tingkat kesulitan dan bobot.
   b. Nomor urut soal disusun tidak berdasarkan tingkat kesulitan dan bobot.
3. Soal dalam bentuk *essay* sebanyak:
   a. 3-5 buah soal
   b. Lebih dari 5 buah soal.
4. Soal dalam bentuk *multiple choice* sebanyak:
   (a) 50 soal
   b. Lebih dari 50 soal.

Figure 1. The results of instrument validation by experts

Step 6. Doing the test

The instrument testing was carried out on tests that had been declared valid by the lecturer coordinator for the course group. The trial was carried out on 194 FTIK students, UIN Saizu who took statistics courses in the even semesters of the 2020-2021 academic years. The test subjects consisted of students from 3 (three) educational programs, namely English tadrias, Madrasah Ibtidaiyah teacher education, and Arabic language education. The trial aims to determine the construct validity and reliability of the instrument using SPSS software.

Step 7. Analyzing the instrument

Empirical validity was carried out using the Pearson Correlation formula. The results of the analysis can be seen in Table 2.

Table 2. Results of empirical validity tests on HOTS-based questions

No.	Pearson Correlation	Signficance	Results
1	0.214	0.003	Valid
2	0.209	0.004	Valid
3	0.367	0.000	Valid
4	0.268	0.000	Valid
5	0.223	0.002	Valid
6	0.232	0.001	Valid
7	0.220	0.003	Valid
8	0.287	0.000	Valid
9	0.238	0.001	Valid
10	0.196	0.007	Valid
11	0.258	0.000	Valid
12	0.187	0.011	Valid
13	0.312	0.000	Valid
14	0.147	0.018	Valid
15	0.226	0.002	Valid
16	0.107	0.147	Invalid
17	0.317	0.000	Valid
18	0.444	0.000	Valid

19	0.373	0.000	Valid
20	0.362	0.000	Valid
21	0.312	0.000	Valid
22	0.345	0.000	Valid
23	0.026	0.720	Invalid
24	0.317	0.000	Valid
25	-0.005	0.945	Invalid
26	0.135	0.065	Invalid
27	0.146	0.047	Valid
28	0.045	0.539	Invalid
29	0.259	0.000	Valid
30	0.075	0.311	Invalid
31	0.213	0.004	Valid
32	0.186	0.011	Valid
33	-0.098	0.185	Invalid
34	0.104	0.157	Invalid
35	0.092	0.213	Invalid
36	0.065	0.378	Invalid
37	0.369	0.000	Valid
38	0.113	0.125	Invalid
39	0.155	0.035	Valid
40	-0.017	0.817	Invalid
41	0.082	0.485	Invalid
42	0.130	0.076	Invalid
43	0.320	0.000	Valid
44	0.022	0.764	Invalid
45	0.253	0.000	Valid
46	0.137	0.063	Invalid
47	0.235	0.001	Valid
48	-0.011	0.885	Invalid
49	0.249	0.001	Valid
50	0.128	0.082	Invalid

Based on table 2 it is known that the question is said to be valid if the significance level is less than 0.05. Based on these provisions, it can be seen that only 32 questions are valid. The other questions were declared invalid, namely numbers 16, 23, 25, 26, 27, 28, 30, 33, 34, 35, 36, 38, 39, 40, 41, 44, 48, and 50. The invalid question was dropped (not included as an instrument) because there are still question items that represent each indicator. All valid instruments used to test the reliability of the test. As a result, the reliability value through Cronbach's Alpha coefficient shows a value of 0.658 with high criteria. Thus, as many as 32 HOTS items were declared to meet the valid and reliable criteria.

Step 8. Assembling the instrument

A total of 32 valid and reliable HOTS items spread over 3 aspects, namely 9 items measuring analytical aspects, 20 items measuring evaluation aspects, and 3 items measuring creating indicators with details in Table 2. The 32 questions were then reordered by issuing invalid questions first. Table 3 contains framework of valid and reliable HOTS-based questions.

Table 3. The framework of HOTS-based question which valid and reliable

HOTS Indicators	Questions	Item number
Analyzing	Distinguishing descriptive statistics and inferential statistics	1,2,3,4, 5,6,11,12, 15,16,23
	Asserting data types based on traits	
	Analyzing the content of the graph of the research results	
	Analyzing research data	
	Analyzing prerequisite tests before using a certain statistical test	
Evaluating	Choosing a research design that uses statistical tests	7,8,9,10,13, 14,17,18,19 20,21,22,24 25,26,27,28, 29
	Assessing research data	
	Interpreting the results of research data processing	
Creating	Creating a statistical test design to answer the problem formulation	30,31,32
TOTAL		32

To complete the information, here are some examples of item questions that represent each HOTS indicators.

Question with the analyzing aspect

Statistics are divided into 2, namely descriptive statistics and inferential statistics. Here's the exact difference between the two, namely….

A. Descriptive statistics test hypotheses, inferential statistics do not
B. The results of descriptive statistical analysis are generalizations, inferential statistics are not
C. Inferential statistics analyze the data in detail, descriptive statistics do not
D. Inferential statistics analyze data in a limited way, descriptive statistics do not

Question with the evaluating aspect

Pay attention to the results of the data normality test using the following SPSS

The correct conclusion from the data in the table above is….
A. The speaking skill data is not normally distributed because the significance value is greater than 0.05
B. The speaking skill data is not normally distributed because the significance value is less than 0.05
C. The speaking skill data is normally distributed because the significance value is greater than 0.05
D. The speaking skill data is normally distributed because the significance value is less than 0.05

Question with the creating aspect

A study aimed to determine the effect of using learning methods on the achievement of higher order thinking skills (HOTS). The best sequence of research steps is….
A. Homogeneity test, normality test, correlation test, regression test
B. Homogeneity test, normality test, t-test, gain test
C. T test, regression test, homogeneity test, normality test
D. Correlation test, regression test, homogeneity test, normality test

Through the 8 steps of developing the instrument, this research finally produces a HOTS assessment instrument on valid and reliable educational statistics material. Furthermore, the existing instruments are used to measure student HOTS through the Even Semester Final Examination for the 2020/2021 academic year on educational statistics material.

4. CONCLUSION

The research showed that as many as 32 HOTS items met the valid and reliable aspects with a Cronbach's Alpha coefficient value of 0.658 (high criteria). This is obtained through 8 steps, namely (1) determining the specifications of the instrument, (2) writing the instrument, (3) determining the measurement scale, (4) determining the scoring system, (5) reviewing the instru-ment. , (6) conduct trials, (7) analyze the instrument, (8) as-semble the instrument. All item questions are spread over 3 aspects, namely 9 items measuring analytical aspects, 20 items measuring evaluation aspects, and 3 items measuring creating indicators.

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AUTHOR'S CONTRIBUTIONS

The author discussed the results and contributed to from the start to final manuscript.

CONFLICT OF INTEREST

There are no conflicts of interest declared by the author.

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