The relationship between question grid and quality of multiple choice questions in high school biology made by prospective teacher students

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ABSTRACT

The problem grid is an important part of the problem formulation rules which serves to maintain quality so that the measurement function can be carried out properly. The purpose of this study was to analyze the relationship between the multiple-choice question grid and the quality of Biology questions. The approach used in this research is descriptive quantitative. The research was conducted at the University of Muhammadiyah Malang. The research sample is Biology Education students in 2020/2021 who are taking the learning evaluation course using a purposive sampling technique. The research instrument used was the form of a questionnaire containing the assessment of the item grid. Path analysis is used in data processing with the help of SmartPLS software. The results showed that there was a positive relationship between the grid of multiple choice questions on biology material and the quality of the questions which consisted of the accuracy of the material, the accuracy of the indicators, the accuracy of the item indicators, operational verbs, cognitive processes, answer choices, statement suitability, and language suitability. In addition, prospective educators must have the ability to compose a question grid following the components and quality of the grid so that they can compile quality instruments so that they can measure what should be measured.

Introduction

Evaluation of learning in teaching and learning activities is mandatory and must be carried out by teachers, evaluations are carried out in the process of learning and teaching activities and for students who are planned and carried out with good preparation. Evaluation of teaching and learning activities one of which functions to measure the level of achievement of student competence[1]. Given the importance of learning evaluation the ability to make good assessments and meet standards for students is a mandatory competency that must be possessed by a teacher or student-teacher candidates[2]. Evaluation of quality learning will determine the quality of learning and vice versa[3].

In the context of the importance of competence in compiling good questions and tests that teachers and prospective teacher students must have, some rules and conventions apply and must be considered by the teacher in compiling them. Test planning activities and preparation of test questions must be supported by general and specific technical instructions[1]. There are several important things that the teacher needs to pay attention to in carrying out tests, compiling standardized test kits or questions including questions, answer keys along with the scoring rubric, and a question grid[4]. The grid can be defined as an information matrix that can be used as a guide for writing and compiling questions into tests[5].

The grid serves as a guide in writing questions and or in preparing tests[6]. The teacher can use the grid in compiling questions so that it will be able to produce questions that are in accordance with the objectives of the test besides that it will make it easier for the teacher to arrange test kits[7,8]. Referring to the meaning of the test itself as a process to distinguish achievements with certain procedures that are systematic, of course the test in the form of questions must be able to be constructed properly and precisely[9,10].

Good and standardized question papers with the right criteria that have been prepared by the teacher will have an impact on the quality of the questions made by the teacher and will have the same quality wherever the test questions are made[11]. Some of the components that must be listed in the grid include basic competencies, materials, question indicators and measured cognitive levels[5]. The characteristics of a good grid are: 1) Representing the contents of the curriculum or abilities to be tested; 2) the components are detailed, clear, and easy to understand; 3) The questions can be made according to the indicators and form of the questions set, 4) refers to subject matter according to the set curriculum, 5) has a number of components with clear and easy-to-understand information, 6) uses one or more operational verbs in one indicator formulation[10].

Facts in the field with various educational backgrounds, ages, experiences, institutions or institutions where teaching, insights, academic activities followed, level of education, availability of supporting facilities, human resources, and other things, not a few teachers and student-teacher candidates still find obstacles so that the quality of the questions prepared is not optimal or still needs to be improved. There are several aspects that become obstacles for teachers in compiling grids so that teacher-made grids are of less quality[12]. According to Astiti, aspects that affect the quality of the poor quality teacher question papers include (1) the selection of basic competencies that are not correct, (2) many indicators that contain material that is not supposed to be, (3) indicators on the grid that do not develop, (4) one grid does not contain key indicators so that if the grid is used correctly, (5) the questions do not measure basic competence achievements[13]. The question grid should be able to describe the abilities to be measured, their proportions, the scope of the material being tested, the level of difficulty of the questions, the types of assessment tools used, the number of questions or questions, and the estimated time needed to work on the questions.

Based on the explanation above about the importance of the evaluation that must be carried out by the teacher, the importance of quality grids for teachers, the importance of the

question grids in compiling questions, the relationship between the question grids and the quality of the questions, and the facts in the field, it is very it is important to conduct studies and research on the relationship between the question grid and the quality of the questions. The purpose of this study was to analyze the relationship between the item grid and the quality of multiple choice questions in high school Biology compiled by prospective teacher students by describing the resulting correlations and linkages between the components in it.

Method

The research approach uses quantitative descriptive research. This approach describes a person's ability to construct multiple-choice test instruments in high school biology subjects. The research location is at the University of Muhammadiyah Malang, Faculty of Teacher Training and Education, Biology Education Study Program, to be precise in the Learning Evaluation lecture in Even Semester 2020/2021.

The research population is Biology Education students at the Faculty of Teaching and Education, University of Muhammadiyah Malang. A research sample of Semester Biology Education students taking part in the Learning Evaluation course in 2020/2021 Even Semester. The sampling technique in this study was purposive sampling. The sampling criteria are that students are officially registered at theAcademic Administration Agency which programs the Learning Evaluation course by proving that they are registered in lecture attendance, attend lectures with a minimum attendance of 80%, and collect all course bills in full.

Students are divided into 8 groups. Each group is obliged to compile multiple choice test questions and instruments for one basic competency in high school biology subjects. Each group uses a different material. The method of data collection uses an assessment questionnaire on student-made problem grids. Each grid prepared by students will be assessed based on indicators of the quality of the question grids (Table 1). Giving scores using a Likert scale, namely (5) very suitable, (4) appropriate, (3) quite suitable, (2) not suitable, (1) not suitable.

Table 1. Indicators Assessment of the Question Grid

No	Indicator
1.	Content material accuracy
2.	Accuracy of competency achievement indicators
3.	Cognitive processing accuracy
4.	Accuracy of question indicators
5.	The accuracy of the item instrument

The assessment score on the quality of the student question grids was analyzed using path analysis (Figure 1). Path analysis is an extension of the regression analysis. The path analysis model is used to analyze the relationship pattern between variables to know the direct and indirect effects of the independent variables on the dependent variable. In this study path analysis testing was carried out using the SmartPLS software.
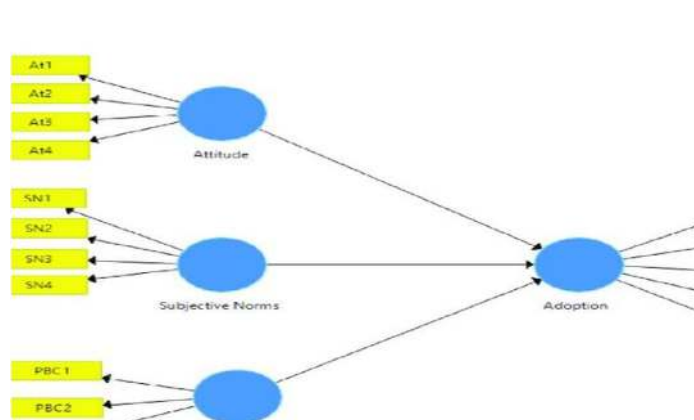
Figure 1. Path Analysis Design with SmartPLS

Results and Discussion

The relationship between the problem grid and the quality of the questions

The existence of the rules for compiling questions is to maintain the quality of the questions so that they can carry out their measurement functions properly, namely measuring what you want to measure[14]. The results of the research on the relationship between the question grids and the quality of the questions composed by students showed that the correlation value was 0.676 > 0.1587 (rtable), so it can be concluded that there is a correlation between the question grids and the quality of the questions (Table 1). The correlation value is positive, so it can be said that the correlation is going in a positive direction.

Table 2. The relationship between the question grids and
the quality of the questions

Sig. value	0.000
Correlation value	0.676
Conclusion	Berkorelasi

The relationship between the Components of the Question Grid and the Quality of the Questions

The results of testing the components of the item grid with the quality of the questions show that these two variables have a correlation (Table 2). The relationship between the accuracy of the material and the accuracy of the item indicators obtained a correlation value of 0.306 > 0.1587 (table), so it can be concluded that there is a correlation between the accuracy of the material and the accuracy of the item indicators. The correlation value is positive, so it can be said that the correlation is going in a positive direction. The relationship between the accuracy of the material and the accuracy of the statement shows that the correlation value is 0.242 > 0.1587 (rtable), so it can be concluded that there is a correlation between the accuracy of the material and the accuracy of the statement. The correlation value is positive, so it can be said that the correlation is going in a positive direction. Furthermore, the test results between the relationship between the accuracy of the material and the suitability of the language show that the correlation value is 0.306 > 0.1587 (rtable), so it can be concluded that there is a correlation between the accuracy of the material and the suitability of the language. The

correlation value is positive, so it can be said that the correlation is going in a positive direction. Finally, the relationship between the accuracy of the material and the choice of answers results in a correlation value of 0.324 > 0.1587 (rtable), so it can be concluded that there is a correlation between the accuracy of the material and the choice of answers. The correlation value is positive, so it can be said that the correlation is going in a positive direction.

In addition to the accuracy of the material, the test results regarding the relationship between the accuracy of the indicators with the indicators of questions and cognitive processes. The relationship between the question indicators and operational verbs and cognitive processes (Table 2). The relationship between the accuracy of the indicators and the question indicators shows that the correlation value is 0.165 > 0.1587 (rtable), so it can be concluded that there is a correlation between the accuracy of the question indicators and the question indicators. The correlation value is positive, so it can be said that the correlation is going in a positive direction. The relationship between the accuracy of the indicators and the cognitive process shows that the correlation value is 0.221 > 0.1587 (rtable), so it can be concluded that there is a correlation between the accuracy of the question indicators and the cognitive process. The correlation value is positive, so it can be said that the correlation is going in a positive direction. The other relationship, namely the accuracy of the question indicators and operational verbs show that the correlation value is 0.466 > 0.1587 (rtable), so it can be concluded that there is a correlation between the accuracy of the question indicators and operational verbs. The correlation value is positive, so it can be said that the correlation is going in a positive direction. In addition, the accuracy of the question indicators has a relationship with the accuracy of student statements in compiling questions, with a correlation value of 0.284 > 0.1587 (rtable), so it can be concluded that there is a correlation between the accuracy of the question indicators and statements. The correlation value is positive, so it can be said that the correlation is going in a positive direction. Furthermore, the accuracy of the question indicators with cognitive processes shows a correlation value of 0.655 > 0.1587 (rtable), so it can be concluded that there is a correlation between the accuracy of the question indicators and cognitive processes. The correlation value is positive, so it can be said that the correlation is going in a positive direction. Finally, the relationship between operational verbs used by students in compiling with cognitive processes shows a correlation value of 0.331 > 0.1587 (rtable), so it can be concluded that there is a correlation between operational verbs and cognitive processes. The correlation value is positive, so it can be said that the correlation is going in a positive direction.

Table 3. The Relationship between the Components of the Grid and the Quality of the Questions

Grating components and quality		Material accuracy	Indicator accuracy	Accuracy of question indicators	Operational Verbs
Material accuracy	Sig. value		0.000		
	Correlation value		0.306		
	Conclusion		Correlated		
Indicator accuracy	Sig. value	0.000		0.041	
	Correlation value	0.306		0.165	

	Conclusion	Correlated		Correlated	
Accuracy of question indicators	Sig. value		0.041		0.000
	Correlation value		0.165		0.466
	Conclusion		Correlated		Correlated
Operational Verbs	Sig. value			0.000	
	Correlation value			0.466	
	Conclusion			Correlated	
Accuracy of statement	Sig. value	0.003		0.000	
	Correlation value	0.242		0.284	
	Conclusion	Correlated		Correlated	
Language suitability	Sig. value	0.000			
	Correlation value	0.306			
	Conclusion	Correlated			
Cognitive processes	Sig. value		0.006	0.000	0.000
	Correlation value		0.221	0.655	0.331
	Conclusion		Correlated	Correlated	Correlated
Answer choices	Sig. value	0.000			
	Correlation value	0.324			
	Conclusion	Correlated			

There are 5 aspects of the assessment of the questions prepared by students (Table 1). This aspect is a necessary aspect in compiling and developing a question, especially questions in the HOTS category[15]. In preparing the test items, they must be prepared in a comprehensive manner. The preparation of questions must go through the question grid maker. Some of the components that must be listed in the grid include basic competencies, materials, question indicators, and measured cognitive level. The higher-order thinking question grids are designed not to make it difficult for educators when designing HOTS questions. Specifically, so that it can be used as a guideline when determining which basic competencies might be designed to

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be HOTS questions, determining the subject matter that is relevant to the basic competencies to be tested, creating question indicators, categorize cognitive levels, compiling the variety of questions and number of questions[16]. As educators or prospective educators really need skills in developing test instruments so that the instrument can measure student competence correctly and precisely[17].

The relationship between the problem grid and the quality of the questions

Based on the research results, the relationship between the question grid and the quality of the questions in Table 2 shows that these two variables have a positive relationship. This is in line with 17 that the quality of the questions prepared for students greatly influences the quality of measurement results and also influences the results of learning evaluations. To get good learning evaluation results, the quality of the tests used must be guaranteed. The quality of the multiple choice test questions designed by the teacher is expected to be of good quality because they are used as a summative assessment to assess student achievement levels[18]. The questions that are made must be in accordance with the grid, so the quality of the questions will be better. The quality of the multiple choice test questions designed by the teacher is expected to be of good quality because they are used as a summative assessment to assess student achievement levels[5].

The question grids prepared by students in this study were HOTS-based question grids. A teacher is said to be professional, one of which is that he must be able to compile assessment instruments. The results of the assessment activities will be used as a follow-up for future learning activities. In compiling assessment instruments, a teacher must be able to compose HOTS-based questions to improve the quality of students' thinking, namely problem-solving, decision making, critical and creative thinking skills[19]. The HOTS question writing grid aims to assist teachers in writing HOTS item items. In general, these grids are needed to guide teachers in selecting basic competencies for HOTS questions, selecting subject matter related to the basic competencies to be tested, formulating question indicators, and determining cognitive levels[20]. This is in line with the 21 achievement test grids that must represent the content of the curriculum to be tested, the components are detailed, clear and easy to understand, the question indicators must be clear and the questions can be made according to the form of the questions that have been set.

The relationship between material accuracy and indicator accuracy, statement accuracy, language suitability, and answer choices

The questions are written in accordance with the rules for writing HOTS items. The rules for writing HOTS items are slightly different from the rules for writing questions in general. The difference lies in the material aspect, while the construction and language aspects are relatively the same[21]. HOTS-based questions direct students to think, research, study, analyze, so that they are able to find and construct the main message of the learning material they are studying[22]. This is in line with opinion 24 bahwa Criteria for selecting essential materials from a material that has been studied before, it is important that students master it and have high applied value in everyday life.

The results in Table 3 show that the accuracy of the material prepared by students has a relationship with the accuracy of indicators, the accuracy of statements, the suitability of language and the choice of answers. This is in line with Wafida's opinion that in compiling a question the indicators compiled must be relevant to the material used[23]. The indicators developed must reach a minimum level of basic competence and may exceed that minimum level[24]. Competency achievement indicators are used as a reference for conducting learning

evaluations. Mistakes in the preparation of material lead to wrong understanding of students[25]. There must be consistency between learning objectives, indicators, indicator questions and multiple choice questions on the test[26].

The relationship between the accuracy of indicators and the accuracy of the material, the accuracy of the question indicators, and cognitive processes

Learning indicators are something that can be observed or measured and then concluded to fulfill the achievement of learning objectives[27]. In learning activities indicators become a benchmark for achieving learning objectives[28]. Learning indicators compiled must be in accordance with basic competencies[29]. In line with this Rosdiana et al, conveyed that competency achievement indicators are benchmarks for the achievement of a basic competency[30]. The results of the study in Table 3 show that the accuracy of the indicators is related to the accuracy of the material, the accuracy of the question indicators, and cognitive processes.

Indicators are used as a reference in compiling questions with the specified material[31]. The National Professional Certification Agency submits several assessment points that must be assessed on the accuracy of the material, namely the accuracy of facts, concepts, principles, procedures, examples, and questions[32]. Indicators must accommodate the characteristics of the material, so they must use appropriate operational verbs and be able to describe the competency hierarchy[33]. The statements compiled in the questions must be able to describe the material in question[34]. According to [15] indicator derivatives are used as the basis for compiling HOTS-based questions. Competency achievement indicators are formulated using measurable operational verbs, which includes knowledge, attitudes, and skills[30]. The research results are in line with[35] 38 the items must be in accordance with the grid to achieve competency indicators. In line with this[36] an instrument of questions with appropriate indicators can be used to measure students' cognitive processes. In compiling questions it is very important to maintain the quality of the questions so that the questions can measure what should be measured[14]. Prospective educators must be able to compile appropriate questions, both indicators and cognitive processes that will be measured in students through the questions presented. A question prepared without starting with a grid has the potential not to achieve the achievement indicators so that the instrument is not proportional[37].

The relationship between the accuracy of the question indicators and the accuracy of indicators, operational verbs, accuracy of statements, and cognitive processes

The results of the study in Table 3 show that there is a correlation between the accuracy of the question indicators and the accuracy of the indicators, operational verbs, statement accuracy and cognitive processes. Questions that can be used to measure student learning outcomes are questions that must have compatibility between the competence of the question indicators and the construction of the questions[38]. These results are in accordance with the results of the study[15] that indicators can be reduced to questions, one of which is HOTS-based questions. Each item written must be based on the formulation of indicators that have been arranged in a grid[39,40]. In addition to the accuracy of the indicators, the question indicators must be in accordance with the specified operational verbs. operational verbs shows the location of the cognitive dimension of operational verbs which is a marker of the hierarchy of learning objectives[41]. The cognitive level of the questions in the problem must correspond to the expected cognitive level in the grid with the question construct and language[38]. Cognitive levels include C1 (knowledge), C2 (understanding), C3 (application), C4 (analysis), C5 (synthesis) and C6 (evaluation)[42]. The questions compiled by the teacher must be able to apply the

cognitive domain that is measured, namely the accuracy of the statements compiled in the questions[43].

Operational verbs relationship with the accuracy of the indicators of questions and cognitive processes

The results of the research in Table 3 show that operational verbs has a correlation with the accuracy of indicators and cognitive processes in the questions prepared by students. operational verbs describes the behavior to be achieved through a learning. This operational verbs is needed by the teacher when compiling syllabus and lesson plans. Each domain, namely cognitive, affective and psychomotor, has different verb formulations[44]. The selection of operational verbs is used as material for formulating question indicators[45,46]. The selection of operational verbs according to the HOTS question indicators can determine the achievement of students' cognitive domain measurements[47]. In formulating indicators of HOTS questions, operational verbs is usually used based on bloom taxonomy to determine the dimensions of knowledge being measured[48]. operational verbs relates to the level of students' high-order thinking skills in learning activities[49]. According to Yenusi's research, operational verbs can be used to group a question, one of which is HOTS-based questions[46]. Anderson & Krathwohl in 2015 said that verbs in cognitive processes are able to provide benefits in formulating objectives, learning activities and more structured assessment activities. Verbs are able to represent the cognitive processes described in theory and verbs involve processes in the formulation of learning objectives and plans[50].

Conclusion

Preparation of written tests is the most important activity in preparing exam materials for a prospective teacher. The items at least cover and indeed must be prepared in a comprehensive manner. The preparation of questions must go through the question grid maker. Some of the components that must be listed in the grid include basic competencies, materials, question indicators, and measured cognitive level. The results showed that there was a positive relationship between the grid of biology multiple choice questions and the quality of the questions which consisted of the accuracy of the material, the accuracy of the indicators, the accuracy of the item indicators, operational verbs, cognitive processes, answer choices, statement suitability and language suitability. The question grid is one of the guidelines for preparing questions to maintain the quality of the questions so that they can carry out their measurement functions properly, namely measuring what you want to measure according to the student's cognitive domain.

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