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Content validity analysis of first semester formative test on biology subject for senior high school

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Abstract. This study aims to analyze the content validity of first-semester formative test instrument of biology subjects on senior high school in the early stages of developing the good test instrument. The test was multiple-choice format with a reason which uses for diagnosis of biology misconceptions. The content validity was determined by quantitative analysis of expert judgments and qualitative expert reviews. Two quantitative approaches to content validity estimations (*Lawshe's CVR* and *Aiken's V*) were compared in the analysis of a newly developed instrument which consists of 35 items. The data obtained from a panel of five expert judges. A Content Validity Ratio (Lawshe's CVR) initially determined that only one item lacked inter-rater proportion agreement about its essentiality to the test instrument (CVR = -0,2). The result of further content validity analysis shows three items had low content validity coefficient (Aiken's V), that is indicating poor item relevance to the test. The qualitative reviews suggest to give attention to questions stem language to nine items include three items earlier. The findings supported the revision of nine items.

1. Introduction

Nowadays, the quality of education has focused on public accountability. One of the ways by which such accountability is measured is by the extent to which students' performance in teacher-made tests can predict their potential performance on the standardized tests [1,2]. Teacher-made tests here can be interpreted as a formative test conducted when the learning is still in progress in the framework of formative assessment for evaluation. In recent years, assessment is a central issue in the field of education and often discussed by many stakeholders from grade level in school, regional, national, and international. Important educational assessment is done to obtain data on the extent to which the level of educational objectives achievement that is implemented [3]. Assessment of education specifically refers to the assessment of learning. At the school level, assessment of formal learning refers to the curriculum which is designed in form of subjects learning to students.

One branch of science used in the learning instructional is biology. The structure of biology science is containing a lot of conceptual knowledge and becomes the part of the national educational goals or in the narrow sense is a objectives of learning biology. Campbell & Reece [4] lays out the knowledge of biology as related knowledge of living things and the ins and outs of his life. Biology encompasses the knowledge of things simple to complex, concrete things start to abstract with regard to living things. Biology is the science of matter with coverage of a very broad and deep. On the path to formal

education, biology noted in the national curriculum and studied ranging from basic education up to the level of higher education.

With regard to the learning material, the material complexity can potentially be a constraint learning achievement of goals, including learning in biology. The demands of mastery the biological material on the dimensions of knowledge includes knowledge mastery of factual, conceptual, procedural, and metacognition. In this case, the biology teacher is required to facilitate and guide students to master concepts, principles, laws, theories, etc. [5]. According to Carin & Sund [6], conceptual knowledge is scientific products or products Science. In other words, students who study Biology need to know aspects of the product of science especially in the fields of biology. Because of the many products of science (biology), in the study of biology is often found the knowledge of students which are not comprehensive.

In Biology, the learning ability of students is expected to experience an increase in the teaching-learning activities through comprehensive and organized. In other words, the goal is to increase the ability of the Biology learning students especially in the field of biology. Related to the biology learning achievement, it is required an assessment of learning biology well when ongoing learning and after completion. On the other hand, Earl [7,8] explained that the assessment of the ongoing learning can support the learning objectives achievement with the principle of *assessment as learning*. Assessment is the Earl refers to types of formative assessment is applied to the learning process [9]. Through formative assessment, the teacher can collect data or related information about learning process that are still running, and teachers also provide feedback to the students so that they are motivated to maintain or improve the achievement of their study.

The teachers are suggested to give attention to the formative assessment as the means of *assessment as learning*. One information in the learning process which can be obtained from formative assessment to improve the biology learning achievement is the data about the student's misconception. Misconception is a barrier to understanding biology [10]. It must be healed by the teacher in the learning process through the formative assessment. In the context of assessment, data or information particularly a quantitative data is obtained through the measurement. To be able to measure the ability of the students needed a measurement tool called the instrument. In this case, the ability of the students may be referred to a variable which is generally a hidden variable (*latent variables*). Mardapi [11] describes these variables can be measured based on the manifest indicator of the variable because it is very difficult to get the data of the hidden variables directly. Bollen [12] added that "*it is impossible to date the first use of latent variables*". Constructing manifest indicator of the variable along with the development of the instrument not as easy as on physical variables. Therefore, the assessment instruments need to be arranged according to the appropriate rules in order to get a quality instrument and a good assessment data.

Azwar [13] imply in general the instrument of measurement is a tool that because certain criteria so it can be used to measure an object's measure or collect the data of a variable. Subali [14] added that in essence the instruments can be divided into two kinds, namely test, and non-test. Group tests such as TOEFL, potential academic test, learning achievement tests, and tests of intelligence, while which are included non-test, for example, the interviews guidelines, questionnaires, observation sheets, a checklist, rating scale, the scale of assessments, and so on. In a narrow sense, and in particular in the field of education, the research instrument can equate with assessment instruments to measure students' ability.

Associated measurement/assessment instruments given the object being measured is the hidden variable, emerging questions whether a measurement tool really measures what would and should be measured as well as the extent to which such reliable measurement tool, really useful, and trustworthy. These questions refer to the two principal things about the terms of a good instrument, namely the validity and reliability. The quality of the research instrument greatly affects the accuracy of the results of a research. Although the design of the study, scale data, and statistical tests are applied is in compliance, to draw conclusions still depends on the quality of the research instrument. When the research instrument has validity and reliability is low, then the conclusions of research or statistical

hypothesis test results become inappropriate. Subali [14] emphasize that the analysis of validity and reliability are very important and need to be done in the development of an instrument.

Based on above description it can be said that the formative assessment of learning in Biology can be applied to measure at the same time supporting learning objectives achievement. The assessment in question can be carried out using instruments that were developed in accordance with the rules of development of the instrument. Given the importance of the quality of the instrument to obtain data accuracy assessment of students ' ability, then it needs to be done the investigation against these qualities, one of them with the analysis of the validity of the content of the instrument. The research is specifically focused on the analysis of the validity of the content as an early stage development instrument assessment formative on biological subjects in the form of tests. Further, research is also done in the comparisons of the technique of determining the validity of a test instrument development related content of good quality. In addition, the results of this research are also expected to be a reference to the reader to apply the technique of determination of the validity of the content in the development of the instrument.

2. Method

The content validity in this study was determined by quantitative analysis of expert judgments and qualitative expert reviews. Two quantitative approaches to content validity estimations (*Lawshe's CVR* [15] and *Aiken's V* [16]) were compared in the analysis of a newly developed instrument which consists of 35 items. The data obtained from a panel of five expert judges. Five experts are consist of two experts of biology education (V1 and V2), one biologist (V3), one expert of learning assessment (V4), and one practitioner; high school biology teacher (V5). The research instrument used in the form of assessment sheet that contains a column of essentiality statements (with three options i.e. *essential*, *useful but not essential*, and *not useful*) and score in five scales for each item accompanied by a column for giving advice. This assessment sheet filled out by the experts of the related test items that are being developed.

The statement essentiality and score for each item is used for the analysis of the validity of the contents quantitatively using the formula *Lawshe's CVR* (the data from essentiality where the essential items are getting 1 score) and *Aiken's V* (from the score of items), while suggestions/feedbacks from expert analyzed qualitatively to the refinement of the instrument. For the purposes of interpretation, the item is valid according to the CVR is the item with a value results of the analysis is greater than or equal to 0 and the item is valid according to the V index is the item with a value of V index is greater than or equal to 0.8. Table 1 containing the formula for calculating the validity of content according to the CVR and V index.

Table 1. Formula calculation of the content validity quantitatively.

Lawshe's CVR	*Aiken's V*
CVR = (2ne/n) – 1	$V = \sum s / [n(c-1)]$
ne = number of expert(s) stating that essential items n = total number of experts who gave the statement	s = r – lo r = the value given by expert lo = lowest validity score c = highest validity score n = number of experts who gave the score

[16]

3. Results and Discussion

3.1. Results

The stating and scoring results quantitatively by experts shows essentiality and the relevance of the items on the formative test instruments being developed on high school biology subjects in form of multiple choice for a reason. The essentiality statement and score given by five experts toward 35 test items are presented in the Table 2.

Table 2. The results of the stating of essentiality and score of test items by five experts.

No. Item	V1		V2		V3		V4		V5		Total	
	Es.[a]	Sc.[b]	Es.[a]	Sc.[b]	Es.[a]	Sc.[b]	Es.[a]	Sc.[b]	Es.[a]	Sc.[b]	Es.[a]	Sc.[b]
1	1	5	0	3	1	4	1	5	1	4	4	21
2	1	5	0	2	0	4	1	5	0	3	2	19
3	1	5	1	4	1	4	1	5	1	4	5	22
4	1	5	1	3	1	4	1	5	1	4	5	21
5	1	5	1	3	1	5	1	5	1	5	5	23
6	0	4	0	3	1	5	1	5	1	4	3	21
7	1	4	1	4	1	4	0	4	1	4	4	20
8	1	5	1	4	1	4	1	5	1	4	5	22
9	1	5	1	4	1	4	1	5	1	4	5	22
10	1	4	1	3	1	4	1	3	0	4	4	18
11	1	5	1	4	1	4	0	4	1	5	4	22
12	1	5	1	3	1	4	1	5	1	5	5	22
13	1	5	1	4	1	4	1	5	1	4	5	22
14	1	5	1	3	1	4	1	5	1	5	5	22
15	1	5	1	3	1	4	1	5	1	5	5	22
16	1	5	1	4	1	4	1	5	1	4	5	22
17	1	5	1	4	0	4	1	5	1	4	4	22
18	1	5	1	4	1	4	1	5	1	5	5	23
19	1	5	1	4	1	4	1	5	1	5	5	23
20	1	5	1	3	1	4	1	5	1	5	5	22
21	1	5	0	3	1	4	1	5	1	4	4	21
22	1	5	1	4	0	4	1	5	1	3	4	21
23	1	5	1	4	1	5	1	5	0	5	4	24
24	1	5	1	3	1	4	1	5	1	4	5	21
25	1	5	1	3	1	4	1	5	1	4	5	21
26	1	5	1	4	1	4	1	5	1	4	5	22
27	1	5	1	4	1	4	1	5	1	4	5	22
28	1	5	1	4	1	4	1	5	1	4	5	22
29	1	5	1	4	1	5	1	5	1	4	5	23
30	1	5	1	4	1	4	1	5	1	4	5	22
31	1	5	1	4	1	4	1	5	1	5	5	23
32	0	5	1	4	1	4	1	5	1	4	4	22
33	0	5	1	4	1	5	1	3	1	4	4	21
34	1	5	1	4	1	5	0	3	1	4	4	21
35	1	5	1	4	0	4	1	5	1	5	4	23

[a]*Es. = essentiality;* [b]*Sc. = value of item relevance.*

Table 3. The results of the content validity analysis quantitatively with *Lawshe's CVR* and *Aiken's V* formula.

No. Item	*Lawshe's CVR*		*Aiken's V*	
	Index (CVR)*	Category	Index (V)*	Category
1	0,6	Valid	0,80	Valid
2	- 0,2	Invalid	0,70	Invalid
3	1,0	Valid	0,85	Valid
4	1,0	Valid	0,80	Valid
5	1,0	Valid	0,90	Valid
6	0,2	Valid	0,80	Valid
7	0,6	Valid	0,75	Invalid
8	1,0	Valid	0,85	Valid
9	1,0	Valid	0,85	Valid
10	0,6	Valid	0,65	Invalid
11	0,6	Valid	0,85	Valid
12	1,0	Valid	0,85	Valid
13	1,0	Valid	0,85	Valid
14	1,0	Valid	0,85	Valid
15	1,0	Valid	0,85	Valid
16	1,0	Valid	0,85	Valid
17	0,6	Valid	0,85	Valid
18	1,0	Valid	0,90	Valid
19	1,0	Valid	0,90	Valid
20	1,0	Valid	0,85	Valid
21	0,6	Valid	0,80	Valid
22	0,6	Valid	0,80	Valid
23	0,6	Valid	0,95	Valid
24	1,0	Valid	0,80	Valid
25	1,0	Valid	0,80	Valid
26	1,0	Valid	0,85	Valid
27	1,0	Valid	0,85	Valid
28	1,0	Valid	0,85	Valid
29	1,0	Valid	0,90	Valid
30	1,0	Valid	0,85	Valid
31	1,0	Valid	0,90	Valid
32	0,6	Valid	0,85	Valid
33	0,6	Valid	0,80	Valid
34	0,6	Valid	0,80	Valid
35	0,6	Valid	0,90	Valid
Total	**0,81**	**Valid**	**0,84**	**Valid**

*) Category by Azwar [16]

Table 4. Advices on the results of the qualitative review by experts toward the test instruments being developed

Expert	Advices
V1	Giving attention to the basic of *blue-print* construction. The biological material in the stem of question need specification, for example, focus on the structure and function of living things. The answers choice in item 10 is less homogeneous.
V2	In item 11, basic classification already mentioned, then better modified the construction of the statement. Item 26 construction need to be changed to fit the indicator to "comparing".
V3	Some indicators need to be revised so that it becomes essential to be tested. If possible, pictures can be clarified. The selection of words needs to be reviewed.
V4	Some verbs in the indicators need to be formulated precisely according to the aspects measured. A choice answers in item 10 is less homogeneous. The negative statement needs to be print underlined or in bold. Item 33 needs to be changed so that is match with the indicators in construction.
V5	The indicator is high relevance with this aspect of the measure, but need the proper statement in the stem of the question. Item 2, a branch of biology needs to be formulated precisely. Item 6, the better its plant species mentioned. Item 7, need added emphasis that the mention of the biodiversity levels in order. Item 11, the basic classification already mentioned, then better modified the construction. Item 25, no need to mention about the role of bacteria in the stem of the question. Item 29 has already mentioned the causal relationship that can confuse students/testee filling the reason. Item number 26 and 33 need to be changed in construction.

Qualitative results Summary: The advice of experts directing on the improvement of construction, grammar and writing in general, and in particular for the revision of nine items i.e. item numbers 2, 6, 7, 10, 11, 25, 26, 29, and 33.

3.2. Results

One of the fundamental questions in an assessment is the extent to which the accuracy of the values obtained with the ability possessed by the subject is assessed [17]. In other words, the question related to the validity of the results of the assessment or in this case the corresponding validity of the instruments used to assess. Assessment instruments need to be developed in accordance with the rules of the development/construction of the instrument. On learning in schools, assessment instruments could be developed in the form of varied ranging from the form of multiple choice tests to an expanded field. The validity of the instrument is one of the terms of the construction of good quality instruments, including an instrument tests. Therefore, the construction of the test requires an analysis of the validity for the refinement of test items at once proves that the test results can be meaningful and useful to the assessment as expected [18].

In the development of instruments, the first step of the test developer should do is investigate the validity of the contents [19]. Hinkin [20] stated that the validity of the contents is required on the development phase the scale of psychology. In this case, the development of psychological scale can be equated with the development of the test. This can be done with consideration of experts to assess the suitability of the item with the concept measured. Index of agreement or relevance is acceptable should be determined before the test conducted trials. The validity of the analysis conducted in this study is the analysis of the validity of the content that is part of the initial construction of formative tests on biological subjects in high school. There are several ways to analyze the validity of the content of the test instrument either quantitative or qualitative nature [21]. Many techniques of analysis of the content validity quantitatively, two of which applying in the analysis are the Lawshe and Aiken formula. Both types of analysis are the simple technique and easy to do to prove the validity of an instrument with the consideration of the expert.

Based on the judgment of the experts who served on Table 2 then do calculations using formula Lawshe (CVR) and Aiken (V) index gained validity in Table 3 where the overall index of 0.81 for a

test CVR and 0.84 for V index. This value indicates that the content validity of the instruments is in the high category. From the results of the analysis of CVR, it appears that there is only one item that stated invalid (item 2) and based on the results of the analysis V index on these items also showed below of 0.8. Next, on the analysis according to the formula of Aiken, in addition to the item 2, there are two other items entered an invalid category i.e. item number 7 and 10. In other words, quantitatively, item 2, 7, and 10 needs to be revised so that such items be useful in tests. Revision of item in question also need to consider the qualitative review results (Table 4) in the form of expert advice toward related items. In item 2, more experts who stated that this item is not essential but still useful in a test because the item is still quite relevant to aspects of the "exemplifies" on the scope of biology (biology as a science), whereas the constructions of item 7 and 10 and its language need to be fixed. Particularly, in item 10, also to note its homogeneity of the answer.

In addition to the three items above, further associated revision, Table 4 shows some of the items that need to be the focus of the revision, that are item number 6, 11, 25, 26, 29, and 33. Revision or improvement that emphasized by the experts is the writing in terms of grammar and construction of test items. Both these aspects are also advised to note on the preparation of test items as a whole. The revision instrument based analysis results support this content validity of proof of the validity of the instrument test empirically next once done testing instruments. The validity of the content critical to proved to support the accuracy of the measurement results on a test. However, Hinkin [22] mention that some technique the determination of the validity of the content that has been applied by the researchers haven't been able to ensures that the scale or test has valid content, but it will provide a proof that the item is a reasonable of construction under testing and reduce the need for improvements in the future.

Research results of Polit and Beck [23] getting a conclusion that clarity about the validation of the content in the development of a test is very necessary. Validation of content give some recommendations that can be used to improve the content of an instrument that will be used for assessment or research in learning. Furthermore, Polit and Beck [23]. and Polit, *et. al.* [24] describes that the validity of the contents shows the size of the deal about the relevance of the items among the experts. This is in accordance with the formulations presented by Azwar (2017:134-135) i.e. the validity of the formula according to Lawshe (CVR) and Aiken (V) formula. Furthermore, Wynd, Schmidt, & Schaefer [25] added that the validity of the content of the instrument is often determined through either an expert review qualitative or in quantitative agreement against reviewers.

The two quantitative approach to analyze the content validity applied in this analysis in accordance with the results of the research Hinkin [22] that testing the validity of it can be done continue to - continuously and not simply use one of the techniques in doing. From the data analysis the analysis, it is known the distinction of results of CVR analysis there is only one item that is not valid while the analysis on V index there are three items that are not valid. This difference is indeed often found in the analysis of the content validity [26]. Further, if the results of the analysis of the content validity of both formula are correlated to use Pearson correlation, the results obtained are not high enough (r = 0.514). With no negative correlation values, it can be said that both of these techniques are in line (not against), but because the value is not high enough then for decision-making category valid and invalid items should preferably be based on one calculation between the two. Although the test results according to Lawshe's CVR and Aiken's V are slightly different, both techniques are still often recommended by experts to analyze the validity of the contents quantitatively [16].

Based on the description of this, it can be stated that the content validity is important to be done as an initial step in the test construction to prepares the good measurement. Study on the content validity is still needed in further research [27], either qualitatively or quantitatively [28]. On the other hand, in addition to the content validity, there are several other types of validity that are also important to note such as factorial concurrent, construct, and predictive validity. Several types of validity can be further analyzed through trials of the use of instruments in the field [16]. The results of the content validity analysis on this study is an early stage in the construction of formative tests of biological subjects for senior high school. The next stage, in order to complete the construction of the tests, will be carried

out revisions and testing tried out and doing the analysis of validity as well as the reliability of the test empirically.

4. Conclusion

The content validity of a test instrument can be determined using either quantitative or qualitative approach based expert judgment/review. Quantitatively, the content validity of the tests instrument can be analyzed using the Lawshe (CVR) or Aiken (V) formula and can be done through qualitative expert review of the content material, construction, and language. A Content Validity Ratio (Lawshe's CVR) initially determined that only one item lacked interrater proportion agreement about its essentiality to the test instrument (CVR = - 0,2). The result of further content validity analysis shows three items had low content validity coefficient (Aiken's V), that is indicating poor item relevance to the test. The qualitative reviews suggest to give attention to questions stem language to nine items include three items earlier. The findings supported the revision of nine items. Furthermore, related to the content validity quantitative analysis, it is advised to use one technique/formula for the calculation so that it can be more focused on doing the revision of instrument.

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