Inovation of Biology learning through the development of authentics assessment based on scientific literacy for student of senior high school

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Abstract. This study is a development research, which uses ADDIE development model. The study was conducted in the even semester of the academic year 2019/2020. The authentic assessment instruments developed consist of cognitive and psychomotor assessment instruments for measuring the students’ science literacy skills in 10th grade on Environmental Change material. Indicators of scientific literacy refer to indicators developed by Gormally (2012). Measurement aspect were the validity by the expert appraisal and empirical validity test, difficulty level and practicability of instrument. The results of study showed the authentic assessment instruments that had been developed were proper to use with validity value 4.43. Empirical validity data for multiple choice were analysed using point biserial correlation. Result showed 76% in valid category with reliability value 0.82. For essay and psychomotor assessment showed 100% in valid category. The reliability value for essay is in the reliable category with value 0.62. Psychomotor assessment with reliability value 0.89. Difficulty index of assessment instrument in cognitive domain for multiple choice were 24 % in difficult level, 44 % in moderate level and 32 % in easy level, meanwhile for essay 40 % difficulty index in moderate level and 60 % in easy level. Result of data analysis for and practicability of authentic assessment instruments based on scientific literacy were in practically category.

1. Introduction

The assessment process is an integral part of the learning process, it should be holistic that covers all aspects of the learning objectives. The assessment process is considered as one of the problems in education, because the assessment instruments made by the teacher only focus on measuring the cognitive domain of students. Based on the observation results at school which show students tend to memorizing subject matter rather than understanding the material so it’s less able to apply it in real life and causes low achievement of students' scientific literacy.

Based on Permendikbud No 104/2014, the implementation of the 2013 curriculum recommends the use of authentic assessments. Authentic assessment describes an assessment process in every aspect and able to provide holistic information about students' abilities. Authentic assessment refers students to do real tasks [1]. Authentic assessment also encourages students to develop analytical skills, even to be able to real task as application of their understanding of the subject matter [2].
Scientific literacy skills of students in Indonesia is recognizing basic facts level [3]. The low achievement of students' scientific literacy is caused by several factors, including: students are not familiar with questions with characteristics of PISA test and the learning process less support the students' scientific literacy aspects [4]. To improve the achievement of students' scientific literacy, teachers need assessment tools based on scientific literacy. Based on the above background, it is necessary to conduct research with the title "Innovation of Biology Learning through the Development of Authentic Assessment Instrument Based on Scientific Literacy for Students of Senior High School".

2. **Research Method**

This study uses the Research and Development which is oriented to develop an authentic assessment instrument based on scientific literacy which refers to the ADDIE model which is consist of Analyse, Design, Develop, Implement and Evaluate [5]. Each of this stage are described as follows.

2.1. **Analysis**

Preliminary data collection, problems analysis which experienced both teachers and students in Biology learning. The analysis stage is divided into several stages as follows.

2.1.1. **Need analysis.** This stage aims to analysing the problems, reviewing and analysing the format of existing assessment instruments and analysing the factors that cause the low achievement of scientific literacy.

2.1.2. **Student analysis.** This stage aims to analysis the characteristics and student academic abilities towards Biology learning.

2.1.3. **Content analysis.** This stage aims to identify and arrange systematically the subject matter and analyse the conceptual structure of the material studied by students in accordance with the 2013 curriculum and refer to core competencies (KI) and basic competencies (KD).

2.2. **Design**

Initial design or prototype 1 of authentic assessment instrument based on scientific literacy. This stage consists of determine the form of assessment, indicators of scientific literacy and designing the test grids.

2.3. **Develop**

Validation the initial design of the authentic assessment instrument by the experts of biology education. Results of the validation used for revision called as prototype 2.

2.4. **Implement**

Prototype 2 is tested on research subjects, then conducted the reliability test.

2.5. **Evaluate**

Determine the validity, reliability, difficulty index, and practicality of the instruments has been developed and implemented in 10th grade.

3. **Result**

3.1. **Analysis**

3.1.1. **Need analysis.** The majority of the assessment process conducted which is limited to the cognitive domain obtained from the students test scores at the end of the lesson and tends to ignore the assessment of the learning process. So that teachers need authentic assessment instruments based on science literacy. Mastery of scientific literacy is important for students, because it is related to their
ability to solve the problems in real life. Scientific literacy skills can make students become problem solvers.

3.1.2. Student analysis. This stage was conducted for 10 grade students of the academic year 2019/2020. It showed the lack of student’s involvement when the teacher asked questions or problems that required analytical skills or high order thinking skill (HOTS). Students will only provide feedback when ruled by the teachers and seemed hesitate. This indication shows the students have difficult to conveying ideas to solve problems related to the learning topic being studied.

3.1.3. Content analysis. Content analysis aims to determine the concepts that will be presented in assessment instrument based on the curriculum 2013 in Basic Competencies 3.11 Environmental changes. This basic competence was chosen because the problem of environmental change such as pollution can be used to train analyzing phenomena in real life and make a decision to solve it, and it’s also one of the materials which tested in measuring scientific literacy skills held by PISA.

3.2. Design
Activities prototyping assessment instrument in design stage consists of three activities as follows.

3.2.1. Determine the form of assessment. The form of assessment for measure the cognitive domain is using a written test, which consists of two, namely: a test held for each end of learning (authentic test) and a test at the end of basic competence 3.11 Environmental change (non-authentic test). Assessment for measure psychomotor domain is performance assessment consist discussions and conducting simple experiments. Overall developed into an authentic assessment instrument based scientific literacy.

3.2.2. Determine the scientific literacy indicators. Scientific literacy indicator refers to the indicator which developed by Gormally consists of 7 indicators [6]. This study only uses 5 indicators of scientific literacy, namely: a) identifying valid scientific opinions, b) conducting effective review of literature searches, c) understanding the elements of research design and how the findings impact / conclusions, d) making an accurate graphs based on data, e) making inferences, predictions, and conclusions based on quantitative data.

3.2.3. Designing the grids. Cognitive assessment instruments made in the form of multiple choice and essay tests. Then arranged a test grid with cognitive domain C4-C6. Cognitive assessment instrument consists of 25 numbers multiple choice with 5 choices and 5 numbers essay. The psychomotor assessment instrument is designed using a rating scale and analytic rubric with a scale range 1-4.

3.3. Develop
The initial product of authentic assessment instrument based on scientific literacy that has been developed is validated by the expert of Biology education as validator. The results of the validator's assessment obtained an average value: 4.43 including the "Valid" category. The results of the analysis of the validity of the teacher response questionnaire obtained an average value: 4.61, including the category "Very Valid", so it was declared proper to use on the subject.

3.4. Implement
The implementation process in the class is carried out for 4 meetings, 3 meetings for the learning process and the implementation of authentic assessments and 1 meeting to conduct non-authentic tests to measure students' scientific literacy skills. The result of the teacher response analysis is presented in Table 1.

| Respondents | Percentage of Teachers | Category |
|-------------|------------------------|----------|

Table 1. Results of Teacher Response Analysis.
The teacher's response is very positive because the assessment instruments are easy to be use and make it easier for teachers to make the assessment process simpler and more directed. Data implementation of assessment was obtained through the observation sheet which is filled in by the observer for each meeting of learning process. The results analysis of the implementation assessment instrument based on the observations of the observer showed an average 1.55 in the implemented category. The results of the observer's assessment show that the authentic assessment instrument developed can be implemented in the learning process and students can carry out activities according to the provisions.

3.5. Evaluate
This stage is aims to evaluate the products that has been developed which include empirical validity and reliability tests of cognitive and psychomotor assessments, analysis of difficulty index for multiple choice and essay.

3.5.1. Validity test. Validity test of the authentic assessment instrument in this study was conducted in two ways, first the logical validity based on the expert assessment, second, empirical validity using point biserial correlation for multiple choice and product moment correlation for essay and psychomotor assessment instruments with help of JASP and PSPP software. Results of the empirical validity analysis of 25 the number of multiple choice that have been tested, there are 76% valid questions with $p \text{value} (\text{p-value}) < \alpha = 0.05$. Results the empirical validity analysis for multiple essay questions and psychomotor assessments were declared valid 100%, with a value of $p \text{value} (\text{p-value}) < \alpha = 0.05$.

3.5.2. Reliability test. Reliability analysis of authentic assessment instruments was carried out with help of PSPP software. Summary result of reliability test analysis is presented in Table 2.

| Form of assessment     | Reliability value | Coefficient reliability | Reliability level | Conclusion |
|------------------------|-------------------|--------------------------|-------------------|------------|
| Multiple choice        | 0.82              | 0.80 ≤ 1.00              | Very reliable     | Reliable   |
| Essay                  | 0.62              | 0.60 ≤ 0.80              | Reliable          | Reliable   |
| Performance Assessment | 0.89              | 0.80 ≤ 1.00              | Very reliable     | Reliable   |

Overall results of authentic assessment reliability analysis have been declared reliable with the level of reliability in “very reliable” category with an R value 0.82 for multiple choice questions and for essay the level of reliability in “reliable” category with an R value of 0.62. Psychomotor assessment instrument with an R value 0.89.

| Category       | Number of questions | Total | Percentage (%) |
|----------------|---------------------|-------|----------------|
| Multiple choice|                     |       |                |
| Difficult      | 5, 10, 15, 16, 21, 22 | 6     | 24 %           |
| Moderate       | 3, 4, 7, 8, 9, 12, 13, 14, 18, 19, 25 | 11    | 44 %           |
| Easy           | 1, 2, 6, 11, 17, 20, 23, 24        | 8     | 32 %           |
3.5.3. Difficulty Index. Difficulty index was analysis with help of Microsoft Excel 2016. Summary result of difficulty index is presented in Table 2.

| Essay | Difficult | Moderate | Easy |
|-------|-----------|----------|------|
|       | -         | 2, 3     | 1, 4, 5 |
|       | -         | 2        | 3     |
|       |            | 40%      | 60%   |

Result analysis of difficulty index of multiple choice items are generally in the “moderate” category with a percentage of 44%, the “easy” category 32% and the “difficult” category 24%. Difficulty index of the essay in “easy” category with a percentage of 60% and 40% in the moderate category.

4. Discussion

Authentic assessment instruments based on scientific literacy on cognitive aspects were in the valid category. This is because the material presented in the items is in accordance with the material in the curriculum 2013 which uses in Indonesia. Similarly, validity on the language aspect obtained in valid category, because the assessment instruments uses sentences that easy to understand, the time allocation also obtained in valid category because assessment instrument has rational allocation as needed. Results empirical test of the assessment instruments shows the validity of the matter relatively good, because more than 50 percent number of questions in valid category. It means that matter is able to provide information which is used to measure the scientific literacy skills.

Psychomotor assessment is used to assess performance during discussions and conducting simple experiments. The results of validity test for performance assessment overall declared "Valid". Assessment consist of how to observe, preparation tools and materials, analyse data, discussions and presentations and make conclusions based on data. Performance assessment is believed to be able to train students' scientific literacy skills through contextual experimental activities.

Authentic assessment instruments based on scientific literacy, both cognitive and psychomotor domain which tested the reliability value were in the "Very Reliable" category. It is accordance with Alpha Cronbabach's reliability level criteria that the value 0.80 to or equal to 1.00 is at a very reliable level of reliability [7]. Meanwhile, the level of reliability essay is in the "Reliable" category. The level of reliability indicates that the essay form is appropriate to be used to measured students' abilities on the scientific literacy aspect.

Difficult index for multiple choice in the “Difficult” category is 24%, in "Medium" category is 44%, and "Easy" category is 32%. Difficult Items use as a marker for students does not mastered the cognitive level indicators analysis, evaluation, and creation. Meanwhile, essay questions have a moderate difficulty index. It means the essay questions are feasible and good. This is in accordance with Arikunto who states that a good question which question not too easy or not too difficult [8].

Results data analysis of teacher response in the practicality category is "Very Positive". Interpretation data of teacher response according to Arikunto that teacher's response is between 80.1% -100% meaning that the practicality interpretation is very positive [9]. Likewise, the implementation of the assessment instrument based on the observer's observations obtained the implemented category. This is in Accordance with Arsyad who states data interpretation of assessment instrument implementation with the value range 1.5 < M ≤ 2.0 is implemented category [4].

Based on the results of the validity test and empirical test, the authentic assessment instrument based on scientific literacy is declared "Practically", because it is qualify two criteria, namely "Valid" and "Implemented". This is in accordance with Arikunto in [7] who states that practically instrument with characteristics are easy to implement and easy to examine.

5. Conclusion

The conclusions of this research and development are: 1) The authentic assessment instrument based on scientific literacy that has been developed is valid, reliable, practically, implemented and has difficulty, moderate, and easy levels of difficulty index. 2) the availability of authentic assessment
instruments that are suitable for teachers to use is an innovation in learning biology, especially in "Environmental Change" material.

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