Desemination of Authentic Assessment in Local Content-Based Sciences Learning to Achieve The Learning Outcomes Based on Nature of Science

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Abstract. This research aimed at disseminating the valid and practical instrument of authentic assessment to be used in sciences learning of junior high school in order to realize the learning outcomes based on Nature of Science. The implementation of this authentic assessment is based on the utilization of local content (natural potential, culture and local wisdom of the archipelago) in Indonesia. This research used Research and Development (R&D) method which was done by taking sample from the schools in some regions with various local content characteristic. The subjects consisted of 89 students from two schools in Kulonprogo and Gunungkidul Regencies, Yogyakarta Special Region. The development model in this research was Four-D Models. The model was implemented through the Define, Design, Develop, and Disseminate stages. The results of this study were (1) the dissemination results of valid authentic assessment to achieve learning outcomes based on NOS with V’Aikens coefficient of 0.86-1, and the inter-rater reliability can be catagorized as “Good”, (2) the effectiveness result of authentic assessment dissemination can be catagorized as “Good” for achieving NOS-based learning outcomes, and (3) the level of practicability of the authentic assessment of NOS-based learning outcomes catagorized “Good” according to both users (teacher and learner).

1. Introduction
Nature of Science (NOS) is an interisic value and assumption to develop scientific knowledge [1]. It contains knowledge of the epistemology (method) of sciences, the process of sciences phenomena, or the inherent values and beliefs of sciences development [2]. NOS is represented by 10 characters, the two characters attach to the epistemology of sciences and other characters belong to the epistemology of the sciences development. Moreover, Sciences, in this case, Natural Science is focused on how to systematically learn about nature, which not only the mastery of a collection of knowledge in the form of facts, concepts or principles but also a process of discovery.

Hacieminoglu [3] explains that an important aspect of NOS is to make the distinction between observation and inference as well as understanding the relationship between theory and principle of sciences. It can help students to develop the understanding and the thinking habits that are to be loving and self-sufficient human beings. Understanding of NOS is crucial as the graduation criteria to make sure that the students possess science literacy ([4]). Even, Mullis and Jenkins (in [5]) argue that a good NOS comprehension can provide the intellectual abilities to develop science and technology. However, some findings indicate that both teachers and pre-service science teachers have low understanding of NOS.

One important element in NOS development is the utilization of local content as the sciences learning resource. The local content is the result of a particular society / ethnicity through their experience which may not occur in other communities. It adheres strongly to a particular society or ethnicity, because the value of local wisdom is reliable that has been through a long process. In fact, it lasts as long as the existence of its particular society or ethnicity ([6]). Subali, et al. ([7]) attempt to designing the science learning based on local wisdom and reveal an increase of 11 positive characters of students, with the dominant positive character including honesty, discipline, thoroughness, diligence, carefulness, responsibility, and environmental care.

One of the problems that still occur in the learning process is in case of assessment which implemented only after the learning process (assessment of learning). It Ali just focus on cognitive aspect. It makes the assessment incomplete to answering the process standards and it does not match NOS requirements. Yahaya [8] states that in order to measure the achievement of student learning objectives, the nature of science learning does not always make assessment in the form of a test but it can be done through information collection about students to provide more accurate data about students’ skills and attitudes [9]. A direct assessment can also be done to measure the learning process of students [10] where this kind of assessment called authentic assessment. It is implemented through three approaches, namely assessment of learning, assessment for learning, and assessment as learning.
Assessment for learning is developed during the learning process as a foundation to improve the teaching and learning process. In this assessment, teachers provide feedback on students’ learning process, monitor the progress, and determine the progress of learning. It can also be utilized by teacher to improve the students’ performance. The examples of assessment for learning are assignments, presentations, projects, and quizzes [11].

Moreover, assessment as learning as part in the authentic assessment has a similar function to the assessment for learning, which is formative and implemented during the learning process or based on the assessment results. The difference is that assessment as learning involving the students active participation in the assessment activities. Learners can have an experience to be assessor for themselves. Self-assessment and peer-assessment are the examples of assessment as learning. Authentic assessment itself is a direct assessment or measurement that require the students involvement in formulating assessment procedures, criteria, or rubric/ guidelines to make them know exactly what should be done in order to obtain maximum learning outcomes [12].

Authentic assessment can be used to measure the students’ performance, achievement, motivation, and attitudes on relevant activities in learning. Moreover, Stiggins [13] suggests the decent learning outcomes that can be used as the basis to determine the type of authentic assessment should cover the students' ability towards (1) the substance of knowledge; (2) knowledge in reasoning and problem solving; (3) skills in knowledge mastery; (4) products creation; and (5) attitudes of knowledge application. Stiggins [13] also offers the types of basic assessment methods, such as (a) selected response assessment; (b) essay assessment; (c) performance assessment; and (d) personal communication assessment. The assessment can be done in the form of written test, action test, assignment, authentic assessment based on NOS, product assessment, attitude assessment, and portfolio assessment [14]. Therefore, it is very important for teachers to consistently apply authentic assessment in implementing Kurukulum 2013. With the application of authentic assessment, the learning process should involve complete activities in developing cognitive, affective and psychomotor abilities.

2. Research Method

The research procedure was carried out through the stages of Research and Development (R & D). The main objective is to develop and to validate a program or model of authentic assessment in local content-based science learning to realize the learning outcomes which is in accordance with the nature of Science to make sure the objective of product development becoming effective and ready to be implemented. The R & D stages were formulated into 4-D models [15] and adjusted to [16].

The research was using Research and Development method, as the research flow illustrated in Figure 1. The phase of “define” or “research and information collection” [16] was the initial research and data collection through literature study, Seed analysis and field study. The design or planning phase [16] was the product design that would be produced, including the purpose of using the product in the form of authentic assessment in local content-based science learning to realize learning outcomes based on the nature of science, product users and description of components product. The stage of develop or develop preliminary form of product [16] was an early product development. The disseminate phase had four developmental steps, namely preliminary field testing [16] which were initial field trials, main product revision [16] or test results revision, main field testing [16] or field trials and operational product revisions.

In the define stage, it was conducted research and information collection, covering; (1) theory analysis or literature study. This stage analyzed theoretically about authentic assessment in local content-based science learning to realize learning outcomes-based nature of science, and (2) needs assessment, by identifying the key process of skills and analyzing them in a set of sub-skill required. This analysis ensured the integrity of the tasks in the authentic assessment of local content-based science learning to achieve the learning outcomes based on the nature of science, as well as the activity plan approach to the selection of the learning model and the evaluation design. The activity of assessment development included information discussion, modeling, assignment, group work, and practice. Meanwhile, evaluation of the implementation process consisted of observation, performance test and practice test and NOS-based learning model, conducted collaboratively.
The next stage was to identify the key concepts in developing authentic assessment in local content-based science learning by organizing them in hierarchy and outlining the key activities [17]. The development activities of the authentic assessment covering all student activities in the learning i.e. assessment of learning, assessment for learning and assessment as learning.

The design phase was started by identifying the learning needs of science based on the 2013 curriculum. Then, developing the product included the purpose of using the product in the form of authentic assessment in local content-based science learning to realize learning outcomes based on the nature of science, product users and description of product components, as well as planning the product implementation and evaluation. The phase of “develop” was producing an authentic assessment model in local content-based science learning to realize learning outcomes in accordance with the nature of science, which was empirical in terms its practicality and effectiveness through trials in several schools.

The authentic assessment of local content-based science learning to realize learning outcomes based on Science, then it was disseminated (Main Field Testing), and all the variables that became the focus or development goals were observed. The instrument that had been compiled was validated to ensure that the instrument used was measuring what it was supposed to measure [18]. The items that had been developed based on the distributed guidelines according to the description of the material listing in the curriculum, so that the content validity or theoretical validity had met the requirement. The content validity coefficient in this research was processed from the score given by expert judgment. Those results were processed using the Aiken formula [19]:

\[ V = \frac{\sum s}{n(c - 1)} \]

\( s = r - l_o \)
\( l_o = \) the lowest validity score
\( c = \) the highest validity score
\( r = \) the given scores from the assessor

Four ratings categories were used, namely “irrelevant, less relevant, relevant, and highly relevant” then the aiken index should be 0.87 (\( \alpha = 0.05 \)) or 0.93 (\( \alpha = 0.01 \)) [19]. However, according to Sireci & Geisinger [20], the validity coefficient of 0.7 was still acceptable and considered satisfactory. Based on the analysis using aiken formula, it was obtained index average content validity of 0.924. The content validity for the items of authentic assessment moved from 0.86 to 1. Thus, it can be concluded that the items in the test instrument were valid. The
3. Result and Discussion

The initial phase of this research was the development of conceptual definition into the operational definition of the NOS variable [21]. The results of the research on the define or research and information collection stage were NOS-oriented learning design encouraging students to understand the process of inquiry and to know that science constituting logical and imaginative guidance, explaining and predicting facts, but it was not authoritarian. The students understood that science was a complex social activity. A broad understanding of NOS was complemented with the knowledge related to scientific nomenclature, intellectual process skills, rules of scientific evidence, postulates of science, scientific disposition, and major misconceptions about science.

Further, the design or planning phase [15] was the product design including the purpose of product use in the form of pre-service teacher training model, product users and product component description. At this stage, authentic assessment was performed on NOS-based learning based on the specified format at the instrument specification stage [17]. The results of the operational definition was relevant to Next Generation Science Standards [22], as follow.

Table 1. Aspect and Indicator of Nature of Science (NOS)

| No | Aspect                                                                 | Indicators                                                                                     |
|----|------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| 1  | Scientific investigations with arises methods                          | a. Scientific inquiry with the methods and instruments for measurement and observation.       |
|    |                                                                        | b. Scientific inquiry is guided by a set of tools to ensure the accuracy of measurement, observation and findings objectivity. |
|    |                                                                        | c. Sciences depends on the evaluation of the proposed explanation.                           |
|    |                                                                        | d. Scientific values serve as criteria for differentiating both Sciences and non-Sciences.  |
| 2  | Sciences is based on empirical evidence                                | a. Sciences is based on the logical and conceptual relationship between evidence and explanation. |
|    |                                                                        | b. Sciences has common rules for obtaining and evaluating empirical evidence.                 |
| 3  | Sciences is open to improvement when new evidence has been found       | a. The Sciences description can be revised and corrected if new evidence is found.           |
|    |                                                                        | b. The certainty and consistency of sciences is varied.                                     |
|    |                                                                        | c. Sciences findings are often revised and/or reinterpreted based on new evidence.          |
| 4  | The models, laws, mechanisms and theories of science that explain natural phenomena | a. Theory is an explanation of observable natural phenomena.                                 |
|    |                                                                        | b. Scientific theory is based on a collection of facts that evolve over time                  |
|    |                                                                        | c. Law is the regularity or the mathematical description of natural phenomena.              |
|    |                                                                        | d. A hypothesis is used by scientists as an idea that may contribute important new knowledge to the evaluation of scientific theory. |
|    |                                                                        | e. The term "theory" in Sciences is very different from general use outside of Sciences.     |
| 5  | Sciences is the way to know                                            | a. Sciences is a collection of knowledge as well as scientific processes, in other words a collection of knowledge is produced from a scientific process. |
|    |                                                                        | b. Scientists of various generations and nations have contributed to science knowledge.     |
|    |                                                                        | c. Sciences as a way of knowing it has been used by many people.                            |
6 Sciences assumes a sequence and consistency in the natural system
a. Sciences assumes that objects and events in natural systems occur in a consistent pattern and can be determined by measurement and observation.
b. Sciences considers and evaluates anomalies in data and evidence thoroughly.

7 Sciences is the result of human effort
a. Men and Women, from different social, cultural and ethnic backgrounds, work as scientists.
b. Scientists rely on various human qualities, such as diligence, precision, reasoning, logic, imagination and creativity.
c. Scientists are guided by various thinking habits, such as intellectual, honesty, tolerance of ambiguity, skepticism, and openness to new ideas.
d. Technological advances affect the science, and vice versa.

8 Sciences answers questions about nature
a. Knowledge of science is limited by human capacity, technology and materials.
b. Sciences limits explanations for systems that allow for observation and collection of empirical evidence.
c. Science can explain the consequences of action but it is not responsible for community decisions.

The develop or develop preliminary form of product [15] was an early product development. This stage was the implementation of authentic assessment in local content-based science learning. The observation sheets were used to measure its implementation which constituting learning preparation, implementation and learning report. Meanwhile, the questionnaire was to reveal students’ responses in applying authentic NOS-based assessments and whether the learning using authentic NOS-based assessment can improve their creative thinking skills. The observation sheet and questionnaire in field trials had been clarified its validity and reliability.

The data from the observer and the teacher using the observation sheets were converted into the rating category based on [22], where the assessment category was divided into 4 as shown in Table 2, namely; very high (A), high (B), low (C), and very low (D). The result data of the assessment analysis on the observation sheet presented in Table 3.

### Table 2. Catagorization of assessment score

| No | Range   | Score | Category |
|----|---------|-------|----------|
| 1  | X ≥ 3.1 | A     | Very high|
| 2  | 3.1 > x ≥ 2.5 | B | High     |
| 3  | 2.5 > x ≥ 1.9 | C | Low      |
| 4  | X < 1.9 | D     | Very low |

### Table 3. Measurement Results of NOS-based Authentic Assessment

| No | Learning Stage | Mean Evaluation Score per Meeting | Mean | Score | Category |
|----|----------------|----------------------------------|------|-------|----------|
|    |                | 1  | 2  | 3  |         |          |
| 1  | Preparation of learning | 2.57 | 2.35 | 3.45 | 2.83 | B | High   |
| 2  | Implementation of learning | 2.65 | 2.77 | 2.90 | 2.77 | B | High   |
| 3  | Reporting       | 2.66 | 2.98 | 3.1 | 2.98 | B | High   |
|    | Total Mean      | 2.86 |      |     |      |          |
The obtained mean score from the observation sheet analysis showed the range of 2.77-2.98, that indicated all components in high category. In case of the lesson preparation, the score was 2.83 which indicated that 70% of the learning preparation activities were running well and can be observed. Meanwhile, other components, the score categorized as high which indicated most of components running well and can be observed. In general, teachers had conducted preparation activities which means the teacher already presented the assessed aspects, namely the achievement criteria, the type of assessment and the assessment procedure through observing each student activity, giving time to the students to improve their outcomes.

Besides the teacher activities, the students activities had also been done well. The learning activities used project based learning approach and the theme was the interaction of living things and the environment with the worksheet. The students were asked to answer creative questions and to report their observations in the form of presentations. More clearly, the mean of the measurement results towards the authentic assessment of the learning process was presented in Figure 2.

![Figure 2](https://example.com/figure2.png)

**Figure 2.** The graph of NOS-based learning evaluation using authentic assessment

The questionnaires on the feasibility of authentic assessment based on students' responses consisted of 25 statement points with five alternative answers including “Strongly Disagree”, “Disagree”, “Moderate”, “Agree”, and “Strongly Agree”. The analysis result of student response on questionnaire was shown in Table 4. It can be seen the analysis result of student response in questionnaire to authentic assessment NOS-based learning with worksheet to improve creative thinking skills.

| No | Aspect                                                                 | Mean | Category |
|----|------------------------------------------------------------------------|------|----------|
| 1  | Student response to learning using authentic assessment based on NOS     | 69.9 | Good     |
| 2  | Learning using worksheet interaction of living things with its environment that enhance creative thinking skills | 72.6 | Good     |

The data presented in table 4 indicated that the learners' response to the worksheet and the learning considered good with the scores range of 69.9 to 72.6. This showed that learners understood the material of living things interaction with its environment more easily when using authentic assessment based on NOS. They were more enthusiastic in implementing learning activities, they were willing to carry out learning activities in groups, and they became more courageous to express opinions within the group during the experimental reports preparation. By referring to the results, the evaluation can be implemented systematically.

The differences in learning outcomes, before and after the learning, were assessed through pre-test and post-test. Based on the results of hypothesis analysis with Paired Sample t-test to determine the difference on the learning outcome in the experimental class, the sig value (2-tailed) test for the science literature 0.000 <½ α (0.025) or less ½ α (0.025) in which indicated that Ho was rejected. It indicated the hypothesis of there is
difference in the learning outcome with the model of the authentic assessment application of NOS-based learning was accepted. This result is in line with the research findings from [21]. Moreover, [1] also states that NOS integration and scientific inquiry explicitly through reflective instruction in sciences content is able to assist the development of students’ sciences literacy.

4. Conclusion

Based on the results of research and development of authentic assessment, it is declared valid and practical to be used for sciences learning of in junior high school and it effectively realize the learning outcomes based on Nature of Science (NOS), the summary is as follows; The model was implemented through the stages of define, design, develop, and disseminate. The results of this study were; (1) the dissemination results produced valid authentic assessment to achieve the learning outcomes based on NOS with V’Aiken’s coefficient of 0.86-1, and reliability of inter-rater categorized “very good”, (2) the effectiveness result of authentic assessment dissemination showed good category in achieving the learning outcomes based on NOS. It can be seem from the hypothesis acceptance of there is difference in the learning outcome with the model of the authentic assessment application of NOS-based learning where the experimental class was significantly higher than the control class, and (3) the practical level of the authentic assessment categorized “good” from both the users and the students. Given the result of authentic assessment development that has proven its validity, prakticity, and effectiveness, the science teacher can apply it in the science learning class to develop Nature of Science.

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