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Development of Assessment Tools Science Process Skills in Natural Sciences Learning of Junior High School

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Abstract: This study aims to: (1) develop assessment tools of science process skills in Natural Sciences learning of junior high school; (2) formulate appropriate assessment tools of science process skills in Natural Sciences learning. Developmental approach was employed to develop assessment tools of science process skills in Natural Sciences subject learning of junior high school. The research procedures applied 4-D (*define, design, develop, disseminate*) development model. The assessment tool formulated was tested in Junior High School SMP Negeri 1 Gorontalo during odd semester of 2018/2019 academic year. The result shows that the assessment tool is considered **appropriate, valid, effective, and practical** to measure seventh grade students' learning outcome of junior high school**;** validated by expert validator and Natural Sciences teachers.

1. Introduction

Natural science is closely related to systematic way of exploring nature. It is not only limited to the mastery of knowledge such as facts, concepts, or principles; but also a process of invention. Education of natural sciences acts as a medium to nurture the students to study about their selves and nature, as well as developing and integrating the lessons in their daily life. Therefore, it is essential to implement scientific inquiry approach in natural sciences education in order to stimulate students' competence in scientific thinking, performing, behaving, and communicating as important aspect of life skills. Moreover, natural sciences education in junior high school level emphasizes direct learning experience by implementation and development of science process skills and scientific behavior. By that, an integrated approach that involves sciences, environment, technology, and society aspects is essential to be applied in learning process of Natural Sciences subject to develop students' competence of scientific performance [1].

Based on the previously stated background, the study intends to investigate the questions: 1) "How can one develop assessment tool of science process skills in Natural Sciences learning in junior high school?"; 2) "How is the feasibility, validity, effectiveness, and practicality of developed assessment tool in its implementation in Natural Sciences learning process?" This study aims to: (1) develop assessment tools of science process skills in Natural Sciences learning in junior high school; (2) formulate appropriate assessment tools of science process skills in Natural Sciences learning.

Science process skills are certain scientific skills that involve cognitive, manual, and social competence to acquire and develop scientific facts, concepts, and principles [2]. Science process skills

are instrumental in natural sciences education in ways that the skills contribute to (1) nurture students' thinking development; (2) facilitate students in invention process; (3) improve students' memory; (4) provide intrinsic pleasure to students after completing a task; and (5) enables students' to grasp concepts of natural sciences with ease [3].

Moreover, implementation of science process skills in natural sciences learning helps optimize students learning outcome by stimulating students' self-exploration of knowledge by conducting experiments. Therefore, it enhances students' capability to grasp and memorize learning material for relatively longer period [4].

Funk (in Nur, 2011) classifies science process skills into two, i.e. basic and integrated science process skills. Basic science process skills consist of observing, classifying, predicting, measuring, calculating, inferring, and communicating. Moreover, integrated science process skills involve skills i.e. variable identification, data tabulation, data presentation in graph, data interpretation, experiment, and conclusion formulation [5].

2. Research Method

The research was conducted in Junior High School SMP Negeri 1, Gorontalo City to test the developed assessment tool. It employed 4-D (four-D models) that are *define, design, develop, disseminate*) model [6].

3. Findings and Discussion

3.1. Definition Phase

The phase involves analysis of developmental needs, adjustment of development requirements to users' needs, and implementation of suitable development model. The phase is conducted in five steps, i.e. front end analysis, learner analysis, task analysis, concept analysis, and assessment objectives analysis; described as follows:

Front End Analysis

During this phase, the authors conduct analysis on 2013 Curriculum. The 2013 Curriculum consists of Core Competence and Standard Competence to be achieved. Curriculum analysis is critical to determine competencies in which the assessment is developed. Based on the curriculum analysis, the authors intend to develop assessment on junior high school students' science process skills.

Learner Analysis

Learner analysis involves individual academic competence, physical characteristics, group work ability, learning motivation, economic and social background, and prior learning experience.

Task Analysis

Task analysis involves analysis of students' tasks based on the chosen Basic Competence to be developed in order to enhance students' learning competence and exceed minimum competence set.

Concept Analysis

Concept/material analysis is conducted by identifying the main concepts/materials to be assessed, collecting and selecting relevant material, and systematically rearranging the chosen material in form of conceptual maps that combine concepts/material and assessment of natural science learning in seventh grade of odd semester.

Assessment Objective Analysis

During this phase, the authors determine and formulate desired assessment objectives and competence in order to emphasize focus solely on the determined objectives. The formulation of assessment objectives is based on concept analysis and task analysis to be more operable and expressed by observable behavior [7].

3.2. Design Phase

The phase is conducted to prepare prototype of authentic assessment tools in Natural Sciences learning. The phase involves: (a) Core Competencies and Basic Competencies determination, as a reference for teachers in developing assessment techniques and instruments; (b) compilation of content outline containing assessment indicators and strategies; (c) selection of assessment methods and techniques, as well as form of assessment instruments used; and (d) scoring guidelines formulation.

In this study, analysis of design objectives is carried out based on the survey results and learning objectives in schools that are considered in accordance with characteristics of science process skills to be developed [8].. Analysis of design objectives is also adjusted to the Regulation of Ministry of Education and Culture No. 104 on 2014 concerning Assessment of Learning Outcome by Educators in Primary and Secondary Education, which stipulate that dominant cognitive aspects on Natural Sciences subject consist of accuracy, persistence, and logical/systematical problem-solving capacity [9]. Analysis of core competence, basic competence, and learning objectives of affective, cognitive and psychomotor aspect in Natural Sciences subject in junior high schools is displayed in following table 1 [10].

Table 1. Identification of Core Competence and Basic Competence of Natural Sciences subject in junior high school based on 2013 Curriculum.

Core Competence (CC)	Basic Competence (BC)
C1 : Respect and appreciate towards religion teachings the student adheres to.	1.1. Admire the regularity and complexity of God's creation regarding physical and chemical aspects, life in ecosystems, and role of humans in the environment and actualize it in the student's own religious practices.
C2 : Respect and appreciate honesty, discipline, responsibility, care (tolerance, mutual cooperation), politeness, and confidence in interacting effectively with social and natural environment around the student.	2.1. Demonstrate scientific behavior (curiosity; objective; honesty; thoroughness; carefulness; diligence; responsibility; openness; criticality; creativeness; innovation, and environmental awareness) in daily activities as a manifestation of student's attitude in conducting observation, experiment, and discussion.
C3 : Understanding knowledge (factual, conceptual, and procedural) based on students' curiosity about science, technology, art, and culture related to observable phenomena and events.	2.2. Appreciating individual and group work in student's daily activities as implementation of carrying out experiments and reporting the experiment results.
C4 : Testing, processing, and presenting concretely (utilizing, elaborating, arranging, modifying, and making) and abstractly (writing, reading, counting, drawing, and composing) in accordance with learned material in school and other sources in perspective /theory.	5.5. Understanding the characteristics of substances, as well as physical and chemical changes in the substances beneficial for daily life (e.g. mixture separation) 5.5.1. Conducting mixture separation based on physical and chemical characteristics. 5.5.2. Conducting investigation to determine the characteristic of any solutions in the environment using artificial or natural indicators.

3.3. Development Phase

The phase involves two activity: expert appraisal and developmental testing. Expert appraisal is a technique to validate and assess a product's feasibility. While developmental testing is the activity to

test a product towards the targeted subject. The phase consists of steps as follows: (1) Validation of appraisal devices by experts; (2) Revision of assessment tool based on experts' input; (3) Limited trial; (4) revision of assessment tool based on the trial results; and (5) Implementation of assessment tool in broader scope.

An analysis of assessment tool is conducted prior to a wider scale testing by expert team consisting of lecturers of Natural Sciences Department of Universitas Negeri Gorontalo. The analysis result indicates several inappropriate instrument points regarding the analyzed aspect as viewed from the statements or the contents.

Table 2. Analysis result of expert team of assessment instrument of science process skills in junior high school.

Analysis Criteria	Indicator	Assessment Expert - 1	Assessment Expert - 2
General Criteria	Construction of sentences of instruments	Not good	Not good
	Sentence errors in instruments	Good	Good
	Grammar used in instruments	Good	Good
Conformity of construction with its theoretical operations		Appropriate	Appropriate
Conformity with the level of respondents		Appropriate	Appropriate
Conformity of statements with indicators		Appropriate	Appropriate
Conformity of number of statements		Appropriate	Appropriate
Format of assessment instrument of science process skills		Appropriate	Appropriate

The calculation result of experts' assessment in percentage form is summarized in the following table

Table 4. Percentage of Feasibility of Assessment Tool of Science Process Skills by Expert Validators

Feasibility Criteria	**Feasibility Percentage (%)**
Graphic design and layout	82.23
Construction of instrument	85.36
Language	86.53
Contents	89.72
Average percentage of feasibility	**85.96**

The feasibility of the assessment instrument of science process skills developed is measured by four main indicators, i.e.: the feasibility of graphic design, construction, language and content/material.

Each of these indicators is described by sub-indicators. The percentage of graphic design feasibility is 82.23%, which is assessed from clarity of the letters, color, and layout of sentences in the printed paper. The percentage of construction feasibility is 85.36%, this indicator is supported by four sub indicators, i.e. conformity with the curriculum, distribution of indicators, conformity of question items with indicators, and conformity of indicators with aspects measured. The language feasibility of the instrument scores 86.53%, as assessed from use of correct language rules, simplicity of language, ease of interpretation, and proper interpretation. Therefore, the instrument is considered feasible in language terms. The content feasibility indicator scores 89.72%; as the main indicator in validation phase of instrument development, the percentage score illustrates that the instrument is quite feasible in terms of content. The average feasibility scores 85.96%, thus, the assessment instrument is considered feasible to use.

Further, the following table 5 displays the feasibility score of assessment tool as validated by two expert validators and two users (senior Natural Sciences teachers).

Table 5. Recapitulation of validation result of expert validators and users on the assessment tool of basic and integrated science process skills.

Score/ Validator	**Total score (%)**				**Average Score Percentage (%)**
	Expert 1	**Expert 2**	**User 1**	**User 2**	
Score	91.25	91.89	93.85	94.38	92.84
Validator	Expert 1	Expert 2	User 1	User 2	
Score	86.67	87.48	81.20	81.11	84.17

Based on results of the expert validator and users' assessment, it is found that the assessment tool for basic and integrated science process skills developed is **valid** with the average score of 92.84%. Moreover, the validation result indicates that the assessment tool is practical with the average score of 84.17%, or categorized very good.

The expert validators' assessment result is further analyzed descriptively by employing method by Aiken's V and Cronbach's alpha analysis. The analysis result illustrates that the feasibility of assessment tools is able to be measured as displayed in following table.

Table 6. Feasibility of assessment tool of basic and integrated science process skills.

Assessment	Validity			Reliability		
	$V_{average}$	Interpretation	Description	R	Interpretation	Description
Basic science process skills	0.81	Very Appropriate	Valid	0.82	Very High	Reliable
Integrated science process skills	0.83	Very Appropriate	Valid	0.84	Very High	Reliable

The table 6 indicates that basic and integrated science process skills result in Aiken's V score of 0.81 and 0.83 respectively, therefore interpreted as "very appropriate" in valid criteria. The validity analysis result is further supported by consistency calculation of the validator's assessment using the

Cronbach's alpha formula; thus resulting in 0.82 and 0.84 score of basic and integrated science process skills respectively, categorized as "very appropriate" in reliable criteria [11].

Limited Test
Limited test is conducted to 30 students of Junior High School SMP Negeri 1 Gorontalo to measure the effectiveness of the assessment tool.

Field Test
Field test is conducted to 80 respondents, consisting of 39 students of Junior High School SMP Negeri 2 Gorontalo and 41 students of Junior High School SMP Negeri 1 Northern Gorontalo. The result of validity and reliability analysis on assessment instruments shows that the instruments developed are effective and feasible to use.

Product Improvement
Within the phase, the instruments are improved by adding theoretical basis and usage guidelines sections. The finished product is then assessed by Natural Sciences subject teachers at the school. The result indicates that the assessment instruments are categorized as good and feasible to use in measuring students' learning outcome in Natural Sciences subject in junior high school.

3.4. Dissemination Phase
The dissemination stage of the assessment tool is conducted in form of workshops by involving Physics subject teachers included in Subject Teachers Forum (*Musyawarah Guru Bidang Studi*) and related institutions. Further, the developed product of science process skils assessment tools is published in accredited national and international scientific journals.

4. Discussion
The limited trial of the assessment tool draft is conducted in a small group of 30 students of Junior High School SMP Negeri 1 Gorontalo. The result illustrates that the average 83.38% of instruments items are categorized highly valid, as shown by the rcount > 0.22; while the rest 16.62% are categorized less valid. Due to the high validity score, hence, a wider-scale field test is conducted.

Field tests were conducted on 80 respondents, consisting of 39 students of Junior High School SMP Negeri 2 Gorontalo and 41 students of Junior High School SMP Negeri 1 Gorontalo Utara. The result shows that all instruments score good validity, categorized in good and very good with percentage of 12.69% and 87.31% respectively. In determining the quality of instruments, a guideline of assessment tool formulation by the Directorate of Junior High School Development. The analysis result on limited and wider-scale tests illustrates that the overall items within the assessment instruments are effective to use.

The final activity of the development phase is packaging, diffusion and adoption, in order for the product to be beneficial by public and its users. The packaging step is done by printing the guidelines of assessment tool. Afterwards, the assessment tool is then disseminated so that it can be absorbed (diffused) or understood by public and used (adopted) by users.

5. Conclusion
The assessment tool of science process skills in junior high school level developed based on the 4-D development model is categorized feasible, valid, effective, and practical to measure learning outcomes in Natural Sciences subject in seventh grade of junior high school. These criteria are obtained from the assessment and analysis of expert and user validators. The average score of feasibility / validity criteria, reliability, practicality, and completeness of learning outcomes was 92.84%, 0.81, 84.17%, and 83% respectively.

References

[1] Materi Lokakarya Kurikulum 2013. Tahun 2013. Educational Reform. School Reform, Classroom reform, Community Reform, CHANGE, 121.

[2] Rustam, 2005. *Strategi Belajar Mengajar Biologi*. Bandung: Universitas Pendidikan Indonesia, 79-80.

[3] Trianto, 2010. *Mendesain Model Pembelajaran Inovatif Progresif.* Jakarta. Kencana Prenada Media Group, 132-135

[4] Taruh, Enos and Mursalin 2018. *Development of Authentic Assessment Tolss in Physics Science Learning.* Journal of Physics: Conference Series, vol 1028, (2018) 012200. IOP Publishing.

[5] Nur,Mohamad, 2011. Modul: *Keterampilan-Keterampilan Proses Sains* (Disadur dari *Inquiri Skills Activity Book*). Surabaya: Universitas Negeri Surabaya Pusat Sains dan Matematika Sekolah, 47-48.

[6] Thiagarajan, S. Semmel, DS. Semmel, M. 1974. *Instructional Development for Training Teacher of Exceptional Children*. A Source Book. Blomington: Central for Inovation on Teaching the Handicapped p 112-113.

[7] Widayanto, 2009. *Pengembangan Keterampilan Proses dan Pemahaman Siswa Kelas X Melalui Kit Optik*. Jurnal Pendidikan Fisika Indonesia. vol 5. No.1. January 2009, 142-146.

[8] Taruh, Enos. 2014. *Strategi Pengembangan Perangkat Pembelajaran IPA Terpadu SMP/MTs Dengan Menggunakan Model 4 D (Define, Design Develop, and Desiminate)* Penelitian Hibah Bersaing. *Laporan Penelitian*, Gorontalo: Lemlit UNG, 42.

[9] Permen Dikbud No.104 Tahun 2014 tentang *Penilaian Hasil Belajar oleh Pendidik pada Pendidikan Dasar dan Pendidikan Menengah, 14.*

[10] Permen Dikbud No.66 Tahun 2015 *tentang Standar Penilaian Pendidikan dasar dan Menengah, 34.*

[11] Rabiudin, Enos Taruh, and Mursalin. 2018. *Development of Authentic Affective Assessment Instrument in High School Physics Learning.* Journal of Physics: Conference Series, Vol 1028, (2018) 012201. IOP Publishing.