Developing laboratory skill assessment based on multiple competence for prospective biology teacher

Developing laboratory skill assessment based on multiple competence for prospective biology teacher

E Fitriah[1,*] **and D Maknun**[2]

[1] Pendidikan Biologi, IAIN Syekh Nurjati Cirebon, Jl. Perjuangan Bypass Sunyaragi Cirebon, Indonesia 45142
[2] Program Pasca Sarjana Universitas Negeri Yogyakarta, Jl. Colombo Karangmalang Depok Sleman Yogyakarta, Indonesia 55281

*ekafit2808@gmail.com

Abstract. Practicum activity in the laboratory is one part that cannot be separated from biology learning. Prospective teachers are expected to demonstrate mastery of the four dimensions of multiple competencies, namely task skills, contingency management skills, task management skills, and role or job environment skills. This study aims to develop an assessment to assess the prospective biology teacher's skills and to determine the effectiveness of a comprehensive assessment integrated with the curriculum. This research uses Research and Development method. Research subjects were 40 prospective teachers who were carrying out teaching practice. Data collection technique used was tests, observations and questionnaires. Techniques of data analysis we used were descriptive quantitative analysis and T test. The results of research indicated that practicum activity that had been done could improve the laboratory skill based on multiple competences. The effectiveness of the assessment used to assess student's laboratory skills is quite high. The developed assessment can detail and comprehensively assess laboratory skills based on clear work indicator criteria. The conclusions of the research results show that the assessment of multi competence-based laboratory skills developed is valid, reliable, and effective to be used to assess the laboratory skills of prospective biology teachers.

1. Introduction

Preparation of the standard qualification of human resources is realized in the Standard Competency of Expertise which is a reflection of the competencies that a prospective teacher should have. In addition, the standards must have equivalence and equality with relevant standards applicable to the education sector in other countries that even apply internationally as a benchmark [1, 2].

Assessment is a way to know the success of a person achieving a goal through performance. The assessment consists of two components, namely: the collection of information about the performance of a person and making a conclusive assessment based on the information that has been collected [3]. To know the achievements of a student, the student is given some tasks in the circumstances that have been determined in such a way as to know the ability of the student through various tasks in different situations and conditions. Assessment is needed to measure what a person can do, the extent to which a person's performance improves after a lesson.

One function of assessment is to determine whether a person has mastered a certain skill, or knowledge. In this case the skill or knowledge is required to carry out a job. This type of assessment, referred to as a mastery assessment and this is an important part of competency-based training [3]. The

purpose of the assessment is to gather sufficient evidence that individuals can perform or behave according to the standards defined in a particular role. Another form of assessment is the measurement of the ability level. Assessment of abilities allows to determine whether a person has mastered something he or she has learned. Assessment is intended to collect sufficient evidence to show that a person can exercise or behave according to certain standards in a particular role [4].

Laboratory skills are the most important part when conducting psychomotor assessments. According to the Australian Science Teachers Association (ASTA) [3] laboratory skills include: a) working with equipment and chemicals, including: handling procedures, use and maintenance, and conscious attitudes for safety, b) working with live specimens, c) work environment, developing skills. Various laboratory skills students must possess are: selecting, installing, operating, opening, cleaning and returning equipment; Matching equipment; Reading the measuring instrument carefully; d) Handling, preparing and being aware of chemical hazards; Detecting, calibrating and correcting errors in adjusting equipment; Drawing equipment accurately. In biology learning practicum is one type of learning method that is often used. Practicum activities become inseparable from Biology learning. Practicum [5] is an integral part of science learning. The underlying reason why biology, physics, and chemistry are referred to as experimental science. The teaching and learning process by practicum will give students the opportunity to experience themselves, follow a process, observe an object, analyze, prove, and draw their own conclusions about a particular object, situation, or process. Therefore, one of the skills that must be mastered by prospective biology teachers is the skill to design lab activities.

Knowledge of how to develop learning by practicum method is part of Pedagogical Content Knowledge (PCK) which is one of the initial capitals of students to become professional biology teacher. PCK [6] is knowledge of pedagogy, learning practices and lesson planning, as well as appropriate methods to teach a lesson material. PCK is also defined as pedagogical knowledge that applies to teaching specific content. The PCK application in learning manifests itself in a variety of different learning approaches for materials with different content characteristics. The ability of prospective teachers in designing biology learning with practicum methods is useful for them in order to plan, implement, and evaluate the practice when teaching at schools.

Competency-based assessments emphasize assessment of the application of skills and knowledge in practical situations, or more to actual work situations (authentic assessment), whereas traditional assessments emphasize assessment by holding written or oral tests indoors. However, the position of assessment in a curriculum, assessment techniques, assessment usefulness, and the importance of validity and truth remain the same [7].

To implement a competency-based assessment, there must be agreement on the types of competencies and measures used. A useful statement of competence must contain evidence of three elements, namely (1) a detailed description of the range of skills performed in the competence. This needs to be stated precisely and concisely and will refer to two kinds of skills: (a) routine skills, which usually produce clear results (eg a teacher who teaches his students). (b) Non-routine skills, requiring the ability to deal with things that are not fixed and changes in the work environment such as managing time and stress. (2) Performance standards in the form of productivity level, error rate, quality level. (3) Situations where good performance is demanded, such as work environment, time constraints, equipment limitations [8, 9].

Competency-based education is focused on the achievement of specific target skills and follows its development for a number of specific circumstances. To enter the competitive world of work, students are required to have intellectual intelligence as well as basic skills. The three basic skills that must be possessed are knowledge, skill, and attitude [10]. Therefore, students need to apply their knowledge in the real world of work. Implementation of Field Experience is intended to train students to have factual and technical experience on the learning process and basic learning skills that can be used as provision to develop themselves as educators[10]. Field Experience is a student learning activity undertaken in the field to integrate theoretical knowledge gained on campus with practical experience in the field so that specific targets which are the targets of the study program's competencies can be achieved. Although

competency-based assessments are growing rapidly, there is little research related to the scoring system designed for a competency-based curriculum.

This study aims to develop a valid, reliable, practical and effective competency-based asseessment that is fully integrated with the curriculum to foster an educational environment that focuses on learning.

2. Method

This research uses Research and Development method. There are four stages of research: Initial Stage, Assessment Design, Assessment Development, and Implementation. The research design is quasi experiment. Subjects in this research were 40 prospective biology teachers of semester VII majoring in biology education who were following field experience program taken by random sampling.

The research steps include: conducting need assessment to understand the model and condition of practicum guidance in schools located in Cirebon. The assessment plan consists of three aspects: (1) planning the assessment, (2) conducting the assessment, and (3) reviewing the assessment. The competency-based assessment developed in this study is a biological practicum guidance assessment that has distinctive characteristics in the components of knowledge, skills, and attitudes. There are four dimensions of competence in a competency-based assessment i.e. (1) task skills, (2) contingency management skills, (3) task management skills, and (4) role / job environment skills. Before trial, expert validation was done first. Next a gradual test is conducted on a limited scope and then followed by extensive testing.

Research instruments include the followings: SKKNI (Indonesian National Competency Standards), pre-assessment consultation form, performance indicator form, critical aspects of the competency, observation, question bank (oral and written), assessment rubric, feedback questionnaire, performance assessment. Processing and data analysis were done quantitatively using descriptive statistics and t test.

3. Results and discussion

In developing this laboratory assessment, several steps were carried out. In the initial phase we did some observation and analysis activity by literature study and field survey. This is done to find other theories and studies that discuss the multiple-competency-based laboratory assessment. Based on the results of preliminary study, practicum activity in the laboratory of Biology Education Department of a teacher training institute in Cirebon can be observed from three main components: practicum guides, evaluation instruments, and learning procedures. Existing practicum activities were using general practicum guides (general biology, basic chemistry, basic physics, and taxonomy of plants, zoology, plant anatomy, animal physiology, plant physiology, microbiology, genetics and ecology). The guide consists of 8-12 practicum topics.

Practicum activities conducted in the form of regular practicum learning include: (a) explanation of practicum guide from supervisor / assistant at the beginning of each practicum; (b) a practicum student groups guided by lecturers / assistants; (c) class presentations and led discussions of student groups which were rarely implemented; (d) the practicum assessment from the lecturer which was sometimes not continuous; and (e) practicum reports. The practicum had not yet trained students to formulate the title, variables, problems, hypotheses, experimental procedures, data collection and analysis, formulating conclusions and suggestions, working safely in accordance with laboratory procedures and competencies. The practicum that had been implemented had not developed laboratory skills. Practicum guides available were in the form of guidance prescription model, not very much developing the ability to design the practicum activities. The practicum is more toward verification, and less towards investigation.

The design stage was followed by determining the assessment components. After that Expert Validation was done. validation phase or feasibility assessment draft I was conducted by involving 2 experts, 3 high school teachers, and 4 colleagues as a reviewer. Validation results were as follows: expert 1 gave the score of 82.50%, and expert 2 gave percentage score of 86.56%, so the average score from expert was 84.53%. The score category was good. Both experts also stated that the developed assessment laboratory skills was valid and feasible to use.

Based on the responses from 4 peers each gave the percentage score 82.33%, 84.52%, 84.29%, and 86.90%, so the average score given by colleagues was 84.51%. The score category is good, while for the teachers, the responses from 3 high school biology teachers gave 79.57%, 82.33%, and 84.71%, respectively, so the average score of peers was 82.20%. The score category is good. The average outcome of teacher response in small group trial was 78.86% with good category.

The initial product in the form of draft I is validated by the expert. If in the assessment there are suggestions and revisions from experts, then revisions are made and refinements of products by researchers based on evaluation results. The revision resulted in the draft II product. Draft II was produced, and then a trial was conducted to limited prospective teachers of VII semester. The trial involved 4 prospective teachers as a pilot sample. The results of a limited trial allowed for further revision of the results of its evaluation. Improvement was done to correct the deficiencies. The results of the refinement in the form of draft III products that would be used for the expanded trial. The draft III development results were tested to expanded prospective teachers who were practicing field experience. After an extended test, the results were evaluated and refined into the final product stage.

Based on the results of the assessment and from the questionnaire data, the prospective teachers' response can be seen as follows: the activity of the lecturer, especially in explaining the competence to be achieved by the students at the beginning of the practicum learning got 13% statement saying yes, while 87% stated no. In the case of variations in teaching models, 64% said yes, and 36% said no. Student competencies achieved after the practicum, those who stated it was informed only 10%, while 90% stated that the competence was not informed. Students as much as 99% stated that the lecturers did not do the enrichment after completing the practicum, the remaining 1% stated yes. Regarding the distribution of practicum materials related to lab skills, students stated 32% yes they were given, while 68% said no.

Based on the laboratory skill assessment results, 90% of the students are competent, indicating that practicum activities provided are adequate to develop this type of competence. The incompetent 10% especially are related to subcompetence of making practicum guidance (experiments) in Worksheet format, and designing the evaluation tool of practicum activity in which they generally are still low. 85% of biology teacher candidates have competence in calibrating and maintaining laboratory equipment while 15% are not competent. 95% of prospective biology teacher have competency in operating pipette, while 5% do not have the competence. In the subcompetence of using the pipette, the average students show their competence, although they are still wrong in doing the pipetation. There are 90% of prospective biology teacher who have competence in operating the microscope, while 10% do not have the competence. In the subcompetence of operating a microscope, most skills that they have not mastered is in preventing and mitigating damage to the microscope. 85% of prospective biology teacher have competence in recording and processing data, while 15% do not have the competence. The type of sub competence that seems quite low is on doing laboratory computation, displaying data in the form of graphs, tables, and diagrams, as well as interpretation of tables, graphs and diagrams. There are 95% of prospective biology teacher who have competency in safe work according to the health and safety procedures in laboratory, while 5% do not have that competence. This competence shows positive things when sub competence cleaning tools and materials after the lab finishes is high.

The performance level of prospective biology teachers in the competence of preparing representative materials and equipment according to the practicum plan is high, 61% stated they have high score, and their competence in calibrating and maintaining laboratory equipment 61% of them stated they reach medium level. A total of 33% of students stated their high performance level for the competence of operating pipette. In general, the performance level of biology teacher candidates in the mastery of these 6 competencies is in the medium category (34.26%) and high (46.30%), while the performance level in very low category is only 1.85%, and in very high category is 12. 96%. The competence of calibrating and maintaining laboratory equipment, as well as recording and processing of data shows a high percentage of students' responses stating their competence is medium. The availability of laboratory equipment is limited, so that students are not fully familiar with all the tools used when doing lab work.

The limited number of computers also causes some students still have problems in recording and processing data.

Based on the results of laboratory skill assessment for prospective biology teacher, we obtained the results of N-Gain calculation for them as follows: the highest is 0.92 and the lowest is 0.56 with average N-gain of 0.74 which includes in high gain category. There is an increase in pretest and posttest values, so the assessment applied is effective. To test the effectiveness of assessment t test has been applied. The result of t test shows that the t-count is 7.585. If t-count is bigger than t-table with p value 0.000 (p <0,005), it is considered significant. This means there is a significant improvement in the laboratory skills of prospective teachers.

The effectiveness of the assessment can be viewed from the following aspects: more laboratory skills or cognitive strategies, positive impact on practical activities, mastery of concepts and practices, trained independence in doing tasks, can assess practice performance, assessment centered on students' motoric, improve practicum guide from prescription model to troubleshooting form; rated well by practicing prospective teachers. Thinking habit is the highest aspect in the learning dimension. The dimensions of learning include: attitudes and perceptions about learning, acquiring and integrating knowledge, development and selection of knowledge, the use of meaningful knowledge, and thinking habits. Cognitive strategy is an internal process or individual intellectual ability that serves as a controller in learning and thinking to solve problems in a practical and efficient way [11].

The laboratory assessment used has advantages over regular test instruments, including the following: It can be used to train and assess the competence of laboratory skills, criteria of work indicators, It can improve the competence of laboratory skills. Some weaknesses of this assessment of laboratory activities, as follows: coordination among lecturer, assistant, and laboratory technician is required, this assessment tends to be experimental, explanation is required when using a complex tool, it takes extra time to be tested, a comprehensive assessment method is required (observation, written, oral, demosntration, feedback), It requires basic knowledge related to laboratory skills. Based on the results of preliminary study, practicum activities in the laboratory of a Teacher Training Institute in Biology Education Department in Cirebon, can be reviewed from three main components namely practice guide, evaluation instrument, and learning procedure.

Practicum activities conducted in the form of regular practicum learning, include: (a) explanation of practicum guide from the supervisors / assistants at the beginning of each practicum; (b) practice student groups were guided by lecturers / assistants; (c) class presentations and led discussions of student groups were rarely implemented; (d) the practicum assessment by the lecturer was sometimes not continuous; and (e) practicum reports. The practice has not yet trained students' ability to formulate the title, variables, problems, hypotheses, experimental procedures, data collection and analysis, formulating conclusions and suggestions, work safety in accordance with laboratory procedures and competencies. Practicum that has been implemented cannot yet develop laboratory skills. Practicum guide was still in the form of prescription model, less developing the ability to design lab activities. Practicum learning is more toward verification, and less towards investigation. A critical aspect of key competencies is required. There are three main components of laboratory skills: procedures, principles, and memories. The procedure is a set of steps used to perform the skill. Principle is concerned with the ability to understand and explain certain concepts to give guidance on when and how a step or procedure should be done. Memory is to remember the sequence of steps [12].

4. Conclusion

The conclusion of the research result is as follows: The assessment which is developed to assess the prospective teachers laboratory skill is valid, reliabel, practical and effective so that it is worth using, the result of assessment implementation shows that the laboratory skill competency of the prospective biology teachers is generally in the category of fair to high, the effectiveness of the assessment used to evaluate the students laboratory skill is fairly high since it can measure clearly the subcompetence of the labortory skills assessed.

Acknowledgments
The authors are grateful to those who have provided financial and moral support for this research. This study was supported by the Ministry of Religious Affairs, Republic of Indonesia (Kementerian Agama RI). Infinite thanks to colleagues at the College who have assisted in the collection and processing of this research data. Without the help provided by friends this research could not possibly be done well.

References
[1] Biemans H, Nieuwenhuis L, Poell R, Mulder M and Wesselink R 2005 "Competence based VET in the Netherlands: background and pitfalls," *Journal of Vocational Education and Training* **56** (4) p 523-538
[2] Burke J W 1995 *Competency Based Education and Training* London (New York: The Palmer Press)
[3] Hall W dan Saunders J 2004 *Memahami Penilaian* (Jakarta: Badan Nasional Sertifikasi Profesi)
[4] Imhanlahimi E O and Aguele L I 2006 "Comparing Three Instruments for Assessing Biology Teachers Effectiveness in the Instructional Process In Edo State, Nigeria," Journal *of Social Science* **13** (1) p 67-70.
[5] Fletcher S 1997 *Competence - Based Assessment Techniques* (London: Kogan Page)
[6] Rustaman, Nuryani Y 2010 *Pendidikan Dan Penelitian Sains Dalam Mengembangkan Keterampilan Berpikir Tingkat Tinggi Untuk Pembangunan Karakter* (Bandung: Universitas Pendidikan Indonesia)
[7] Callaghan K, Hunt G and Windsor J 2006 *Issues in implementing a real competency-based training and assessment system* (Departement of Surgery, The University of Auckland, Auckland)
[8] Cheng M H and Francis Cheung W M 2005 "Science and Biology Assessment in Hongkong - Progress and Developments," *Journal of Biologycal Education* **40** (1) p 170- 177
[9] Mishra P and M J Koehler 2006 *Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. Teachers Knowledge College Record* **1086** (6) p 1017-054
[10] Departemen Pendidikan Nasional 2003 *Standar Kompetensi Nasional Bidang Keahlian Analis Kesehatan* (Jakarta: Depdiknas)
[11] Foyster J 1999 *Getting to Grips with Competency-Based Training and Assessment* (National Centre for Research and Development, Adelaide)
[12] Gibb J 2002 *The Collection of Research Reading on Generic Skill in VET*