

## MODEL OF ASSESSMENT OF CAPABILITIES OF COMBINATORIAL STUDENTS OF TEACHER SCHOOL TEACHER INITIAL SCHOOL

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### Abstract

*The ability of combinatorial reasoning is part of the formal operational phase that must be owned by college students, the ability to think of solving problems in a way how to analyze the problem. This study aims to assess the ability of combinatorial reasoning by using test questions as a basic biology concept appraisal tool in graduate Education Primary School Teachers. The research method used is research development with Borg and Gall model, which includes gathering information, planning, developing the initial product, field trials, and field operational trials. The instrument used in this research is a questionnaire. Validation is done by material experts, evaluation experts, and linguists. The subjects of this study are students of Primary School Teacher Education. The study was conducted in three stages of one to one test of 8 students, initial field testing of 15 students, and large group trials of 30 students. Data analysis technique in this research is qualitative data analysis and quantitative data analysis. The result of research based on field trials that have been done and the revision of expert percentage average of the whole aspect of 78.43%. Based on observations from 30 students, it can be concluded that combinatorial reasoning capability includes regulatory aspects, finding solutions, classifying with new ideas and solving problems for students Primary school teacher education in basic biology concepts This indicates that test questions can be a tool of ability assessment combinatorial reasoning.*

**Keywords:** *combinatorial ability, assessment, development research*

The ability to think combinatorial is an important aspect of intelligence, but not the only one. The aspect emphasized in combinatorial thinking is the effective use of concepts and symbols in the face of specific situations in solving a problem. The ability to think combinatorial can not be separated from the knowledge of the concept, because thinking requires the ability to imagine or describe objects and events how to combine them. People with good combinatorial thinking skills can easily understand concepts and solve problems well. So the ability to think combinatorial is the ability to find problem solving with the combination, in the sense that students do imaginative thinking activities against the object of the problem and how to combine with each other.

Science learning that is capable of developing high-level thinking skills applies to the education of early childhood teacher candidates. However, the role of teachers in the learning process is difficult to replace. Therefore, the teacher's education should be able to develop the ability to think, the material about science lesson will be adequate to benefit a teacher and prospective teachers (students).

Problems that exist in the field Student reasoning to solve problems is still low because lessons are lesson, less develop creativity that is limited to the understanding of the material taught by the lecturer, how the practice done in the learning process. The weaknesses of learning science is the field is still in the learning process, the media used less varied, less conducive class atmosphere..

In fact, Mwamwenda's research finds that only a small percentage of students, and their adults tested have reached formal operational stage. The study uses problem solving to improve reasoning

knowledge. Students who have been classified as a formal operational stage will be able to understand and correctly answer problems related to problem solving, which although students have not been taught about it. In other words it can be stated that students who have entered formal operations will have combinatorial reasoning abilities.

From the results of Coenen's research entitled "Combinatorial reasoning to solve problems, observe the mathematical thinking of students aged 14-16 by studying the variation of student solution strategies in modeling". The results show that students are interested in starting the problem-solving process at the highest level of the activities undertaken. So in this study combinatorial reasoning is enhanced through problem solving, and student strategies in solving a problem.

Further research Abdullah, Lütfi İncikapı Kastamonu entitled *An Analysis Of Mathematics Teacher Candidates Logical Thinking Levels: Case Of Turkey*. The research was conducted on prospective mathematics teachers who were students at a northern Turkish college. The results show that the logical thinking level of mathematics teacher candidate is significantly influenced by the variable of class level, learning media, assessment and type of high school, but not with gender.

It is therefore important to provide high-level thinking that refers to the concept of combination to learners. Problem is expected to train students to think critically and creatively in solving problems in the matter. Higher thinking skills require not only the ability to memorize, but also the ability to think critically, the ability to think creatively, and the ability to solve problems.

The problems that have been described above, then required a solution that can be a way out. So this study aims to produce a test assessment model that can measure the assessment of the basic concepts of biology to measure combinatorial reasoning. In this research, the researcher attempted to develop a model development of biology basic concepts in measuring the combinative reasoning ability of the Basic Education Teacher Education Students.

## **LITERATURE REVIEW**

### **1. Combinational Reasoning**

The cognitive development of children presented by Piaget consists of four stages: a) motor sensory, b) operational pre, c) concrete operations, and d) formal operations. At a certain stage of development certain schemes will emerge which success at each stage is very much dependent on the previous stage. The cognitive development of children presented by Piaget consists of four stages: a) motor sensory, b) operational pre, c) concrete operations, and d) formal operations.

Nur (2013) explains the reasoning in formal operational period that is 1) proportional reasoning; 2) controlling variables; 3) probabilistic reasoning; 4) correlational reasoning, and; 5) Combinatorial reasoning. In some reasoning in the formal operational phase an adult person can develop in accordance with his abilities, proportions or ratios, variable controllers, relationships and combinations.

The ability of combinatorial reasoning according to the Roadrangka in Nawi (2012) states that combinatorial reasoning is the ability to consider all possible alternatives in a given situation. Individual formal operations when solving a problem will use all possible combinations or factors that are related to the problem.

According to Monks (2014) Combinatorial reasoning is a study that engages a boss's relationship to cognitive structure when one learns an inclusive proposition in which to categorize new ideas. The ability to propose new ideas by generating combinatorial meaning on the conceptual from within proportional learning. The ability of combinatorial reasoning is also called combinatorial thinking where the properties are the completeness of the problem-solving nature and relate to the way in which the analysis is performed. For example, by giving 5 cups of a given liquid to the child a combination of these fluids makes the liquid change color, looking for a color combination. By thinking combinatoris where the child can think about combinations that exist, from how to do, the process of carrying out.

Batanero (1997) Combinatorial is an object that is mathematical as anything that can be used, showing when when doing something, communication or learning mathematics. Then combinatorial

can also be interpreted as a mathematical object that can be used anytime and anywhere in the learning of mathematics.

According to Brouli and Hart (1998) the meaning of combinatorial reasoning ability is as art of enumeration by using all the ways in which a certain number of objects can be mixed and combined to ensure the result is not lost.

Combinatorial ability is the ability to consider alternatives by combining where thinking encompasses all objects, ideas used, combinatorial reasoning ability with the following aspects: 1) overcoming situations; 2) finding solutions; 3) classify in new ways; 4) solve the problem with a new idea.

## **2. Assessment**

Assessment Model is a systematic and continuous process or activity to collect information about the learning process and learning outcomes of learners in order to make decisions about the learner as assessed to be provided. Assessment activities should be able to provide information to teachers to improve teaching skills and help learners.

According to Chittenden assessment activities in the learning process should be directed to four things: 1) tracing is the activity undertaken to track whether the learning process has taken place as planned or not; 2) checking is to menceer information whether there are shortcomings in learners during the learning process; 3) the search is to search for and find the cause of the deficiencies that arise during the learning progress; 4) the conclusion that is concluded about the level of learning achievement that has been possessed learners..

According to Grounlund states assessment as a systematic process of collecting, analyzing and interpreting information to determine the extent to which students achieve goals.

From some opinions on the assessment can be concluded that the assessment is a process to take decisions by using information obtained through the measurement of learning outcomes using both tests and non-nontes.

## **3. Science In Children Early Class**

Conant defines science as a sequence of concepts and conceptual schemes that relate to one another, growing as a result of a series of experiments and observations that can be observed and tested further.

According Juwita in Yulianti science is the product and process. As a science product is a well-organized body of knowledge about the physical and natural world as a process, science is an activity of searching, observing and experimenting. It is important for children to participate in the scientific process, because the skills that the child can bring to other developmental areas and will be beneficial throughout his life. These skills include skills for observing, comparing, explaining, thinking, communicating, clarifying and measuring.

Spodek suggests Science is a system of knowledge about the physical form of the world. It includes ideas about the process of the object and the relationship between the two. In the development of concepts, scientists or scientists involved himself in the process of making that science. Based on that knowledge, science is also understood science that care about the physical nature of the world, identify a concept, and organize information systematically.

In line with what Carlesworth says, science is the way to explore the beauty of an object. That is, science is useful for exploring an object.

Furthermore, Jaksmen believes that science for early childhood is a combination of skill processes (how children learn and what content children learn). Science teaches children about what is learned. Based on some concepts and understanding above can be concluded that science is a science that deals with some facts and natural phenomena arranged systematically obtained through observation and experiment.

## **METHOD**

Research using research and development method (R n D). The research design used is Borg an Gall Gall model. Subjects in this study are Students of the Department of Primary Teacher Education Education who have attended lectures on Basic Biology Concepts. This is adapted to the objective of the study itself, namely to develop a Basic Biology Concept Course assessment to measure combinatorial reasoning.

Data collection techniques such as observation, interview and questionnaire. Data analysis techniques conducted in this research are qualitative data analysis techniques and quantitative data analysis techniques. Quantitative data obtained from the results of questionnaire scores of research subjects. While the qualitative data obtained from the responses of experts and research subjects. Data obtained from the validation of the expert feasibility test and from the feasibility test (whether from individual trials, small groups, and field or large-scale testing) to be analyzed by calculating values based on a predetermined assessment scale.

## **RESULTS AND DISCUSSION**

### **1. Test Results Product Effectiveness Assessment Model**

Based on the evaluation of the effectiveness of the assessment conducted on the Basic Biology concept course to form combinatorial reasoning ability, the following results are obtained:

#### **Discussion of Expert Material Validation Results**

In this study there are several types of data collected ie small groups and large group test. Data obtained from the validation results of expert materials and experts serve as a reference to revise the evaluation tool before it is tested to the learners. While the data of learners used to determine the response of learners to the problem developed.

Validation by biology lecturers aims to find out whether the developed problem can be used in the field as a tool for assessment of biological learning. The lecturer involved in biology is 1 lecturer. Assessment is given through validation questionnaire lecturer. Validation First lecturer 7 items of questions that exist in the expert validation instrument of the grain as for suggestions given: The relevance of the material used with the questions used are in accordance with the question, the suitability of the sample with the discussion of the material is appropriately used, the problem in accordance with the criteria of PGSD Students.

At the end of the validation questionnaire, the materials expert is asked to advise on the developed judgment. As for some suggestions given by the material experts are as follows:

- a. Add references and load in the web
- b. Fix the question sentence to make it easier for readers to understand
- c. Use articles that are sourced before giving a celebration

As for the problem that must be completed, there are some problems that are still on the level of c1 that must be changed in accordance with the indicators and aspects.

From the evaluation results of biological material experts, the developers make improvements in accordance with the suggestion, then show back the item to the material expert for validation. Validation from biological material experts concludes that the product can be piloted on small and large scale trials.

As for some suggestions given by the second material expert is as follows:

- a. Problem adjust according to indicator
- b. Problems that are made easy to understand by students and students' combinatorial reasoning can be measured through the questions made.

- c. As for the problem that must be completed, there are some problems that are still less appropriate to be used for combinatorial reasoning indicators that must be changed in accordance with indicators and aspects.

Validation Second lecturer Same with previous expert material experts / experts in teaching to give 7 items in the instrument and he agreed with the concept of questions given to the students are in accordance with existing indicators and syllabuses in the science course PGSD with the improvement of some problems should be fixed.

Language specialists provide an assessment of 9 questions in the expert validation instrument. Out of all these points, the language experts are the same with instruments created with some revisions. Revisions include; the language used should be in accordance with the Spelled Spellings, subtract the foreign terms that can cause ambiguity for students who read the problem, improve the writing on the matter made.

### 1. Small Group Trials

After this assessment model is improved in accordance with input and follow-up on the one o one test, the model will be tested again in small groups.

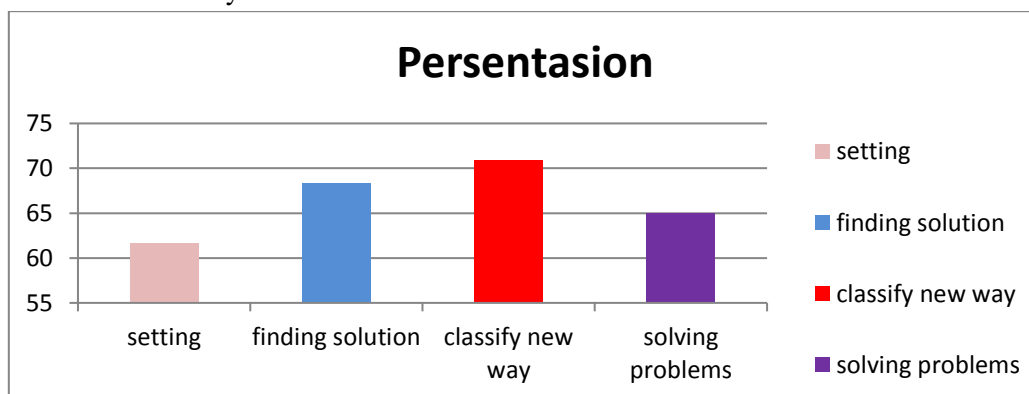
The purpose of small group trials is to identify deficiencies in assessment products after revision based on validation results of biologist and language experts. A small group trial was conducted on 15 students of Primary Teacher Education State University of Jakarta 3rd semester. Assessment is provided through a small group trial questionnaire. Based on the data recapitulation, the results of small group trials are as follows:

**Table Small Group Trial Results**

No	Aspects Assessment	Presentation Scores	Interpretation
1	Setting	61,66	Good
2	Finding Solution	68,33	Good
3	Classify New Way	70,83	Good
4	Solving Problems	65	Good
<b>Average Percentage</b>		66,45	Good

**Information :**

- 0% - 25%: Not Very Good
- 21% - 40%: Not good
- 41% - 60%: Medium
- 61% - 80%: Good
- 81% - 100%: Very Good



**Diagram Percentage of Combinatorial Aspects of Small Groups**

The results of small group trials, obtained the average percentage assessment of the overall aspect is 66, 45%. And the result of the answer item obtained an average percentage of 64%. This indicates that the developed assessment product has a good interpretation.

The results of validation and trials indicate that the penilian instrument for measuring reasoning in Basic Biology Concepts is feasible to be implemented as a learning assessment tool in field trials. Prior to use as a learning appraisal tool, instruments were first revised in accordance with expert material, language and student suggestions on small group trials.

**2. Large Group Trial**

In the ready-made assessment will be tested in large groups to see if effective and efficient products are used to measure students' combinatorial reasoning.

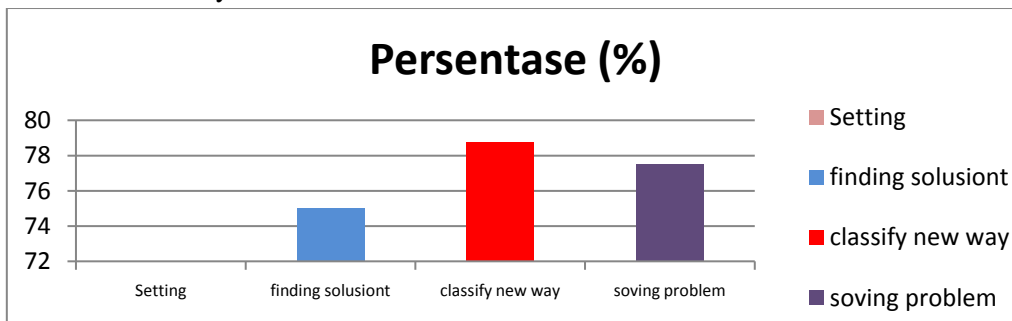
Problems that have been revised based on validation results and tested in a small group try, then field tested. The purpose of large group trials is to know students' or students' assessment of the instrument model used to measure students' combinatorial reasoning can be used as an evaluation in a learning activity. Field trials were conducted at Universitas Negeri Jakarta campus E on students with the number of students where the number of students tested on a large scale amounted to 30 people. Assessment is provided through a field trial questionnaire. Based on the data recapitulation, the results of field trials are as follows:

**Table Large Group Trial Results**

No	Aspects Assessment	Presentation Scores	Interpretation
1	Setting	82, 49	Very Good
2	Finding Solution	75	Good
3	Classify New Way	78,75	Very Good
4	Solving Problems	77,49	Very Good
<b>Average Percentage</b>		66,45	Very Good

**Information :**

- 0% - 25%: Not Very Good
- 21% - 40%: Not good
- 41% - 60%: Medium
- 61% - 80%: Good
- 81% - 100%: Very Good



**Diagram's Percentage of Combinatorial Aspects of Large Groups**

The results of large group trials obtained the average percentage assessment of the overall aspect is 78.43%. And the result of the answer item obtained an average percentage of 72.39%. This indicates that the developed assessment product has a good interpretation.

### **3. Test Results Product Effectiveness Assessment Model**

Based on the evaluation of the effectiveness of the assessment conducted on the Basic Biology concept course to form combinational reasoning abilities. In this study, in addition to data collected through language validation data, qualitative qualitative material validation, there are one to one data, small group test and group test large and questionnaire responses from students about the assessment model. Data obtained from the validation results serve as a reference to revise the product before it is tested to the learners. While the data from learners used to determine the response of learners to the assessment model developed.

Based on the validity of the questionnaire of students responses distributed by researchers to 16 students, the results obtained for the indicator of Material 85, 35%, language 82.08%. The average percentage score for the overall aspect was obtained at 83.51% with excellent interpretation. This indicates that developed judgments are worthy of use for measuring combinatorial reasoning

Based on small group trial that has been done, obtained percentage of assessment for regulatory aspects of 61.66%, finding solutions 68.33%, classified in new ways 70.83% and solve problems 65%, the average percentage of the overall aspect of 66 , 45%. The results show that the assessment model for measuring combinatorial reasoning developed suggests good interpretation.

Based on field trials, the percentage of assessment for the regulatory aspect was 82.49%, found a 75% solution, categorized in a new way 78.75% and solved the problem 77.49%, the average percentage of the overall aspect of 78.43 %. From these results indicate that the assessment developed shows good interpretation.

### **4. Discussion on the Development of Assessment Model**

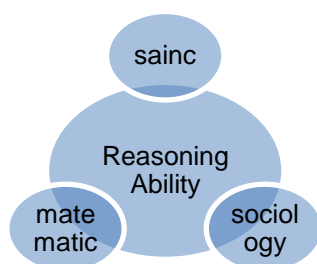
#### **Model Development**

This research and development aims to produce assessment products used to measure students' reasoning. In this assessment the researcher chooses to measure the reasoning in the basic concepts of biology. This assessment is aimed at students who will teach in the future, especially those who will teach the initial class, this research is conducted on students who have followed the basic biology concepts course.

The research and development of this assessment is carried out by using Borg and Gall model design models including: research and information collection, planning, developing preliminary product a product, preliminary field testing, main revision, main field testing, product revision, operationalfield testing. From the eight steps Borg and Gall Models are modified into three stages namely; 1) preliminary study includes literature study and field study, 2) product development stage of the instrument including expert validation, trials, analyzing trials and 3) refining the model to final model.

Prior to the development of the model, the researcher first conducted an observation on the students of E Primary Teacher Education campus. From the observations that researchers do researchers find some problems. One of them is the lack of reasoning of college students who have to be improved. Along with the development of the era of reasoning should develop students who will become educators will be demanded innovative. Researchers conduct research by developing combinatorial reasoning that researchers develop based on student courses, based on syllabus in the course.

The development of this assessment model can not only be studied in multidisciplinary science but also in interdisciplinary studies. The following is an interdisciplinary section of research and development. In combinatorial reasoning ability, there are still many other factors that influence, because basically reasoning ability is related to other disciplines. Can be illustrated in the following chart:



### **Chart of Linkages of Combinatorial Reasoning Skills with Multidisciplinary and Interdisciplinary Other Science.**

This developed assessment model is used to measure students' reasoning in how students solve problems using high-level reasoning. Students are expected to be able to answer the subject matter that they follow by reasoning. Especially as it is known that primary school teacher education is required to be more creative in teaching in the early classes.

Development of assessment to measure combinatorial reasoning abilities in multidisciplinary studies is concerned with several areas of science such as education / pedagogic, psychological, sociological and scientific.

In the field of pedagogy in chemistry, it is presented that combinatorial reasoning is one of the reasons students need to accommodate all possible possible isomers of an organic compound. Sometimes organic chemistry for students to be one subject that is not too drab because not too many calculations.

In the field of mathematics and science According to Piaget there are five types of formal reasoning that develop at the level of formal operational thinking as well as consolidation and solidification conservation reasons. The mastery of the five types of reasoning is an excellent predictor of the formal thinking ability in science and mathematics (Valanides, 1997). The reasoning is: Conservation reasoning, Correlational reasoning, reasoning reasoning, Proportional reasoning, Combinatorial reasoning and Controlling variables The problems that arise in the world of education, especially in the learning of mathematics is the development of formal reasoning.

In the philosophy of science explained that reasoning is a process of thinking in drawing a conclusion in the form of knowledge. Man is essentially a creature who thinks, feels, acts and acts. Attitudes and actions derived from the knowledge gained through the activities feel or think. Humans are able to reason means to think logically and analytically. Because of his reasoning ability and because he has a language to communicate his abstract mind results, man has not only knowledge but is able to develop it. Reasoning produces knowledge that is associated with thinking and not feeling.

It is realized that the research and development process of research model In this research and development there are some limitations, among others: in the development process not all steps Borg and Gall implemented. The steps of dissemination and implementation are not implemented. This has an unsatisfactory impact on implementation aspects on a wider scale. The study was conducted only on Primary Teacher Education students, especially those who have followed the basic concept of biology.

Having elaborated on the limitations in the assessment development process to measure students' reasoning abilities in basic biology concepts, they will discuss some of the advantages and disadvantages of assessment products in measuring combinatorial reasoning in basic biology concepts as follows:

#### **Advantages assessment model**

Some of the advantages possessed by this assessment model are as follows:



- 1) The assessment is based on syllabus / lecture material by linking the material with reasoning indicator. It aims to measure students' reasoning as to how they think with the difficulty level of problem solving and problem solving.
- 2) Can be used as a benchmark of students who are really serious to follow the courses and who do not.
- 3) Learning becomes interesting and challenging for students

### **Disadvantages of Assessment Model**

Besides having some advantages this product also has some drawbacks. However, after some improvements and revisions have been made, it is expected to minimize the deficiencies contained in the model. The following are the drawbacks in the product assessment model

- 1) There are some unfinished vocabulary in the model.
- 2) This newly developed model of appraisal has difficulties and some understandings are poorly understood.

### **CONCLUSION**

Based on the discussion and data analysis, research and development of assessment products to measure combinatorial reasoning in the basic concepts of biology at Strata 1 of Elementary School Teacher Education, Jakarta State University can be concluded that the development of the Basic Biology Concept model in measuring combinatorial reasoning in Primary Teacher Education students is solved by using several stage validation . Pre-development stage consisting of problem identification, situation analysis, collecting data and information related to assessment model that has been used in Strata 1 of Elementary School Teacher Education, Jakarta State University. Second is the stage of development, product development begins from the development of the question items into the instrument.

In the next process is panel discussion, evaluation by material experts, biologists and linguists. From the results of panel discussions each authors provide suggestions to improve the product is a matter of adjusting with the indicator, the problem made easy to understand by students and students' combinatorial reasoning can be measured through the problem. As for the problem that must be completed, there are some problems that are still less appropriate to be used for combinatorial reasoning indicators that must be changed in accordance with indicators and aspects, the language in use must be in accordance with the enhanced spelling Indonesian language correctly.

Based on the results of research and discussion, the following conclusions are obtained:

- 1) Problem description for the developed assessment has a good problem quality. This is indicated by the results of qualitative analysis conducted by experts and quantitative analysis of reliability of each item whole item. From the results of validity test obtained that each item has a high average category and reliability test results of 0.707. The value can be categorized that the reliability of the question is very high.
- 2) The developed problem can be used as a valuation tool in the basic biology concept course. This is shown from the results of feasibility tests of materials experts, language and lecturers, while the response of learners obtained average percentage overall is 83.15% with good interpretation.

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