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Connecting Concepts Test: An Alternative Instrument Form to Improve Students' Logical Thinking Ability in Conceptual Understanding (Case Study on Geography Subject)

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Abstract. Types of test instruments are known in learning evaluation such as multiple choices, essay, brief description, and pairing. Each type has its own advantage, but still considered ineffective in improving students' logical thinking ability. According to meaningful learning theory that based on cognitive and constructive learning, to learn is an effort to enrich the concept and connect a new concept with the old one which has been known before. There has no type of instrument yet to measure the relationship between two or more concepts. Therefore this study aimed to prove that the connecting concepts test is effective as an alternative form in measuring logical thinking ability and conceptual understanding. The subjects of the study were the students of class XII IPS 3, SMA Labschool Universitas Pendidikan Indonesia with the number of participants were 28 students. The result showed that the improvement on logical thinking ability and learning outcomes of the students can be measured by using the connecting concepts test format. The recommendation of this research is to encourage other researchers to develop the Connecting Concepts Learning model based on strengthening the relationship between relevant concepts

1. Introduction

One of the most popular assumptions of Piaget's cognitive learning theory is that a child's knowledge does not depend on the knowledge transfer process undertaken by others. But the knowledge is constructed by the child himself based on what is seen, heard, andor based on his life experience. Learning is not driven by the desire to gain respect from others, but intrinsically, the will of the child's learning comes from his own motivation.

Piaget's theory does not agree with the idea that the child's intelligence is fixed, but on the contrary, intelligence continues to evolve along with the biological maturity and intensity of its interaction with the environment [1]. Furthermore, Piaget does not measure how well the child can calculate, spell or solve problems as a way of measuring the child's IQ, Cognitive Theory is more likely to be how basic concepts such as the idea of quantity, time, quantity, causality, justice and so on arise and formed in the child's cognitive scheme [1]. Piaget defines a scheme as: *'a cohesive, repeatable action sequence possessing component actions that are tightly interconnected and governed by a core meaning'* [2].

With the above assumptions, the authors assume that the test instruments that have been used to measure aspects of student knowledge are less relevant. Tests' format such as multiple choice, brief description, and even essay have no advantage in detecting the "conctruction" of new knowledge in the

child. This study would like to propose the idea of an alternative test form called Connecting concepts Test with a simple form but effective.

1.1. Logical thinking

Logical thinking is a difficult process to observe but the results can be measured. A conventional measurement tool is by understanding someone's answer when asked about something. If someone is questined, he or she will be hooked to do the logical thinking process. One's answer is evidence of logical thinking. The second way is by syllogism, which is a form of the ability of people to deductively deduce from the premise provided simultaneously [3].

Both the first and second way, when associated with evaluation in learning, ones feel less satisfied, because within certain limits, syllogistic logical thinking is not contextual (usually just syllogistic words). If the statement of the premises does not match facts, then the result of logical thinking is considered to be failure.

Rapar expilan that there are four logical thinking indicators: categories, predicables, classifications, and inferences [4]. Category is the decomposition done as carefully as possible to recognize or understand a situation, both material and nonmaterial. Predicables are thought to characterize, such as giving predicate to something, its kind, distinctive features, special nature or not. Classification is also called división. Inference is the process of drawing conclusions from one or more propositions. There are two ways commonly used in inference: deductive inference and inductive inference.

Analyzing the results of logical thinking, the ones prefer to identify unexplained concepts of two or three connected concepts. For example, the statement: "I cannot cross the river because the current is too strong." This statement implied information that a river with a strong current is very dangerous, and not everyone is able to cross it. The inference pattern above explained that in every concept expressed by someone there is a "hidden" concept that has a broader meaning. The implicit concepts (unexplained) between the two concepts connected are called the logical thinking range [5].

The logical thinking range can be seen from the following simulations. There is a statement said "Demographic bonus is a threat to countries with unqualified human resources." In this statement, many concepts are "hidden" and not everyone is able to understand the meaning of the statement. The hidden concepts are:

1) Demographic bonus relate to productive and non-productive populations.
2) Age of productive population between 15 - 64 years and unproductive age are between 0-14 years and over 65 years.
3) Demographic bonus is if the population of productive age is more than the non productive age population.
4) The productive age should have high education level. If they are not qualified then they will depend on others.
5) The most obvious threats are poverty, social conflict, and evacuation
6) Poverty will cause shortage of food
7) The emergence of social conflict is because many people are scrambling to meet their needs
8) For those who can not stand the conditions of poverty and conflict will choose to evacuate

By way of parsing above, it can be concluded that the relationship between demographic bonus and human resources has eight hidden concepts. Thus "Demographic Bonus poses a threat to a country with unqualified human resources", basically having 8 spacing of reason.

1.2. Multiple choice and connecting conceptss instrument

The superiority of a test instrument is its ability to measure the test object accurately and in accordance with the purpose of measurement. In many references it has been widely acknowledged that multiple choice is still widely selected as a test instrument. Besides, many studies also reveal that multiple choice is still used in various test such as SAT (Scholastic Assessment Test), online (web-based) test, bulk courses, and CPA (Certified Public Accountant) test [6]. Moreover, multiple choice seems faster in providing feedback to students and saving time in result’s examination [7]. Nevertheless, Simkin and

Kuecher also disclose information that several assessment experts still recognize that the Constructed Response (CR) test is better than a multiple-choice test in dealing with real-life cases. Forms of CR test is such as short description, essay, and problem solving.

Multiple choice and constructed response (CR) both have advantages as well as disadvantages. In one's opinion, if the assumption is to observe the appearance of ideas and or to stimulate the students' potentials in a measurable and detailed way, they are both inadequate. Multiple Choices have disadvantage of answer option availability. It makes multiple choice only measures the speed aspect of "assimilation" - see Cognitive Theory [2]. Short descriptions and Essays may be better because they are able to provoke knowledge from students' memories. However, if it to know the ability of students in connecting two or more concepts that may still be far apart, or connecting two or three concepts that have not been connect yet into an integrated concept, need to use another test form such as connecting concepts test.

The connecting concepts test is still a hypothesis, untested, and may even be just a form of work sheets for students to exercise and additional tasks in the classroom. The theory of connecting concepts refers to cognitive learning theory of Ausubel [8] developed by Novak which introduces concept maps as part of meaningful learning strategy. He said that "*expert skeleton concept maps are prepared by an expert in the knowledge domain to guide and "scaffold" learning. The idea of scaffolding learning has gained increased prominence in the past decade and is one of the metacognitive tools teachers can use to facilitate meaningful learning"* [9].

Cross also said that learning is basically a "making connection" process in his book "Learning is About Making Connections." He said *"connections are established by firing synapses in the brain, the "ah ha" experience of seeing the connection between two formerly isolated concepts, or the satisfaction of seeing the cpnnection between an abstraction and a "hands-on" concrete application"* [10]. In the book explained about the enactment of four categories of connection in a person that is *neurological connections, cognitive connections, social connections, and experiental connections.*

2. Methods

This research employed a descriptive approach to explain the Connecting Concepts Test instrument as an alternative to improve logical thinking ability in conceptual understanding. The research step begins by conducting a pre-test in the form of multiple choice as much as 20 questions taken from the National Examination for Geography subject Year 2015 in Indonesia. This pre-test was followed by 28 students of class XII IPS 3 SMA Labschool Universitas Pendidikan Indonesia. The test took place on Wednesday, July 26, 2017. The next two days of July 28, 2017, students were asked to fill the Connecting concepts worksheet consisting of four columns, three columns containing concepts while the last column was a conclusion filled by Students. The following is a form of the Connecting concepts test column.

No	Concept A	Concept B	Concept C	Connecting Concept
1	Atmospheric Pressure	Wind	Rice	.....
2				
...				

Figure 1. Connecting concepts test column.

After completion, the students were asked to do the postest. Data processing is done by comparing the pretest and posttest results to measure the effectiveness of the Connecting concepts Test model. Beside

the test results, researchers also observe and assess the worksheet filled by the students. In this study, the Connecting conceptss test was positioned as a worksheet as well as an alternative test instrument.

3. Results and Discussion

3.1. Connecting concepts test format

Connecting concepts Test is a test format consisting of columns and rows containing two or more concepts that are connected into meaningful statements and or conclusions. The assumption is that the more concepts can be connected, the more students are able to build new knowledge.
In this study, three concepts are used in pairs and there are 20 pairs which are:

1) Interrelation – Sumatera – Palm Oil
2) Antrophosfer - Human Aspect - poverty
3) Ocean Floor – Divergent - Tectonic
4) Eurasian Plate – Pacific Plate - Tsunami Japan
5) Earthquake – Tsunami – Higher ground
6) Land Type – Jawa Island - Andosol
7) Mesosphere – earth cover – Low Temperature
8) Koppen – Aw Type – Tropical Savana
9) Infiltracion – Soil Porosity – Rainfall
10) Flow pattern - Lands of slopes – Dendritic
11) Climatic - Flora – Rainfall
12) Natural - Population dynamics - Death and Birth
13) Population Explosion - Housing – Slum
14) Natural Resources - teristric - Land and Tree
15) Center Sulawesi - Nickel - Resources
16) Environment – Sustainable Development - Continuity of environmental components
17) Higher Ground - Conservation of hardwoods - Soil erosion
18) Map Information - Map of plate boundaries and volcanoes - Earthquake
19) Map - Big scale – Detail Information
20) Elementary School Building - Population density - Transportation Path

Based on the assessment of what the students wrote, below data was obtained:

Table 1. Qualitative assessment of connecting concepts.

No	Component	Precent (%)				
		VP	P	LP	NP	Total
1	Accuracy	16	33	40	11	100
2	Grammar	10	25	55	10	100
3	Logic	26	42	28	4	100

Note:
VP = Very Perfect
P = Perfect
LP = Less Perfect
NP = Not Perfect

Based on table 1, students have the potential to answer the question in the form of Connecting concepts. Researchers have assumed that this model is worth developing and using.

3.2. Conecting concepts test effectivity

The effectiveness of the connecting concepts test instrument in this study only compared the pre-test and post-test results. The results are quite significant, the average score of pretest results of 8.11 points and the average post-test score of 14.32 points reaches the gain of 6.21 points. Thus it can be concluded that the exercise done by filling the worksheet of Connecting concepts Test affect the learning outcomes of the students. The Connecting concepts Test format or instruments effective to help building new knowledge and stimulating the development of the students' learning ability.

Table 2. Reasonable data to try using connecting concepts test.

No	Participant	Pre-Test	Post-Test	Gain
1	A	10	19	9
2	B	11	7	-4
3	C	10	19	9
4	D	8	16	8
5	E	7	19	12
6	F	7	10	3
7	G	8	17	9
8	H	10	17	7
9	I	12	15	3
10	J	11	17	6
11	K	11	7	-4
12	L	7	17	10
13	M	3	6	3
14	N	8	3	-5
15	O	6	17	11
16	P	8	17	9
17	Q	7	15	8
18	R	11	17	6
19	S	10	17	7
20	T	7	11	4
21	U	5	12	7
22	V	6	14	8
23	W	7	15	8
24	X	6	17	11
25	Y	6	17	11
26	Z	8	17	9
27	AA	11	14	3
28	AB	6	12	6
		227	401	174
		8,11	14,32	6,21

Based on table 2, it is reasonable to try using Connecting concepts Test as both worksheet and test instrument i learning.

4. Conclusions

The results show that the connecting concepts test instrument is relatively simple and easy to use and has the advantage to generate the creativity of the students in connecting two or more concepts into a statement and conclusion. The connecting concepts test instrument can be used in students' worksheet to develop their logical thinking ability and can also be used as a test instrument in measuring the number, quality, and frequency of the emergence of ideas as a form of students' ability in building new knowledge on the cognitive scheme. Based on these findings, it is recommended to use connecting concepts tests instruments as an alternative in the learning process and learning evaluation.

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