The Development of Diagnostic Test for Measuring Students' Logical Thinking Range: A Study of Geography Subject

Ahmad Yani*

Abstract : The present study aims (1) to find the procedure of developing logical thinking range diagnostic test, (2) to know the quality of logical thinking range diagnostic test, and (3) to know the correlation of some variables with logical thinking range. The method used in this research is research and development with three stages of research, they are: preliminary study, product development, and trial testing. The result shows that logical thinking range diagnostic test can discover the error of students' logical reasoning. Trial result of the test instrument shows that questions' validity is 0,33; reliability 0,47; and the tricky question relatively good. Even-though the test model is not perfect but this test model is worth to be developed. The result also shows that students' age has a correlation with logical thinking range with significance 0,001 < 0,05 (H0 rejected) meaning the students' ages have a correlation with their logical reasoning. Eventually if teacher (or other parties) intend to develop logical thinking range diagnostic test, then please follow the procedure done in this research by paying attention to its limit.

Keywords : Diagnostic Test, logical thinking range, Geography, mapping concept

1. INTRODUCTION

In 2006 curriculum (KTSP) and in 2013 curriculum (K-13) Geography is one of the subjects taught at high school. In the 2006 curriculum, the total hours allocated to geography as one the subjects for class X – XI – XII were 1 – 3– 3 hour, while in K-13 some hours were added to be make 3 – 4 – 4 hour in social science faculty.

Geography in elementary and junior high school level is integrated with Social Science and it is meant to be *social studies* while Geography in senior high school level is meant to be a *social science*. In the K-13 manuscript, Geography as a Basic Competence (BC) it is described as an integral component of social sciences studies for junior high school, while for senior high school it is taught as an independent course or subject.

Geography subject's in K-13 purpose includes to make the students capable to have basic competence in acquiring data and information, applying the geographical knowledge in their daily lives, and to communicate it for the sake of Indonesia national development (Kemedikbud, 2013). Surely, basic competence in logical and critical thinking is needed to acquire data and information.

All subjects in K-13 structure has the common target which is to make the students capable to think logically and critically. The Rule of Education and Culture Ministry (Peraturan Menteri Pendidikan dan Kebudayaan (Permendikbud)) Number 64 of 2013 about the Standard of Elementary and Middle Education Content, there are division of competences. At an elementary level to middle level there are 12 classes while there are 6 levels for competence. Every level has its own unique purpose called generic

* Universitas Pendidikan Indonesia

purpose (Ahmad Yani, 2014: p. 59). Competence Level I – III (elementary school level), Competence Level IV (class VII dan VIII), Competence Level IV-A (class IX), Competence Level V (class X dan XI) and Competence Level VI (class XII).

The grouping of competence levels has a position of an attribute in classifying the capabilities regarding logical thinking. The thinking capabilities gradation are divided into four, namely: understanding, applying, analyzing, and evaluating and put into competence level columns. See the graphic below.
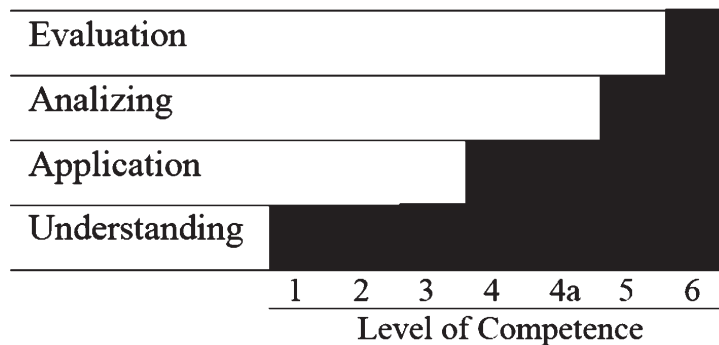

Figure 1: Competence Level KI-3 (Knowledge) based on *Permendikbud Nomor 64 Tahun* 2013

Soruce : Ahmad Yani (2014: p. 63)

Based on the graphic information above, "applying" competence is developed in class VII and "analyzing" competence is developed at the start of high school. Nevertheless, the basic competences "applying and analyzing" are introduced right from the early years or ages.

At a skill level, the competences to be built are reasoning, processing, presenting, and creating. In level I – III, the skill developed is about capability of "presenting" and continue to be developed until the students' graduation from high school. With competence level VI, all skills competences are developed. The graph below illustrates the key competences of skills' area 4 (KI-4).
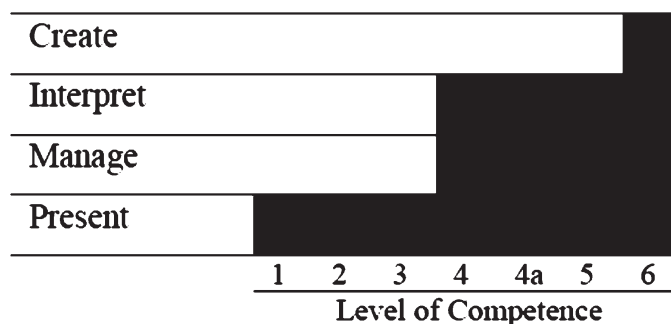

Figure 2: Competence Level KI-4 (Knowledge) based on *Permendikbud Nomor 64 Tahun* 2013

Source : Ahmad Yani (2014: p. 63).

Even though well explained, the rule supports the implementation of K-13 but does not explain in detail about the definition of "reasoning". The Indonesian Dictionary (Kamus Besar Bahasa Indonesia (KBBI)) refers to reasoning as logical thinking. Reasoning is a process for developing and controlling something by thinking not by feeling or experiencing. Reasoning is a mental process and developing thoughts from several facts or principals known to students.

Jan Hendrik Rapar (1996: p. 16) in his book "*Pengantar Penalaran"* explains that reasoning is a thinking activity. Thinking activity needs language to occur. So, reasoning always relates with language. The content of the book directs our comprehension to the definition of reasoning as something relating to proposition and syllogism. Proposition is a statement in a sentence that has full meaning and syllogism is a conclusion drawing indirectly by using two premises which are formal reasoning (Jan Hendrik Rapar, 1996: p. 46).

To train logical thinking, "word game" in syllogism can be accepted. But if applied in the learning context in every subject, the meaning of reasoning becomes more irrelevant. Thus, the reasoning activity needs to be defined wider as intellect activity to proceed the knowledge accepted and directed to find the truth (Ahmad Yani, 2010: p. 56).

Poespoprodjo and T. Gilarso (1987: p. 7) stated that man's knowledge begin from concrete experience and sensitive-rational experience like facts, objects, events or incidents experienced. But ratio (intellect) always wants to understand why everything is at it is. That's why the ratio keep questioning and finding out how everything relates with every other thing, what kind of relationship between the phenomena, how one phenomena affect others, causing or determined other phenomena. Thus, reasoning is not only tinker the sentences in syllogism but thinking stated in language and rationally containing the logical truth.

Geography subject, and other subjects surely have specific missions to train the students so they capable to seek knowledge through reasoning process occurring in their brains. This view is relevant with the constructivism philosophy which stressed that knowledge is constructed by the learning students (Paul Suparno, 1997: p. 53). Constructivism doesn't have strong foundation without respecting reasoning process done by the students.

Specifically, in Geography subject, the reasoning capability is not enough in seeking the cause-result or the relationship between intention and purpose from a reasoning logic. The characteristic of geography learning materials are enchained with other related events. The relation between the events cannot be broken. When one event is "untraced" in reasoning analysis, then the conclusion drawn by the students will be wrong. The reasoning result is meaningless. In the learning process, if one concept loses its connection with other concepts, then the concept is meaningless.

Joseph D. Novak (1998, p. 19) stated that"Meaningful learning results when the learner chooses to relate new information to ideas the learner already knows. Its quality is also dependent upon the conceptual richness of the new material to be learned". From this definition, we can see that relating one concept and events becomes very essential. Geography subject really needs a continuous reasoning process both direct to the cause or to the result from the main concepts.

To comprehend the thinking direction, both to comprehend the cause or the impact, we need to understand how the knowledge is formed and accumulated. Ausubel (1968) as cited in Joseph D. Novak (1998: p. 41) differentiates the primary concept and secondary concept. primary concept is formed by direct observation process of things or events around him. Secondary concept is an existing concept in students' memories. When primary concept is relevant with secondary concept then the primary concept has become meaningful.

When the main concept enters (in the reasoning process), next it will take part in cognitive structure through assimilation process. If there is a coherence between the preliminary knowledge, then primary concept becomes meaningful and will become a secondary concept. Secondary concept usually will be higher than merely facts (primary concept). Secondary concept can be benefitted by the students when they think conceptually, procedurally, and meta-cognitively.

To the contrary if primary concept doesn't suit the existing concept in the reasoning range, students will be confused, because it will be reputed as "unknown" concept or meaningless concept. A new concept can become part of secondary concept if it has passed the accommodation process (Paul Suparno, 1997: p. 31 – 32). In accommodation stage, students will try to understand the primary concept and secondary concept simultaneously. When students succeed in relating primary concept and secondary concept equilibrium occurs and the students can be said has "increasing" their knowledge.

To understand the students' increment of knowledge, Joseph D. Novak (1998: p. 19) proposed three conditions, they are (1) primary concept must be relevant with prior knowledge, (2) primary concept must be relevant with other knowledge and must contain significant concepts, and (3) students must realize that the accepted concept increase their knowledge. If the conditions are not met, the learning done by the students will considered to be meaningless and only considered as *rote learning*.

A Way to test the students' knowledge increment is by using *mapping concept* or by using *mind map.* According to Tony Buzan (2008; p. 4), *mind map* can be illustrated as a city map. M*ind map* center is like city center. City centre represent an important idea. Main streets diverse from city centre represent main thoughts, secondary streets represent secondary thoughts and so on. The wider the map in someone's mind, then the wider his knowledge range.

Both mapping concept and mind map have networks and chains between concepts from the main concept, there are concepts posited as main branch, secondary branch, main twig and smaller twig. There is quite a distance from the main concept to the smaller twig concept this is called as a logical concept range or logical thinking range.

From the explanation, above, we can draw an assumption that in every person there is a capability to think logically and "the range" can be measured. The more we can explain the relationship between the main concept and the farthest twig concepts then we can call him as a person who uses his far-logical thinking range. To the contrary, if a person merely can explain the relationship between the main concept with the closest branch concept then we can call him as a person who uses close-logical thinking range.

As an example, it can be explained from an illustration below. Example there is a question: "Explain the cause of flood in Jakarta?" then the answer surely will be varied. Perhaps a student explains that the flood in Jakarta is caused by human behavior which throw the rubbish not to the proper place. The answer is not wrong, but the student's logical thinking range is very short. To the contrary if there is a student who answers that the flood in Jakarta is caused by the lessening of the rainfall infiltration power to the ground and the increment of run-off as the impact of villa building in Puncak-Bogor, then we of course appreciate the student more because of his far-logical thinking range.

Logical reasoning process is like the analysis level in cognitive area in Bloom taxonomy. Lorin W Anderson and David R. Krathwohl (2001: p. 79) who revised the Bloom taxonomy identified three abilities in "analyzing" they are ability to differ, organizing, and connecting. In the analysis level, the students are expected able to proceed the input information and recognize the relation pattern between the concepts, and even can differ the causal and impact factors from complicated networks. Lorin W Anderson and David R. Krathwohl (2001: p. 80) detailed analysis ability as follows:

- Distinguish fact from opinion (or reality from fantasy);
- Connect conclusions with supporting statements;
- Distinguish relevant from externeous material;
- Determine how ideas are related to one another;
- Ascertain the unstated assumptions involved in what is said;
- Distinguish dominant from subordinate ideas or themes in poetry or music; and
- Find evidence in support of the author's purposes.

From the above definition series, one of the statement "determine how ideas are related to one another", the relationship seems to be singular without tracing the continuous connection series between the concepts. In fact, the main idea can be developed or explained into lower element in the continuous connection between concepts.

If the connection between concepts is singular, then it will be difficult to measure the range. Thus, for the analysis ability to be measured (C-4), the connection pattern needs to be drawn in a mapping concept and or mind map. Mapping concept and mind map are representatif of logical thinking range ability and the range can be measured.

Ratna Wilis Dahar (2011: p. 111) stated that one of the benefit of mapping concept is as an evaluation tool. Dahar suggested mapping concept criteria referred to Ausubel's learning theory kriteria penilaian peta konsepdapat which must have (1) proposition validity, (2) hirarky; (3) cross bonding; and (4) concrete examples.

Besides of that, Dahar also conveys that mapping concept is useful to reveal the misconception experienced by the students. From the mapping concepts written by the students, sometimes can be found the misconception when they connect two or more concepts and form a "wrong" proposition. With a similar assumption, the researcher intend to convey that if the mapping concept can discover the tendency of misconception, then the diagnostic test logical thinking range can reveal the scope level of students' logical thinking range.

From the explanation, above, logical thinking range diagnostic test in analysis level of cognitive area (C-4) is very essential in learning result assessment because of several reasons:

(1) In Geography instruction, students are expected to comprehend many concepts that connected to one another, some have close connection and some have far connection. For example:

"If you are standing in Pontianak at 12.00 (p.m.) in the center of a field under the sun light. On that time, your shadow seems to be stick outwarded to the north. The exogeny process which frequently occurs in Indonesian territory is? The alternative answer is: erosion, abrasssion, ablasion, dan eruption".

The question above can never be answered by merely rote learning but also must use logical thinking range. The range must be far because it must pass through the concept of sun's apparent motion in south latitude 23,5°; munsoon wind concept, rainfall season concept in Indonesia, flood concept, then finally arrive in erosion concept. Commonly the teachers are not giving such wide explanation, so the students are trained to answer the question directly without any logical thinking range. The examples of questions without logical thinking range or short logical thinking range are as follows:

River flow pattern affected by morfologi and geological structure. River flow pattern in the relatively ramp land area is....

- Dendritical pattern
- Radial pattern
- Annular pattern
- Trellis pattern
- Pinate pattern

(**Source:** Soal Ujian Nasional Geografi tahun 2013).

If the question pattern in National Test remains and not improved then the students' learning results will never foster logical thinking as expected in the purpose of social science and Geography.

(2) K-13 curriculum demands the students' creativity. Teachers as the Geography learning guide must be more creative. sometimes, the concepts that used to be coherent in a specific field of study must be connected to other concepts outside its field of study. Logical thinking ability both for teachers and students is very essential. menjadi sangat penting. Even though the application of K-13 is delayed, but creativity to integrate between material concepts kreativitas will be very recommended to be trained.

(3) Geography curriculum both in 2006 curriculum and also K-13 give sign that constructivistic learning is very recommended. In 2006 curriculum, constructivism philosophy is used in EEC learning (Eksploration, Elaboration, and confirmation). in K-13, constructivistic remain used through scientific learning approach (Kemdikbud, 2014). Learning with EEC step and scientific still in one cognitive learning branch which demand the students to use logical thinking process.

Three of them are enough as the reason to develop   diagnostik test questions for detecting logical thinking ability (and detecting misconceptions) which is very urgent in Geography subject.

Therefore, the purpose of this research includes: (1) to discover development procedure of diagnostik test to measure students' logical thinking range in Geography subject, (2) to find out the quality level of the questions in logical thinking range diagnostik test developed in Geography subject, and (3) to find out the correlation between students' ages, parents' professions of the students, and class level with students' logical thinking range ability. Hypotesis proposed in this research is of course it is expected that the higher

the students' age then the farther their logical thinking range. If there are no other variables which affect strongly, then the hypothesis should be strongly accepted. If it is not accepted, then we can have a tentative information based on this research that age does not so much affect to the logical thinking range.

2.   RESEARCH METHOD

Methode used in this research is research and development. The steps done in this research commonly refer to Gall, Gall, and Borg (1989) which has been modified by Nana Saodih Sukmadinata (2005; 189) that consists of three stages: preliminary, product development, and trial.

In the preliminary stage, the researcher observed the Multiple Choices questions used by Geography Teacher and the questions published in Geography National Test. Geography National Test Packages questions since 2009 – 2014 and exercise questions published by *www.zenius.net*.

In the development stage, the researcher developed test (diagnostic) through five stages, they are: making outline of the questions, arranging the questions, validation and reliability test of the questions, and fit and proper test through *Focus Group Discussion* (FGD).

- •   Making the outline of the questions. The questions are arranged by choosing the essential material taught in Geography sunject. The theme chosen to arrange the questions are:
  - •   Hydrosphere (river, ocean flow, ground water)
  - •   Atmosphere (monsoon wind in Indonesia,   global warming)
  - •   Antroposphere (urbanisation)
  - •   Litosphere (vulcanism)
  - •   Biosphere (mangrove, carbon cycle)
  - •   The environment problem (air pollution, forest fire, acid rain, ecoefficiency, agriculture involusion, and flood).
- •   Arranging the questions. The questions are developed based on logical thinking range principal. There are 20 test items, Multiple Choice type, there are 4 options. The questions to measure logical thinking range are arranged by determining the serial process of a cause-impact phenomena or event. Started by determining the theme then the impact are arranged from the closest, the middle impact, and the farthest impact.

For example, the developed questions are as follows: Determine the series of natural process in Indonesia when the position of the sun is in south latitude. The expected answer is Indonesia has rainy season so there will be many erosions. Because of the erosion then the river water will become muddy. And because of that (so many sediments as the result of erosion) then the rivers in Indonesia will be shallower when it is illustrated in a table, the logical thinking range will be as follow:

Table 1
The series of nature process in Indonesia when the position of the sun
is in South latitude of 23.5°

Range	*Statements*
1.	Indonesia has rainy season
2.	There are many erosion in Indonesia
3.	The river water in Indonesia becomes muddy
4.	The river in Indonesia will be shallower.

Based on the logical thinking range Table above, then the question changed into multiple choice form as follow:

The series of nature process in Indonesia when the position of the sun is in South latitude of 23.5°
are...
- The river in Indonesia will be shallower
- Indonesia has rainy season
- The river water in Indonesia becomes muddy
- There are many erosion in Indonesia

Answer key: A

By using the pattern above, all the twenty questions are arranged with multilevel of difficulty.

In Geography subject there are many learning materials which have conceptual and procedural knowledge characteristic as shown in the examples. Below can be listed 16 examples of knowledge that need conceptual and procedural analysis (of course there are many more out there than listed below).
- Water cycle
- Urbanisation
- Ground growing
- Monsoon wind cycle
- Tides of the ocean currents
- Biodiversity
- Poverty
- Flood
- The Dynamic of ocean currents
- Global warming
- El-nino
- Tectonic earthquake
- Disaster mitigation
- Vulcanism
- Health level
- Erosion
- And so on

If we see the form, then the questions arrangement for logical thinking range diagnostic test similar with Multiple Choice question *sequence* that is arranging the order words or statements according the right order. The difference lies in the theme used as the question *steam* which has the closest cause-effect relationship. In Multiple Choice *Sequence*, there is no need to pay attention to the cause and effect relationship between the options used. Another difference is that the options used need to have the sense of truth in each range.

Example of multiple choice *Sequence*

Determine the province order in Indonesia based on the number of the citizens from the largest to the smallest:
- Jakarta
- West Java
- East Java
- Yogyakarta

Review: The Alternative answers do not have any conceptual and procedural connection. The question above has remembered level or (C-1) and not C-4 (analysis). See Bloom Taxonomy again.

- The next step is validation and reliability test to the draft question package. There are 33 Respondent to test the questions package. The validity and reliability Test used ANATES program version 4.0.2. The result is as follows:
  - Correlation XY = 0.57;
  - Instrument's Reliability = 0.72;
  - Level of difficulty middle = 12 questions
  - Difficult = 6 questions
  - Very difficult = 2 questions

Revision is done because there are several questions which less tricky, so it needed to be revised.

Fit and proper test through *Focus Group Discussion* (FGD) is done by 15 high school teachers and 2 evaluation experts on Monday, November 24th 2014. The purpose of FDG is to ask for opinion and to take validation of the test that has been used.

The third step is experiment test that is diverting the diagnostic test to 400 persons in Kota Bandung, Kabupaten Bandung, Kabupaten Garut, and Kabupaten Subang Jawa Barat which consists of:

<div align="center">

Class X = 146 students

Class XI = 146 students

Class XII = 108 students

</div>

3. FINDINGS AND DISCUSSION

There are three research findings that will be explained, first, discover the development of diagnostic test procedure to measure the logical thinking range, especially in Geography subject, the quality of the questions in the logical thinking range diagnostic test developed has been discovered, and the correlation between the education level and logical thinking range has also been discovered.

There are 5 stages of development procedure of diagnostic test to measure logical thinking range. They are:

- Realizing and the intention to help the students in solving their difficulties in analyzing the given learning materials. The symptom of learning difficulty can be seen as misconception to the conceptual and procedural learning materials. Conceptual knowledge covers category, classification and connecting the complicated concepts. The example of conceptual knowledge is earth rotation, tectonic theory, and the wind currents. While procedural knowledge is about how to solve problems with the stages of thinking based on fixed procedures. The difficulty symptom in the conceptual and procedural knowledge can be seen from the students' flow of thinking which incoherent, there are missing concepts when they are doing the analysis, and wrong perception.

- The teachers identify the students' difficulties by filling the outline of diagnostik test development. The outlines are arranged based on Basic Competence (*Kompetensi Dasar* (KD)). The form of the outlines is the same with the questions, but it is added by the theme column, the questions that will be proposed, and answer keys which reflect the flow of logical thinking that will be tested.

- Developing logical thinking range diagnostik test questions by meeting the principle that every option must contain the truth. The difference only lies in the range of the concepts, some short and some far. By this pattern the diagnostik test function not only to measure logical thinking range but also can be used to "fix" the misconception symptom of the students' error in understanding the concepts in the future.

- Doing the validation process of diagnostic Test questions package especially validity, reliability, The difficulty level of the questions, and the quality of the tricky options. Before statistically

tested, especially to develop the answers' option (answer key and tricky option) it is better to validate rationally. Rasional validation is a validation acquired based on logical thinking (Anas Sudijono, 2005, p. 164). Rasional validation si very essential because every option in package questions of diagnostik test logical thinking range must all be true and has a continuous cause and effect order. After considered to be fit and proper, the diagnostik test is ready to use.

- The diagnostic test results are proceeded by using certain application which can calculate the mean of logical thinking range. By seeing the mean, we can determine the materials to be remedied (remedial) classically. The questions package of diagnostic test also can be used as a learning material in the remedial so teacher can improve the students' analytical ability.

The example of diagnostik test finding is that the mean of logical thinking range of each questions as follows. The students' analytical ability is low in question number 20. The logical thinking range only one, meaning, the students can only see the closest impact of an event. To the contrary the students' analytical ability is relatively good and the logical thinking range is quite long in the question number 12. In the case example, can be found that studying the theme of the impact of dust pollution in the air. The students commonly able to analyze that the farthest impact of air pollution is because the lessening ability to grasp carbondioxide in the air (range 3). In fact, the expected logical thinking range is until the concept of the increasing level of air temperature and global warming (range 4):
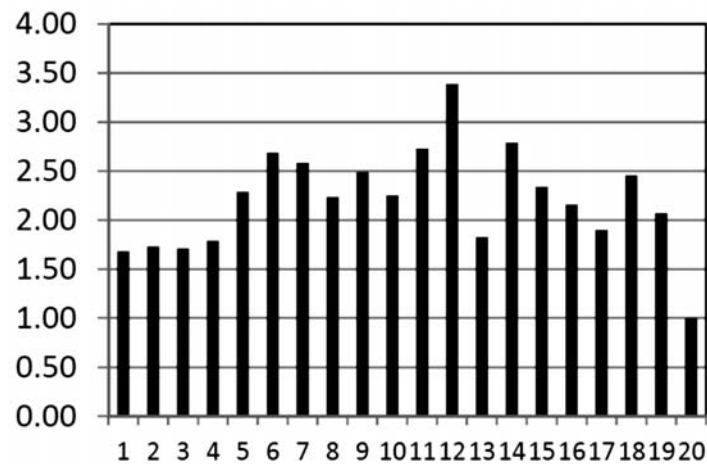

Figure 3: Diagnostic Test Results for the Measurement of Distance (2014)

The second question is how is the quality of each question in the logical thinking range obtained in diagnostic test has been developed? The validity of the question seems to be less satisfactory even though not too disappointing. By using ANATES program version 4.0.2, the validity of the questions package is 0,33 (low). There are several possibilities that causing this. The time allocated is not quite effective this can be too tight and too lose. The researcher only spread the test instrument and entrusted them to the teacher without knowing the exact time used by the students to answer the questions. The time allocated to answer the test might be not enough so the students answered it in a rush. Nevertheless, the cause of the low level of validity is the small number of questions so it doesn't represent the sample (There are only 20 questions).

The reliability value of the test based on ANATES (version 4.0.2) data is also low, that is 0,49. According to Sukardi (2008; p. 51-52) reliability coefficient can be affected by the score spreading, reliability coefficient si directly affected by the form of the score spreading in the measured students group. The higher the spread, then the higher the estimation of the reliability coefficient. It is assumed that the problem lied in the score spreading. logical thinking range coefficient developed with the true tricky option whereas the school selection as the research sample was not selectively selected. Besides, the test level of difficulty has affected this. If the test was too easy or too difficult, it tends to result in low reliability score. From 20 questions, there are 12 questions considered to be difficult and very difficult.

Another important information and need attention in developing logical thinking range diagnostic test is the quality of tricky options. The tricky options in the questions are all true so the quality of the tricky option should be all good. A good question will have the tricky option chosen prevalently by all the students who answered wrongly. To the contrary, a bad question is if its tricky option was prevalently chosen.

Commonly, tricky options are made to "mislead" the answer by using the similar terms with the answer key or by equalize the difficulty level of the tricky options, so then the term homogenitas is known in every answer. To maintain the homogeneity of the answer, logical thinking range diagnostic test instrument seemed to experience a difficulty because every option not in the same logical thinking range. Presented below the table of quality of tricky because of logical thinking range diagnostic test trial. The result of data proceeds by ANATES version 4.0.2 showed that logical thinking range diagnostic test has a relatively good result.

The third question is how is the correlation between the students' age, parents' professions, and class level with students' logical thinking range is proposed to assure that the diagnostik test model developed in this research can be the source of information to trace the affecting variable to students' logical thinking range. The statistical data processing result is presented below.

- Mean score between class level from class VII to class XII showed an increase: Is the mean different ? The researcher tested with simple t-test: $H_{0 \text{ will}}$ be accepted if $t_{count} < t_{table}$, to the contrary H_0, will be rejected (H_A will be accepted), if $t_{count} > t_{table}$. The result is t-counting is 48.391 while t-table 2.920. Thus, null hypothesis is rejected and hypothesis alternative is accepted. The conclusion is that the students' logical thinking range mean score is different or not the same. If involving all respondents, then the t-count is 144.409 while t-table with degree of certainty is 95% is 1.649; meaning the alternative hypothesis also accepted and we can state that logical thinking range mean score is completely different. Logical thinking range mean score from the lowest class level keeps increasing.

Table 2
Logical Thinking Range Mean Table

level/class	logical thinking range mean score
X	2,39
XI	2,40
XII	2,54

- How is the correlation between students' age and students' logical thinking ability? the research finding doesn't satisfy the researcher. Correlation or relationship between the students' ages (x) and logical thinking range mean score (y) = 0.163 or very low correlation. The correlation score showed positive value meaning the relationship is one way, then if the students' age increase then the students' logical thinking range also increase.

If we see the correlation based on the probability between age and logical thinking range mean score then the probability is (significance level) = 0.001. So, the probability 0.001 < 0.05. Thus, we can conclude that H_0 is rejected. This condition shows that there is a close relationship between age and logical thinking range.

Correlation between parents' professions and the students' logical thinking range mean score tends to have a positive relationship that is 0,094 but the significance level si only 0.061, if put into equation 0.061 < 0.05, then Ho is accepted. This condition shows that there is no relationship between the parents' profession with the students' logical thinking range mean score. This Hypotheses is proposed with the assumption that a person's profession usually affects a person's welfare, and the parents' welfare will affect the students' learning facility.

Correlation between class level and the students' logical thinking range mean score seems to have a positive relationship even though with low correlation value, that is 0.174. Nevertheless, if we see the significance level is very perfect, that is 0.000. If put into the equation, then $0.000 < 0.05$ meaning Ho is rejected. This situation shows that there is a relationship between class level and the students' logical thinking range.

Correlation between age and the students' logical thinking range according to this research is weak, but has a positive value and the level of significance is high. By this research finding, the researcher assumes that the age factor is not the only one factor which determine logical thinking range. The main factor is intelligence, learning achievement, and learning motivation. If the students have all the three factors above, their logical thinking range will increase because logical thinking range is identical with the learning result.

Jean Piaget's opinion that cited by Paul Suparno (2001: p. 20) stated that the intelligence developed in intellectual steps. Intelligence is a tool/way that enable individual to seek for balance or adapting with his environment. By this opinion, it can be assured that as the students grow mature, they ability in logical thinking will also grow.

In the mental structure, every person has "scheme" which continuously adapting with the surrounding environment. According to Paul Suparno (2001; 21), scheme will continuously develop. As the experience of a person grows then his scheme of environment and events will also grow and complete.

An older brother in a certain age may have a wider intellectual scheme than his younger brother who's younger in age. This can happen with condition that the older brother has been through the meaningful learning that has enriched his conceptual knowledge more than his younger brother.

In many case, the younger brother is more intelligent than the older one, because the younger one is more diligent than the older one. Meaning, age is not so much related to intelligence and the width of a person's mental scheme. By this explanation we can see that the correlation value resulted from age and class level relatively smaller than the real logical thinking range has been answered. The correlation value doesn't affect the quality of diagnostic test. Diagnostic test model developed in this research can be improved in the future.

4.   CONCLUSION

Based on the research finding, it can be concluded that diagnostic Test to measure logical thinking range is needed by teachers and other parties who will improve students' logical reasoning or fix the errors of students' ways of thinking that caused by the misconception of constructed knowledge in their mental scheme. The using of this logical thinking range diagnostic test will discover the error of students' logical reasoning faster. Diagnostic test development for measuring logical thinking range can be used as Multiple Choice test enrichment varied especially to measure conceptual and procedural analysis. The trial result of the diagnostic test instrument showed less satisfactory level of validity and reliability, nevertheless it didn't affect the idea of logical thinking range test development. If teachers or other parties intend to develop logical thinking range test as has been done in this research, then it is recommended to follow the right procedures given in this research by paying attention to the limit found in this research.

5.   REFERENCES

1. Ahmad Yani (2010). Pengembangan Model Meaningful Learning Untuk Meningkatkan Daya Nalar Siswa Melalui Aplikasi Mind Map Pada Mata Pelajaran Geografi di SMA. *Disertasi*. Bandung. Sekolah Pascasarjana Universitas Pendidikan Indonesia.

2. Anas Sudijono (2005) *Pengantar Evaluasi Pendidikan.* Jakarta. PT RajaGrafindo Persada.

3. Jan Hendrik Rapar (1996). Pengantar Logika. Yogyakarta. Penerbit Kanisius.

4. Joseph D. Novak (1998). *Learning, Creating, and Using Knowledge: Concept Maps as Facilitative Tools in Schools and Corporations*. Mahwah, New Jersey, London. Lawrence Erlbaum Associates, Publishers.

5. Kemdikbud (2014). Konstruktivisme dalam Kurikulum 2013. *Berita*. [online] pada http://kemdikbud.go.id/ kemdikbud/ berita/2311; Fri, 03/14/2014 - 18:03.

6. Lorin W Anderson, dan David R. Krathwohl, (2001) *A Taxonomy For Learning, Teaching, and Asessing, A Revision OF Bloom's Taxonomy Of Educational Objectives*. New York San Francisco Boston London Totonto Sydney Tokyo Singapore Madrid Mexico City Munich Paris Cape Town Hongkong Montreal. Longman.

7. Nana Saodih Sukmadinata (2005) *Metode Penelitian Pendidikan*. Bandung. PT. Remaja Rosdakarya.

8. Paul Suparno (1997). *Filasafat Konstruktivisme dalam Pendidikan*. Yogyakarta. Penerbit Kanisius.

9. Paul Suparno (2001) Teori Perkembangan Kognitif Jean Piaget. Yogyakarta. Kanisius.

10. Paul Suparno (2001). Teori Perkembangan Kognitif Jean Piaget. Yogyakarta. Penerbit Kanisius.

11. Ratna Wilis Dahar (2011). *Teori-teori Belajar dan Pembelajaran.* Jakarta. Penerbit Erlangga.

12. Sukardi (2008) *Evaluasi Pendidikan*. Jakarta : Bumi Aksara.

13. Tony Buzan (2008) *Buku Pintar Mind Map*. Jakarta. PT Gramedia Pustaka Utama

14. W. Poespoprodjo dan T. Gilarso (1987). *Logika Ilmu Menalar*. Bandung. CV Remadja Karya.