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Exploration of Multiple Intelligences for High School Students in Chemistry Learning in Semarang City

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Abstract

Theory of Multiple Intelligences in education world is less so concerned. Some chemistry teachers who teach high school students in Semarang City are not aware to this theory due to lack of references. This research aims to know the level of Multiple Intelligences of high school students in Semarang City in chemistry studies according to the indicators as described by Howard Gardner. Those indicators are intelligences of verbal-linguistic, logical-mathematical, visual-spatial, physical-kinesthetic, musical-rhythmic, intrapersonal, interpersonal, and naturalist. This research is conducted in three schools which takes fifty students of XI IPA from each school using random and simple in retrieving the data. That data is collected using questionnaires which are shared to students to know the level of Multiple Intelligences. The research data is analyzed descriptive-quantitatively, that quantitative data is only used as means of categorizing the level of students' intelligences. The result of this study is obtained various data on each indicator. The result of quantitatively data analysis shows that naturalist intelligence is obtained at the highest percentage of 71.10%, while verbal-linguistic intelligence is obtained at the lowest percentage of 62.23%. The result of this research can be used as a reference and consideration of high school teachers in formulating a lesson plan that will be applied in chemistry learning. Based on the result of this research, it can be concluded that the level of students' Multiple Intelligence in chemistry learning is averagely categorized as "high level".

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INTRODUCTION

The quality of education in Indonesia is still relatively low. The result of *Programme for International Student Assessment* (PISA) survey in 2018 shows that Indonesia in reading category is at 74 with averagely score of 379, mathematic category is 73 with averagely score of 379, and science category is at 71 with averagely score of 396 from 79 countries that are surveyed. Nadiem Anwar Makarim, as the Minister of Education and and Culture said that the results of PISA are avaluable inputs to fix and improve the quality of education in Indonesia (Tohir, 2019). Education in Indonesian institution is averagely still centered on the teacher and is oriented on the result of studying which is on demand (Hasibuan, 2016). Whereas the most important thing about studying is the process, not the outcome. The outcome of studying will get a good result if the learning process is performed correctly.

Culture and community needs have an important role in development of curriculum selection and for serving education demands. The demands to understand, respect, and involved with society include as high demand for students. Each individual is required to thrive by resolving diversity from various communities to meet continuable learning needs and effectively participating in society (Yuksel et al*.,* 2013). Exploration toward issue and material which are interesting for students can give them opportunity to practice a lot of intelligences with activities that can affect them to spend time and to build knowledge (Gunduz & Ozcan, 2016).

Intelligence is defined as a person's ability to solve problem or to create an appreciated product in culture. The theory of Multiple Intelligences produces seven different intelligences. Gardner's seven different intelligences in 1983 are verbal-linguistic, logical-mathematical, visual-spatial, physical-kinesthetic, musical-rhythmic, intrapersonal, and interpersonal. In 1995, he added naturalist intelligence. The existential intelligence which is the nineth intelligence is still in consideration because it still has not fully met empirical and neurological evidences that are required to include it on the list of intelligence (Gardner 1983 in Rahbarnia et. al, 2014).

The theory of Multiple Intelligences has shown that all students can study well when they have opportunity to process an information in their own way (Gardner in Gouws & Dicker, 2011). Multiple Intelligences can be likened as an individual who gains more experience and exposure so he or she can be improved through training and development (Chew et al*.,* 2019). Multiple Intelligences theory needs to be supplied to students so they have very helpful ability in solving problem. One of the education subjects that Multiple Intelligences can be applied in it is chemistry education. Chemistry is a branch of natural sciences that studies composition, structure, characteristic, and change of a substance such as shape, color, and smell.. Nakhleh in Cetin-dindar & Geban (2016) explained that in the chemistry learning process, students often have difficulty in giving an explanation due to lack of understanding about basic concept.

The basic concept of chemistry can be understood by students if they can explore some of their intelligences. In addition, in this case the teachers must also be able to implement a supportive learning system. Teachers can apply a chemistry learning process based on Multiple Intelligences if they know the level of students' intelligences in studying chemistry and the relationship between them. Therefore, this article tries to help teachers in finding the level of students' intelligences in studying chemistry and in knowing the relationship between them by exploring the students' Multiple Intelligences toward chemistry learning. In line with this, Jones (2015) in his research explained that there is a potential use of Multiple Intelligences in teaching and learning methodology in the school. The result of the research of Sari et al. (2017) dan Safitri et al. (2013) stated that learning using Multiple Intelligences approach affects to the attitude and the outcome of students. The result of the research of Septiani et al. (2013) stated that student worksheet based on Multiple Intelligences can facilitate students' activity to understand the concept of material using potential intelligence they possess.

Based on the background description of the issue, then in this research an investigation is conducted toward high school students' Multiple Intelligences in chemistry learning. This research aims to know the level of high school students'

Multiple Intelligences in chemistry learning. The result of it is very important to become a reference for chemistry teachers in formulating a lesson plan in order to apply the Multiple Intelligences theory in chemistry learning process.

METHOD

This research is descriptive-quantitative study which aims to obtain more in-depth information about students' Multiple Intelligences (Yusuf, 2014). The result of quantitative calculation is used as a means of categorizing the level of students' Multiple Intelligences. This research is conducted in three schools in different sub-district in Semarang City which is taken fifty students of class XI IPA randomly and simply from each school. The technique of collecting data is done by distributing questionnaires to the students. The questionnaire is formed according to Multiple Intelligences indicators consisting of 40 questions which are 5 questions from each indicators to know the level of intelligences in chemistry learning. The data is analyzed in descriptive-quantitative in order to systematically describe the fact and the characteristic of students' intelligences, as well as to obtain the result of percentage of the students' Multiple Intelligences level as conducted by Sarie et al. (2016) . The formula used is:

$$\text{Percentage (\%)} = \frac{\text{Total score earned}}{\text{Total score maximum}} \text{ x } 100\%$$

The data obtained is interpreted at the level of students' Multiple Intelligences presented on Table 1.

Table 1. Interpretation of the level of students' Multiple Intelligences

Percentage (%)	Intelligence Level
0 - 20	Very Low
21 – 40	Low
41 - 60	Medium
61 – 80	High
81 - 100	Very High

(adopted from Sugiyono, 2015).

The procedure of this study presented on Figure 1.

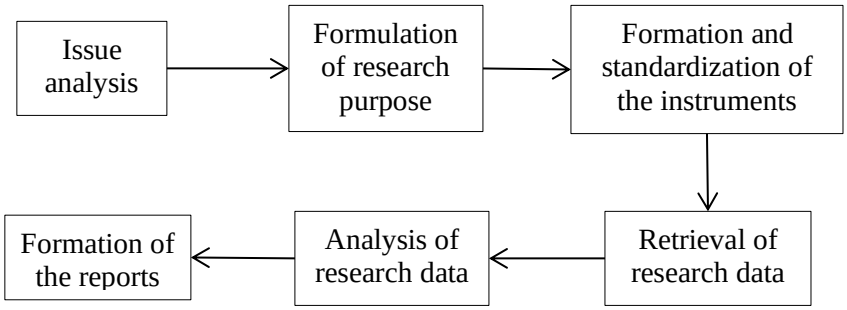

Figure 1. The procedure of descriptive-quantitative research (adopted from Yusuf, 2014).

RESULT AND DISCUSSION

Multiple Intelligences is a theory used by human to solve a problem. This study proves Gardner's theory that every human has more than one intelligence with different level of intelligences. Students involved in this research are high school students who have been studying chemistry for two years and their intelligences are explored. The reason researchers choose these students because they have been knowing enough about various characteristic and content of subject chemistry, so that students can assess themselves related to the intelligences which exists within them through the questionnaire of Multiple Intelligences.

The result of this research indicates that every student has more than one intelligence with the different level of Multiple Intelligences between each other. This distinction is caused by every student has each capability in a particular field. The different level of Multiple Intelligences is not to be likened, but to be appreciated and developed towards a better level of intelligences. Overall the result of the level of students' Multiple Intelligences in chemistry learning presented on Figure 2.

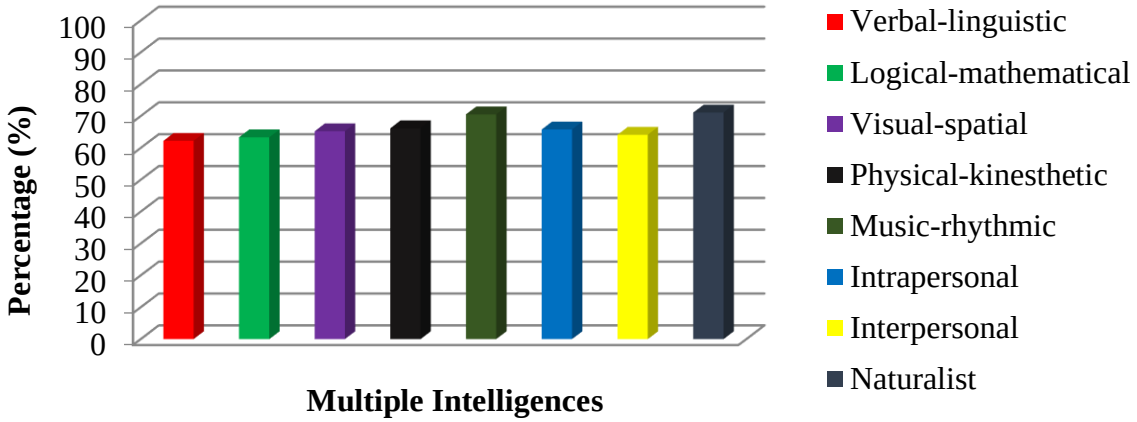

Figure 2. The average result from each indicator of students' Multiple Intelligences

The percentage result of the level of students' Multiple Intelligences shows that the intelligence which students have is at high category in general. This result shows that verbal-linguistic intelligence is at very bottom level, whereas naturalist intelligence is at top level. The following is explained in detail about fact and characteristic of each intelligence contained in students' Multiple Intelligences in chemistry learning.

The percentage result of the students' level verbal-linguistic intelligence in chemistry learning is presented on Figure 3. Verbal-linguistic intelligence is an intelligence which indicates person's ability in terms of language both spoken and written. In chemistry learning, students can develop their language intelligence through practicing to pronounce and to write the chemistry languages such as molecule formulas, names of chemistry element, types of chemistry reaction, and compound characteristic. Students also can exercise their language intelligence by structuring a writing or a paper about the relationship between chemistry material with daily life, then presenting it in front of the class to be discussed by the teacher and students. Students can develop verbal-linguistic intelligence by reading more to chemistry books or other readings about chemistry and by listening to news about natural phenomena which related to chemistry.

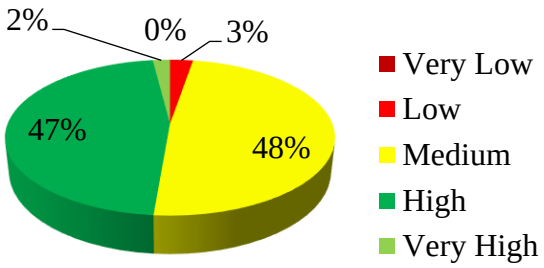

Figure 3. Percentage of the level of students' verbal-linguistic intelligence

The percentage result of the level of verbal-linguistic intelligence in general shows that high school students' intelligence is still at medium. This result is the lowest result when compared to other intelligences. It is influenced by several factors which two of them are the lack of communication between students with a teacher and students are less invited to discuss the material studied. Students' language skill can be improved by providing opportunity for students to inquire about unresolved materials, to discuss a problem solution, and to tell or present in front of the class. In addition, low literacy or reading habit can also affect the level of verbal-linguistic intelligence. In line with this, Imansari et al. (2018) conveyed that the ability of students' chemistry literacy in some aspects is still less optimal.

The percentage result of the students' level logical-mathematical intelligence in chemistry learning is presented on Figure 4. Logical-mathematical intelligence is an intelligence which students have in analyzing something related to numbers. Some examples of chemistry content and material related to numbers are quantity of atom composer particle, length of chemical bond and

molecule geometry form, molecule concept, basic laws of chemistry, thermochemistry, reaction rate, chemistry equilibrium, pH (degree of acidity), and a multiplication product of the solubility of chemistry compound. Students who have logical-mathematical intelligence will be more cautious in acting. In line with this, Wijaya & Sudarmin (2016) argued that students who have logical-mathematical intelligence are capable to carefully compose an answer that is written completely and systematically.

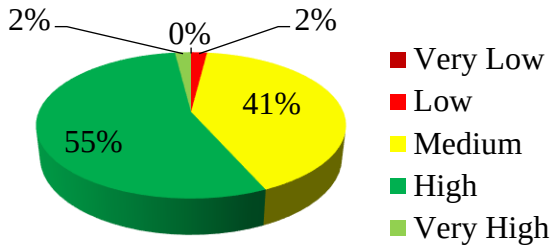

Figure 4. Percentage of the level of students' logical-mathematical intelligence

The percentage result of the level of logical-mathematical intelligence proves that students who are capable to analyze chemistry material related to the operation of numbers are not too many. Students who have high level of logical-mathematical intelligence are capable to accurately solve problem related to computation, whereas students who have low level of logical-mathematical intelligence are not capable to solve the problem. The high level of logical-mathematical intelligence causes students having dislike to computation in early time.

The percentage result of the students' level visual-spatial intelligence in chemistry learning is presented on Figure 5. Visual-spatial intelligence is an intelligence which involves ability of observing, imagining, visualizing, transforming certain objects, and storing them for a long period of time. Students who have visual-spatial intelligence will be able to remember theories or events related to visual such as theory of atom, Lewis' formula, form of molecular geometry, and laboratory experiments on the solubility authentication of electrolyte and nonelectrolyte compounds, and the occurance of natural events about corrosion and colloid phenomena. They have a high sensitivity to lines, colors, shapes, spaces, and buildings. In line with this, Wijaya dan Sudarmin (2016) argued that students who have visual-spatial intelligence are capable to gather informations by using knowledges they have so they can determine a strategy and remember grooves in solving problems. Gani et al. (2017) argued that visual-spatial intelligence can be enhanced through a learning based on Multiple Intelligences with student worksheet.

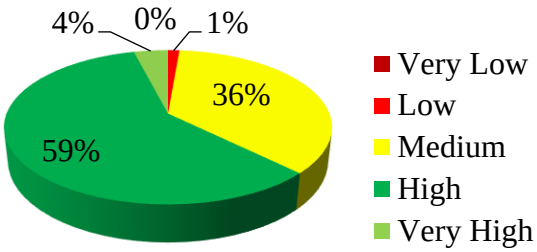

Figure 5. Percentage of the level of students' visual-spatial intelligence

The percentage result of the level of visual-spatial intelligence indicates that there are still few students who have visual-spatial intelligence at "very high" category. Every person doesn't has visual-spatial intelligence indeed. This intelligence needs a repeated activity or habit to be developed. Visual-spatial intelligence is related to human brain's ability to transform any material received in writing or another form such as picture and video.

The percentage result of the students' level physical-kinesthetic in chemistry learning is presented on Figure 6. Physical-kinesthetic intelligence is an intelligence which is related to skills of hand or other limb. A chemistry learning activity that can develop physical-kinesthetic intelligence is laboratory practicum. In line with this, Hartono et al. (2013) argued that Multiple Intelligence is a theory which can be applied in practicums. By practicums, students can engage directly in performing observation, interpretation, classifying, forecasting, communicating, hypothesizing, planning, experiment, implementing a concept or principle, and asking a question. In practicums, students are trained to perform movements, for example performing activities of weighing an object, making a solution, preparing or stringing up practicum instruments, and blending the solution, and washing the practicum instruments after using them. These activities are commonly called as skill of science process. In line with this, Fitriyani et al. (2017) advised that in order to improve skill of science process we can use a guided model of inquiry in the learning process.

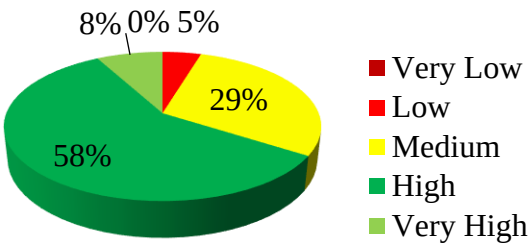

Figure 6. Percentage of the level of students' physical-kinesthetic intelligence

The percentage result of the level of physical-kinesthetic intelligence indicates that students' ability in actuating their limbs in chemistry learning activity are good enough. This intelligence helps students in performing learning activities related to physical touch. Students will be more enjoyable if they are able to involve their limbs entirely in studying chemistry.

The percentage result of the students' level musical-rhythmic intelligence in chemistry learning is presented on Figure 7. Musical-rhythmic intelligence is a person's ability in involving music or rhythm to solve a problem. Students' musical-rhythmic intelligence can be developed through chemistry learning such as the creation of songs about memorization of chemistry learning. Some examples of chemistry material memorization are elements in periodic table of elements, hydrocarbon compounds and their derivatives, benzene compounds and their derivatives, and macromolecules. Students can understand those chemistry materials using memorizing method of songs about chemistry. In addition to make it easier for students in studying, memorizing method using songs can also train students to remember informations for a long period of time. In line with this, Yuwono (2016) conveyed that students who have musical intelligence tend to memorize songs quickly and like playing music instruments and recognize songs easily.

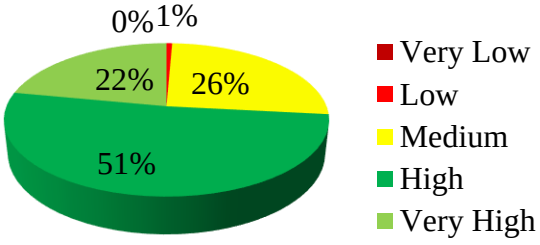

Figure 7. Percentage of the level of students' musical-rhythmic intelligence

The percentage result of the level of musical-rhythmic intelligence indicates that in majority high school students like music. There are some students who only like listening to a music and there are some students who like listening to a music and creating it. There are some students who like listening to all genre of music and there are some students who only like certain music. Commonly students who don't like music have low level of musical-rhythmic intelligence.

The percentage result of the students' level intrapersonal intelligence in chemistry learning is presented on Figure 8. Intrapersonal intelligence is an intelligence which a person has in performing activity or finishing his/her assignment independently. This intelligence intensively supports students in solving their own problems. Intrapersonal intelligence can train students to be independent in their life. This independent causes students to be depending on themselves. In addition, this intelligence also gives students spaces to think flexibly in solving problems. In line with this, Mahmud & AR (2017) said that students who have intrapersonal intelligence are independent and confident because they always be positive thinking on everything they have done in making a decision.

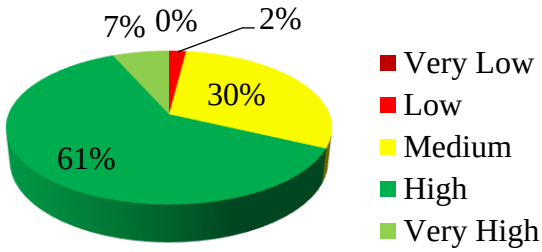

Figure 8. Percentage of the level of students' intrapersonal intelligence

The percentage result of the level of intrapersonal intelligence indicates that students have their own ability that is different and not owned by other. Students are able to do their work independently. Students who have high level of intrapersonal intelligence are capable to create their own studying style that is different from other students, whereas commonly students who are not capable to create their own studying style and imitate other students' studying style have low level of intrapersonal intelligence.

The percentage result of the students' level interpersonal intelligence in chemistry learning is presented on Figure 9. Interpersonal intelligence is

an intelligence which shows a person's ability in performing interaction with others. This intelligence is indispensable for students in learning process. A student can discuss with other students to find his/her own information or knowledge. Interpersonal intelligence needs to be developed on students, because of this intelligence students can exchange opinion and understand other students' character so the information they get is a result of mutual consideration. This intelligence provides students an opportunity to have no individualist when studying in the class. Concurring with this, Pratiwi & Ayriza (2018) said that students who have no interpersonal intelligence will have difficulty in building a relationship with others influenced to the next development.

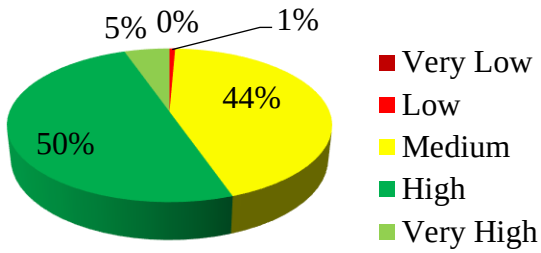

Figure 9. Percentage of the level of students' interpersonal intelligence

The percentage result of the level of naturalist intelligence shows that students are good enough in having relationship with the teacher and other students. When students join the learning process, there must be difficulties in understanding the material. If a student has interpersonal intelligence, he/she will try to find out difficulties that is faced by making a good relationship with the teacher and his/her friends who are asked for help to solve the problem. Sometimes students ask for help and give help in the learning process.

The percentage result of the students' level naturalist intelligence in chemistry learning is presented on Figure 10. Naturalist intelligence is an intelligence which involves a person's sympathy towards environment sustainability. The chemistry learning activity to improve students' naturalist intelligence is students are invited to explore nature and to identify what things can be used for chemistry learning material to be discussed together. This intelligence is very useful for education in 21^{st} century, because it can give new alternatives to students in learning process and finding an information. For example, students can replace materials of synthetic in laboratory using natural materials when they perform an experiment. The replacement of chemicals to natural materials aims to reduce pollutions.

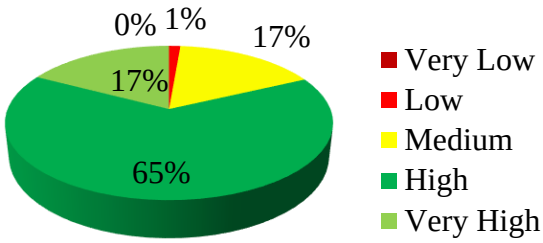

Figure 10. Percentage of the level of students' naturalist intelligence

The percentage result of the students' level naturalist intelligence leans as high. This result is the highest result if it is compared to other intelligences. This caused by several factors which one of them is geographical location of Indonesia that there are many mountains, farms, forests, rivers, lakes, and oceans make students being close to nature, so the students have high level of naturalist intelligence. Many different types of plant and animal can also affect students' naturalist intelligence. This intelligence is very useful because it can produce students' creativeness in conserving nature in order to be protected and sustainable. This result is in line with the research of Bayyinah *et al.* (2014) who collaborated Multiple Intelligence theory with Contextual Teaching Learning (CTL) that there are significant differences between them toward students' creative thinking skill.

Multiple Intelligences cannot be developed by performing only once or two times of learning activities which can trigger its emergence. This intelligence can develop if the learning activities performed repeatedly so it becomes a habit. Wijayanti et al. (2016) explained that repeated performance of learning where students are instructed to be used to solve problem can cause students to be able to give appropriate solutions expected by society.

A determination of suitable learning strategy to be applied in a subject cannot be separated from the result of students' intelligence analysis. Muali (2016) said that if intelligence is interpreted as a value of intelligence, it is not enough for a teacher to assert that the learning process can be successful without involving another intelligence in Multiple Intelligences. An Intelligence is not always

interpreted in domain of cognitive, psychomotor and affective, but it is interpreted as a compound intelligence which is able to accommodate those three domains without discrediting another intelligence.

The Multiple Intelligences theory can be collaborated with a strategy or style of learning and assessment instrument to create a learning activity which is meaningful, comfortable, and and able to evaluate various students' ability. Several examples of the collaboration are the research of Septiana & Ikhsan (2017) which collaborated Multiple Intelligence theory with Problem Based Learning (PBL) style that gives a high influence in understanding a concept and students' creative thinking skill. The research of Mediartika & Aznam (2018) which developed an assessment instrument in the form of portofolio based on Multiple Intelligences to measure students' critical thinking skill and scientific attitude obtained a proper result to be performed.

The learning process using Multiple Intelligences approach which is given to students can activate their intelligence so they can do their assignment maximally according to their field (Candrawan et al., 2017). By implementing the learning system based on complex intelligence, students can resolve their deficiency by utilizing their excess in optimizing the characteristic of each intelligence so they can develop other intelligences (Pertiwi et. al., 2017). Teacher as the educator must be able to identify students' intelligence. This identification is very useful in formulating chemistry learning strategies which are suitable to be applied on students with different character for each discussion of chemistry.

All intelligence in Multiple Intelligences is related to chemistry learning. These intelligences can develop according to each student's ability by performing some supportive practices. However, if it is viewed from chemistry content, the intelligences which have a close relationship to chemistry learning are intelligences of verbal-linguistic, logical-mathematical, and visual-spatial. The three intelligences are related to each other in understanding the chemistry material. Verbal-linguistic intelligence relates to terminologies or vocabularies of chemistry language. Logical-mathematical intelligence relates to formulas and numeral operation of chemistry. Visual-spatial intelligence relates to chemistry processes that are natural and artificial such as processes in chemistry reaction.

CONCLUSION

Every student has the eight intelligences of Multiple Intelligences with different levels and accord to each student's ability. These intelligences are utilized by students as their provision to solve a problem in their life. Based on the result of the data analysis, naturalist intelligence is the highest percentage namely 71.10%, whereas verbal-linguistic intelligence is the lowest percentage namely 62.23%. The level of students' Multiple Intelligences in chemistry learning averagely categorized as "High". Some students excel in one intelligence, but they are weak in other intelligences. Various intelligence in Multiple Intelligences can be developed through meaningful and enjoyable learning activities. High level of intelligence can build a good student's character and they are more ready in facing problems that occurs in society or work. For further research, it will be better if these intelligences are analyzed in detail with various type of instrument of certain subject and sub-chemistry material.

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