The Effect of Various Learning Approaches on Mathematical Learning Outcomes based on the Multiple Intelligences of Students

In learning, students have individual methods of processing information provided by the teacher depending on the type of intelligence they possess. Due to these differences in intelligence, teachers have to be conscious during the design and implementation of mathematics learning in the classroom. This study aims to describe the results of various research on multiple intelligences in mathematics learning, using a descriptive approach. It also ascertains the influence of various learning models on mathematics learning outcomes based on students' multiple intelligences. STAD and TGT learning models improved learning outcomes for students possessing logical-mathematical, kinesthetic, and interpersonal intelligences. Peer tutoring and independent learning models via e-learning improved learning outcomes in students with linguistic and interpersonal intelligences. Furthermore, GI and NHT learning models improved student learning outcomes with logical-mathematical intelligence. The Two Stay Two Stray learning model with peer tutors improved student learning outcomes with linguistic, logical-mathematical, and interpersonal intelligences. The TAI and Jigsaw learning improved student learning outcomes with linguistic intelligence. Lastly, TSTS and NHT learning models improved student learning outcomes with logical-mathematical, and interpersonal intelligences.

Keywords: *Compound Intelligence, Learning Model, Mathematics*

Introduction

This happens There are many students which experience difficulty while learning mathematics. This makes it difficult to master mathematical concepts. Students experiencing difficulties may lack the initiative to try again and do not ask the teacher. They feel afraid or embarrassed to ask when they do not understand a problem, Therefore their learning outcomes are low (Fadila. 2014) due to their difficulty, for example, in calculating the volume and surface area of spaces (Pradana, 2014), solving problems related to the circular elements, and the relationship between two circles (Sholikhah. 2014).

Because mathematics learning in schools is still teacher centered and does not pay attention to the multiple intelligences of students (Pradana. 2014; Sholikhah. 2014; Widyawati. 2014; Taufik. 2017; Suwanto. 2019) (Susilo. 2018; Laksmiwati. 2019). Students have been proven to possess different intelligences. The ones with high visual-spatial intelligence tend to think visually, while the ones possessing verbal intelligence like to read, are good at telling stories, writing stories or poetry. Students with interpersonal intelligence have good interactions with others, are good at establishing social relationships, and are able to know and apply various methods of interacting.

Therefore, during learning, the teacher has to pay attention to the intelligence diversity in students. The learning of mathematics requires conformity with the theory of multiple intelligences (Susilo. 2018). To enhance multiple intelligence in learning, many things can be done, such as choosing models, strategies, approaches, and learning media.

Literature Review

The multiple intelligence theory was initiated by Howard Gardner from Harvard University, United States. Howard Gardner is a humanistic psychologist professor of education at the Graduate School of Education. In 1983, Gardner wrote a book titled “Frames of Mind: The Theory of Multiple Intelligences” which was published in 1993.

Gardner defined intelligence as the ability to solve problems and produce results in a variety of settings and real-life situations (Amir. 2013; Taufik. 2017). Additionally, Gardner explained intelligence as (1) the ability to solve problems that occur in human life; (2) problem-solving skills which enable a person achieve the goals of a certain objective or situation; (3) the ability to determine the right direction or method towards a target (Riyanto, 2010). There are several kinds of intelligence expressed by Gardner (Hamdi. 2011; Amir. 2013; Sholikhah. 2014; Indriani. 2017; Sunendar. 2017; Taufik. 2017; Aini. 2018; Fathani. 2019; Kurniawati. 2019; Laksmiwati. 2019; ; Palayukan. 2019; Suwanto. 2019; Nugroho. 2020) namely:

1. Verbal Intelligence (Linguistic Intelligence)

This is the ability to use and process words effectively, both orally and in writing. The characteristics of children with prominent linguistic intelligence include writing stories or poetry, reading, telling stories, enjoy learning foreign languages, good vocabulary and spelling, writing letters or e-mail, talking about ideas with friends, a strong ability to remember names or facts, enjoys word games (juggling words, hidden words, scrabble or crossword puzzles, puns or rhymes) and enjoys reading about eye-catching ideas

2. Logical-Mathematical Intelligence:

This is an ability to solve problems involving numbers and logic effectively. Students with high logical-mathematical intelligence show a great interest in exploration. This intelligence has characteristics, specifically a sensitivity to logical relationship patterns, statements and propositions, logical functions and other abstractions. A person with high logical mathematical intelligence is usually interested in numbers, science, easily performs math mentally, enjoys solving mysteries, likes to count, make predictions, guess numbers (for instance, the number of coins in a container), easlily memorizes numbers and scores, enjoys strategy games such as chess, pays attention to actions and consequences (known as cause-and-effect), spends time doing brain teasers or logic puzzles, likes to check out how computers work and organize information into tables or graphs, as well as how they can use a computer more productively, instead of just playing games.

3. Visual-Spatial Intelligence

This is the ability to properly capture the visual-space world, such as that of hunters, architects, navigators, and decorators. Students with high visual-spatial intelligence tend to think visually. This intelligence includes sensitivity to colors, lines, shapes, spaces and the relationships between these elements. A spatially intelligent individual usually remembers faces rather than names, likes to draw ideas or make sketches to solve problems, thinks in pictures and easily sees objects mentally. Furthermore, they love to build or construct,enjoys reading, drawing maps, looking at photos / pictures and talk about them, like to see the patterns of the world, doodle, draw in great detail and realistically, remember things learned in form of pictures, observing people performing several activities, solving visual / picture puzzles and optical illusions and builds models or anything in 3 dimensions. Students with visual intelligence are usually rich in imagination, which enables their creativity.

4. Bodily-Kinesthetic Intelligence

This is the ability to use the body or gestures to express ideas and feelings, similar to that of actors, athletes, dancers, sculptors, and surgeons. Students with above average bodily-kinesthetic intelligence, enjoy moving and touching. They have control, balance, dexterity, and grace in movement, and like to explore the world with their muscles.

5. Musical Intelligence

This is the ability to develop, express, and enjoy musical notes and sound forms. Students with prominent musical intelligence easily recognize and remember tones. They can also transform words into songs, and create various musical plays. Additionally, they are good at singing the beat of a song properly, musical vocabulary, and sensitivity to rhythm, melody or sound color in a musical composition.

6. Interpersonal Intelligence

This is the ability to understand and be sensitive to other people's feelings, intentions, motivations, dispositions, temperaments. Students with prominent interpersonal intelligence have good interactions with other people, easily establish social relationships, and are able to know and utilize various methods of interacting. They are also able to perceive the feelings, thoughts, behavior and expectations of others, and easily cooperate.

7. Intrapersonal Intelligence

This is related to self-knowledge and the inherent ability to adapt. Students with prominent intra-personal intelligence have a sense of feeling in ongoing situations, understand themselves, and are able to control themselves during conflict. They also know what can be done and what cannot be done in a social environment. Furthermore, they know the right person to approach when they have to.

8. Naturalist Intelligence

This is the ability to understand flora and fauna well. Students with prominent naturalist intelligence have a great interest in the environment, including animals, at a very early age. They enjoy objects and stories related to

natural phenomena, for example the occurrence of clouds and rain, origin of animals, plant growth, and the solar system.

9. Existence Intelligence

This involves an individual's sensitivity and the ability to answer the deepest problems of human life and existence. Students with such intelligence are curious about human existence, the meaning of life, why humans experience death, and the realities they face. This intelligence was developed by Gardner in 1999.

The benefits of applying multiple intelligence in the learning process of mathematics include (Hamdi. 2011, Amir. 2013; Pradana. 2014; Susilo. 2018):

1) Creates student motivation to learning mathematics.
2) Provides various study methods for students according to their interests,and talents.
3) Improves their abilities in their preferred fields.
4) Provides a positive influence in a pleasant learning atmosphere without limiting students.
5) Ability to facilitate students with various types of intelligence (Armstrong 2009).
6) Reduces the tendency of teachers to teach only in accordance with their most prominent types of intelligence.
7) Improve mathematics learning outcomes.

The dimensions of multiple intelligences contained in the 2013 curriculum can be seen in three ways. Firstly, the development of four core competencies (KI), namely spiritual attitudes, social attitudes, knowledge and skills. Secondly, the application of a scientific approach which includes; observing, questioning, experimenting, associating, and communicating. Thirdly, the assessment system carried out is in form of authentic assessment (Machali, 2014).

Methodology/Materials and Methods

This study was carried out to determine various results on multiple intelligences in mathematics learning. The intensive and rigorous literature review were done to analyze the effect of multiple intelligences in mathematics learning. There were two methods that were used to search the relevant and appropriate literature of the research. These approaches were suggested by Page (2008) and well thought-out as the suitable and efficient ways to ascertain significant literature.

At the first phase, several related electronic databases were explored to investigate for the relevant articles, such as EBSCO host, Elsevier, Science Direct, Emerald, JSTOR, ProQuest, Sage Publications, SciVerse, Scopus, Springer Link, Taylor and Francis Online and Wiley Online. The main keywords used were Compound Intelligence, Learning Model, Mathematics

and learning, twenty-first century teaching and learning, the effective teaching and learning in general and specifically in mathematics subject at primary to higher institution level. Furthermore, each single journal was examined individually to find more pertinent papers, for example, International Electronic Journal of Mathematics Education, Mathematics Education, Eurasia Journal of Mathematics, Science & Technology Education, Procedia-Social and Behavioral Sciences, Asian Social Science, etc.

At the second phase, the relevant articles were identified based on the pull out bibliography of the crucial articles of the above literature review using the snowballing method. The literature exploration was done from 2019 to 2020 and restricted to only teaching and learning studies available between 2009 and 2019. This leads to the limitation of this study. If it is found that an article fulfilled these three elements: (a) it focused predominantly on multiple intelligences in mathematics learning and learning of mathematics in general and specifically in mathematics subject at all level, (b) the investigation was carry out in the venue of primary to higher institutions and among mathematics educators, then this article will be included in this study. The peer-reviewed articles that were published in academic journals were also included. Furthermore, conference proceedings, and theses, were also included from this review. Duplication, indistinguishable and identical publications that irrelevant was removed. Those articles were selected for relevance, essentially based on the title, abstracts, and keywords.

Results and Discussion

The research results on students' multiple intelligences in mathematics learning have been conducted by several researchers (Hamdi. 2011; Amir. 2013; Fadila. 2014; Machali. 2014; Pradana. 2014; Rohman. 2014; Safitri. 2014; Sholikhah. 2014; Widyawati. 2014; Miftachudin. 2015; Indriani. 2017; Sunendar. 2017; Taufik. 2017; Aini. 2018; Susilo. 2018; Fathani. 2019; Kurniawati. 2019; Laksmiwati. 2019; Palayukan. 2019; Suwanto. 2019; Nugroho. 2020).

Hamdi (2011) examined the advantages of learning mathematics through CTL, involving multiple intelligences in building student character. There are seven main components of effective learning involved in CTL, namely constructivism, questioning, inquiry, learning community, modeling, reflection, and authentic assessment). An example of character that was built is honesty. This was observed in the process of proving the formula, which has to undergo a process of honesty and openness. That is, all related aspects will be disclosed openly and thoroughly, including the consequences of such proof. The results showed that multiple intelligence-based CTL was highly suitable for building student character. This was because in the learning process the teacher incorporated the real world into the classroom and encouraged students to make connections between the knowledge they have and its application in everyday life.

Amir (2013) conducted an experiment to determine effects of multiple intelligence-based mathematics learning. The results showed that through paying attention to the multiple intelligences of students, teachers aroused their motivation to learn. This was attainable, because students learned according to their interests, and talents. Therefore, this method improved students' abilities in their preferred fields, as it provided a positive influence in a pleasant learning atmosphere, without limiting students.

Fadila (2014) conducted a research in class VII SMP to ascertain the effect of the Student Team outcomeDivision (STAD) and Team Games Tournament (TGT) cooperative learning model with a contextual approach to learning achievement. It also aimed to determine the affective aspects of multiple intelligence on student mathematics learning. The results showed that: 1) The outcome of students' mathematics learning using the TGT learning model in a contextual approach was better than the STAD learning model; 2) The outcome of students whose learning involved the TGT model with a contextual approach was as good as the STAD model; 3) Student learning outcomes with logical-mathematical intelligence were as good as kinesthetic and interpersonal intelligence. In addition, the learning outcomes with mathematical logical intelligence were better than visual, kinesthetic and interpersonal intelligence.

Machali (2014) conducted an experiment to determine the relevance of changes and curriculum development in 2013 to multiple intelligences. The results showed that the 2013 Curriculum made room for the development of multiple intelligence dimensions which can be seen in three ways. Firstly, in competency development, which consists of four core competencies (KI), namely spiritual and social attitudes, knowledge, and skills. In the multiple intelligence category, there are dimensions of existential, interpersonal, intrapersonal, linguistic, logical-mathematical, musical, visual / spatial, bodily-kinesthetic, and naturalist/environmental intelligences. Secondly, the scientific approach is applied, which includes observing, questioning, experimenting, reasoning, associating, and communicating which is very relevant to the development of learning using multiple intelligence. Thirdly, an authentic assessment method is applied, which is also highly relevant.

Pradana (2014) conducted research in class VIII SMP to determine the effect of the NHT type cooperative learning model using the CTL approach, on the subject matter of flat-sided shapes involving students' multiple intelligences. Students possessing the verbal, logical-mathematical, interpersonal, and spatial types of intelligence had the same achievement. This is because, during their learning process, they were able to take advantage of their verbal intelligence in understanding each sentence in the given problem. The ones with logical-mathematical intelligence had the advantage in performing calculations in questions. Furthermore, students with interpersonal intelligence were also able to work together, ask questions and discuss with other students, This enabled them to obtain adequate information in order to solve the given problem. In addition, students with spatial intelligence were able to imagine shapes, make pictures that helped to solve problems.

The results of the research include (1) the learning outcome for students that used the NHT-CTL learning model was better than the NHT and direct learning models, while the NHT model was as good as the direct learning model, (2) students possessing verbal, logical-mathematical, interpersonal, and spatial types of intelligence had the same achievement, (3) in each of the multiple intelligences, the learning outcome for students that used the NHT-CTL learning model was better than the NHT and direct learning models, while the NHT model was as good as the direct learning model,(4) in each learning model, the mathematics learning outcome for students with verbal, logical-mathematical, interpersonal, and spatial intelligence was equally good.

Safitri (2014) conducted research in class VII SMP to determine the effect of using peer tutoring and independent cooperative learning models with e-learning on the subject of algebra involving multiple intelligences. The results are: (1) In groups where students learned using the peer tutoring cooperative learning model, they had better mathematics learning outcome than students which used the self-learning model with e-learning and direct learning. In the group where students used the independent learning model alongside e-learning, they had better mathematics learning outcome than the group taught using the direct learning model. (2) The learning outcome of students having interpersonal intelligence was better than that of students with intrapersonal and linguistic intelligence. Furthermore, the ones with verbal-linguistic intelligence had better mathematics outcomethan students with intrapersonal intelligence.

(3) In peer tutoring cooperative learning, the mathematics learning outcome in students with interpersonal intelligence was better than the ones with intrapersonal. Meanwhile, students with intrapersonal and interpersonal intelligence had the same mathematics learning outcomewith the ones having verbal intelligence. In independent e-learning, there was no significant difference between the mathematics learning outcomeof students having both interpersonal and verbal types. In direct learning, students having intrapersonal and interpersonal types had the same mathematics learning outcome. Furthermore, the interpersonally intelligent students had the same mathematics learning outcome as the ones having verbal, while students having verbal had a better learning outcome than the ones with intrapersonal intelligence.

Sholikhah (2014) conducted an experiment in class VIII SMP to ascertain the effect of Group Investigation (GI) and Numbered Heads Together (NHT) cooperative learning models on material tangents to circles involving students' multiple intelligences. The results showed that: (1) The mathematics learning outcome for students which used the NHT learning model was better than GI and direct learning, while that of students which used the GI learning model was better than the direct model. (2) The mathematics learning outcome for students having logical-mathematical intelligence was better than in individuals with interpersonal and linguistic, while that of students with interpersonal intelligence was the same as verbal intelligence. (3) In the NHT learning model, the mathematics learning outcome for students having logical-mathematical, interpersonal, and linguistic intelligence were the same.

Widyawati (2014) conducted research in class VII SMP using rectangular flat shapes to determine the effect of the Two Stay Two Stray (TSTS) and Numbered Heads Together (NHT) learning models involving multiple intelligences of students. The conclusions obtained are: (1) the TSTS cooperative learning model produced better mathematics learning outcome than the NHT and direct learning model, while the NHT cooperative learning model produced better outcome than the direct; (2) The mathematics learning outcome of students having logical-mathematical intelligence was better than the ones with interpersonal and verbal. Furthermore, the learning outcome of students having interpersonal was better than verbal; (3) For students having logical-mathematical intelligence, the TSTS cooperative learning model produced better learning outcome than the NHT, while the TSTS and NHT cooperative learning models produced the same learning outcome as the direct learning model. For students having interpersonal intelligence, the TSTS-type cooperative learning model produced the same learning outcome as the NHT and the direct, while the NHT-type cooperative learning model produced better mathematics learning outcome than the direct model. For students having linguistic intelligence, the cooperative learning model TSTS, NHT, and direct learning models produced the same mathematics learning achievement; (4) In the TSTS cooperative learning model, the learning outcome of students having interpersonal intelligence was the same as logical-mathematical, and verbal intelligence. Furthermore, the learning outcome of students having logical-mathematical intelligence was better than the ones with verbal intelligence. In the NHT type of cooperative learning model, the learning outcome of students having logical-mathematical, interpersonal and verbal intelligence was the same. In the direct learning model, the learning outcome of students having logical-mathematical intelligence was better than interpersonal and linguistic intelligence. In addition, the learning outcome of students having interpersonal intelligence was the same in students having verbal intelligence.

Miftachudin (2015) conducted a research in class VII SMP to determine the effectiveness of the TSTS type learning model with peer tutors in learning mathematics on flat shape material which involves multiple intelligences. From the results, the following were observed: (1) The TSTS learning model with peer tutors resulted in better student outcome compared to the direct. (2) Students with logical-mathematical, verbal and interpersonal intelligences had the same achievement. (3) In the TSTS learning model with peer tutors, students with logical-mathematical, verbal and interpersonal intelligence had the same student achievement. (4) Students with logical-mathematical intelligence, verbal and interpersonal intelligence produced better learning achievements compared to the direct learning models.

Taufik (2017) conducted a research in class VIII MTs to describe relations and functions in mathematics learning involving multiple intelligences, using a scientific approach. The steps involved 1) preliminary activities; 2) core activities which include observing, asking questions, gathering information, associating and communicating; and 3) cover. The multiple intelligences involved include verbal/linguistic, visual/spatial, logical/mathematical, musical,

bodily/kinesthetic, interpersonal, and intrapersonal. In the first cycle, the average results of student and teacher activities were 70% and 76%, which was in the poor and sufficient category. In cycle II, the average results of student and teacher observations were 82% and 83% in the good category. In cycle I, the student outcome in class VIII-A was 46%, where 18 students obtained a final score above 75. In cycle II, the outcome in class VIII-A was 80%, where 31 students obtained the final score above 75. Therefore, the increase in learning outcome from cycle I to II was 34%.

Aini (2018) conducted an experiment in class VIII SMP to describe students' mathematical literacy in solving math questions about number pattern problems which involved multiple intelligence. The results showed that students with verbal-linguistic intelligence, logical-mathematical and naturalists have the same tendency to identify concepts, define and determine initial ideas, find relationships between variables, and make mathematical models of problems. However, the indicators used to describe a mathematical situation were different for each intelligence. Verbal-linguistic and logical-mathematical students can write down situations using symbols, but naturalist students cannot. Furthermore, in designing strategies, students having verbal intelligence tend to write down steps with easy-to-understand delivery. logical-mathematical students formulated steps that produced the right solution, while naturalist students tend to use pictures.

Kurniawati (2019) conducted a research in class X SMA to describe the mathematical literacy of students with verbal, logical-mathematical and spatial intelligences in solving PISA problems involving space and shape content. The results showed that students with verbal intelligence underwent several processes, namely identifying mathematical aspects of the problem, translating problems into mathematical language, designing strategies to determine solutions (but not entirely accurate), describing the steps for solving problems according to the strategies designed, reinterpreting the results or solutions into the context of real-world problems, and explaining the reasons for the accuracy of the given conclusions. Students with logical-mathematical-intelligence underwent several processes, namely, identifying mathematical aspects of the problem, translating them into mathematical language, designing strategies to determine solutions, describing the steps for determining mathematical solutions in detail, and systematically not reinterpreting the results or solutions obtained into the context of real-world problems, but clarifying the appropriateness of the given conclusion. In addition, subjects with spatial intelligence underwent several processes, namely, identifying mathematical aspects of the problem, translating them into mathematical language, designing strategies to determine solutions, and not reinterpreting the results obtained in the context of real-world problems, but clarifying the appropriateness of the given conclusion.

Nugroho (2020) conducted a research in class VIII SMP to determine the learning outcome in the TAI and Jigsaw cooperative learning model involving multiple intelligences. The results showed that (1) there was a significant difference in learning outcome in this cooperative learning model before and

after treatment; (2) there was no significant difference in outcome between students having linguistic, logical mathematical, and other types; (3) there was no significant difference in outcome between linguistic, logical-mathematical and others in the implementation of the TAI type learning model; (4) there was no significant difference in learning outcome between students having verbal, logical-mathematical and other intelligences in the implementation of the Jigsaw type learning model; (5) there was a positive, significant difference in learning outcome between the TAI and Jigsaw learning models in students with verbal intelligence.

Conclusions

From the research results, the following conclusions were obtained:

1. Students with verbal intelligence are suitable for peer tutoring and independent learning models with e-learning, Two Stay Two Stray with peer tutors, TAI and Jigsaw.
2. Students with logical-mathematical intelligence are suitable for the STAD and TGT, GI and NHT learning models, Two Stay Two Stray with peer tutors, TSTS and NHT.
3. Students with kinesthetic intelligence are suitable for the STAD and TGT learning models,
4. Students with interpersonal intelligence are suitable for the STAD and TGT learning models, peer tutoring and independent e-learning, Two Stay Two Stray with peer tutors, TSTS and NHT.ables should be editable and must be at an appropriate place in the main text such as figures. For the tables, use the following format.