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STEAM learning approach: realizing 21st century skills through increasing compound intelligence of class x students

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Article Info

ABSTRACT

This classroom action research aims to improve students' multiple intelligences through the STEAM (Science, Technology, Engineering, Arts, and Math) learning approach in class X TKJ at SMK Kristen Tagari with 31 students as research subjects. The classroom action research consisted of three cycles and each cycle consisted of six actions. Collecting data using the method of observation, interviews, multiple intelligence tests, and documentation. The data analysis technique uses the average value and the percentage of multiple intelligence test results. The results showed an increase in all constructs of multiple intelligence in subjects as evidenced by the results of the average score of the first intelligence test 28.19, the second test 28.93, the third test 29.49 while the average percentage change in multiple intelligence scores on the first test to the second test amounted to 2.62%, the second test to the third test 1.96% and the first test to the third test of 4.62%. It is recommended for further research to conduct classroom action research using the STEAM learning approach, students' multiple intelligence tests by learning problems experienced in class.

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Introduction

Globally, the importance of 21st-century skills is determined by various factors such as changes in society as a result of the rapid spread of information, globalization and internationalization, and the shift in the socio-industrial economy to an information and knowledge-based social economy (Joke Voogt, Natalie Pareja Roblin, 2010). Conditions like this make education directed to prepare the workforce in line with metacognitive needs and skills are becoming increasingly important.

Kenworthy and Kielstra (Alina A. von Davier, Mengxiao Zhu, Patrick C. Kyllonen, 2017) identified four main issues that drive change in education, namely: 1). Problem-solving, teamwork, and communication are the top three skills that companies need and will be needed more and more in the years to come. 2). The education system does not provide sufficient skills for the needs of students and the workplace. 3). To make up for deficiencies in the education system, students are working to improve their quality. 4). Teaching practices and resource use have been changed by the use of technology but the education system is still transforming and even leading it.

As a consequence of changing labor market needs, many countries have recognized the importance of 21st-century skills by including them in educational goals and undertaking various curriculum, teaching, and

assessment reforms to prepare all children to be able to compete in life in various fields of work in this era. 21st century (Schleicher, Preparing teachers to deliver 21st-century skills, 2012).

In more detail, 21st-century skill needs are grouped into three categories, namely: 1). Learning skills (critical thinking, creativity, collaboration, and communication) teach students about the mental processes needed to adapt and improve the modern work environment. 2). Literacy skills (information, media, technology) focus on how students can see facts, publishing outlets, and existing technology with a strong focus on determining reliable sources and factual information and sorting out true or false information flooding the internet. 3). Life skills (flexibility, leadership, productivity, and social) see the intangible elements of students' daily lives. These intangibles focus on personal and professional qualities. Overall, these categories include all 12th-century skills that contribute to a student's future career (Stauffer, 2020).

Based on the Global Human Capital Report 2017, it states that "in terms of the success of human resource development, Indonesia is ranked 65th out of 130 countries surveyed. The rating was achieved based on capacity, which was ranked 64th with a value of 69.7. This value is based on the level of illiteracy and numeracy which has reached a value of 99.7 in the 15-24 year age group " (Dungkal, 2019).

If you refer to the 2018 PISA report, in the fields of science, literacy, mathematics, Indonesia still ranks at the bottom of the board. From the test results in 2018, the acquisition of a reading score of 371, a math score of 379, and a science score of 396. Compared to the results of the 2015 test, this score has decreased where reading scores are 397, math scores 386, and science scores 403. Of all these scores, Reading had the lowest score decline, and even below the 2012 score of 396 (Schleicher, PISA 2018 : Insight and Interpretations, 2019).

The need for human resources in the 21st-century era with demands for competence and compared to the real situation regarding education proves that Indonesia, especially the Tagari Rantepao Christian Vocational School, is still far behind developed countries in terms of education. Conditions like this should be a motivation for every education policymaker, even all parties to make efforts to improve the quality of the teaching and learning process in the educational environment. The efforts of the Indonesian government through the ministry of education by making curriculum changes that are by current developments have apparently not been the answer to the needs of the industrial era 4.0, and this must be answered at the level of the education unit by taking concrete steps to improve the quality of education without having to violate applicable regulations.

Competence in the 21st Century Era

In general, the concept of 21st-century skills is accepted because the existence of technology in society develops towards an information or knowledge society. Whereas the metaphor of the information society is associated with the "explosion" of information which refers to an economic system in which the idea or knowledge functions as a commodity (Anderson, 2008).

Reich said that in an information society, there is a lot of work in the production chain that is done over and over again as a result of the increased use of technology. At the same time, there will be an increasing need for service workers, such as child care workers and cleaners, who provide professional services, and symbolic analysts or "mind workers" who are involved in problem identification, problem-solving, and information mediation for a living - such as engineers and journalists (Reich, 1992).

For various reasons, new competencies often referred to as 21st-century skills are being requested. It is important to realize that society is not only facing changes in the types of jobs that are needed, but today's young people also need to be educated for jobs that do not yet exist (Did You Know? - Research & Design by Karl Fisch, Scott McLeod & Jeff Brenman, 2020).

(Anderson, 2008) Lists the following skills a knowledge society needs: 1). knowledge construction, 2). adaptability, 3). discovery, organizing, and retrieval of information, 4). information management, 5). critical thinking and 6). teamwork. Since 2002 the European Commission has stated that all EU citizens should have the opportunity to acquire a number of "key skills", which refer to 21st-century skills.

21st-century skills are defined as lifelong learning competencies. The country's OECD ministers of education adopted the concept of lifelong learning in 2004, which includes all the goals of learning activities in a person's life. In this paper, we will use the term 21st-century skills or competencies as a comprehensive concept for the knowledge, skills, and dispositions that citizens must be able to contribute to the knowledge society (Council, 2012).

STEAM Learning Approach

STEAM is an acronym for Science, Technology, Engineering, Arts, and Math. STEAM is a learning approach that utilizes science, technology, engineering, art, and arithmetic as a way to guide students in discussing, collaborating, and thinking critically with the ultimate goal of a learning process that makes students capable and brave to take risks in research with careful consideration (Rachim, 2019).

The increasing importance of science, technology, engineering, and mathematics education has become a popular topic in recent years. Science, technology, engineering, and mathematics education received by students does not reflect what individuals actually do in careers where students focus more on memorizing rather than identifying problems and finding ways to solve problems (Harland, 2011).

Mathematical Engineering Technology Science (STEM) is a generic curriculum that works on Science, Technology, Engineering, and Mathematics education in learning that makes use of interdisciplinary knowledge and an applicative approach to problem-solving.(Nadeak Bernadetha, 2019)

With the STEAM learning approach, students are directly involved in the learning experience, are diligent in finding solutions to problems, students are active in collaboration, and work with creative processes. Everyone involved in the STEAM approach is a 21st-century innovator, educator, leader, and learner (Riley, 2020). STEAM utilizes interdisciplinary knowledge and an applicable approach in problem-solving (W Liliawati, H Rusnayati, Purwanto and G Aristantia, 2018).

Multiple Intelligence

The theory of multiple intelligences has contributed greatly to education and suggests teachers expand their knowledge of techniques, tools, and strategies in addition to language and logic that have dominated classroom teaching (Armstrong, 2009). According to John Goodlad in "A Study of Schooling" found that almost 70 percent of the opportunities in the class are controlled by the teacher, especially when talking to students by giving assignments, other activities that assign students to write assignments, and jobs that take up learning opportunities in the form of directions (John I. Goodlad, Kenneth A. Sirotnik and Bette C. Overman, 1979). Goodlad's findings after twenty years later, the learning class has not changed much. Even now, there are still many teachers who dominate the learning class.

The theory of multiple intelligences provides a doorway to various teaching strategies that are easy to implement in the classroom and a strategy that is widely used by teachers. The theory of multiple intelligences offers teachers the opportunity to develop innovative teaching strategies in education (Armstrong, 2009).

The theory of multiple intelligences suggests that no one set of teaching strategies will work best for all students at all times. All children have different tendencies in the nine intelligences, so certain strategies tend to be very successful with one group of students and less successful with another group (Armstrong, 2009). For example, teachers using the dangdut song strategy as a pedagogical tool might find that students who tend to music respond while non-musical students remain motionless. Likewise, the use of pictures in teaching reaches more spatially oriented students but may have a different effect on those who are more likely to be physical or verbal.

The theory of "multiple intelligence" developed by Howard Gardner provides nine different potential pathways/constructs of intelligence for learning namely Language, Logical/ Mathematical, Visual/ Spatial Images & Dimensions, Bodily-on/ Kinaesthetic-Action, Naturalist, Harmony & Rhythm Musical, Interpersonal- understanding and interacting with people, Intra-personal/ Self Knowledge, and Metaphysical. It is said that all humans have 9 intelligences at various levels. 9 intelligences can operate independently of each other.

Method

Classroom Action Research

Research methodology is a special procedure or technique used to identify, select, process, and analyze information about a topic (Leedy, 2000). In this study, the method used was classroom action research.

By combining knowledge, research, and action, action research belonging to the scope of applied research (Mulyatingingsih, 2005) is a method of finding out what is best in the classroom that is self-taught so that it can improve the quality of students being mentored. We know a lot about good teaching in general (eg McKeachie, 1999; Chickering and Gamson, 1987; Weimer, 1996), but each teaching situation is unique in terms of content, levels, student skills, and learning styles, teacher skills, and teaching styles, and many other factors.(Nadeak Bernadetha, 2020) To maximize student learning, a teacher must find out what works best in a particular situation (Mettetal, 2012).

Classroom action research can be defined as the study of social situations with a view to improving the quality of action in them. It aims to provide practical judgments in concrete situations and the validity of the theory or hypothesis it produces does not depend much on scientific truth testing, such as on its usefulness in helping people act smarter and more skillfully. In action research, the theory is not independently validated and then applied to practice, but action research is validated through practice (Elliot, 1991).

Multiple Intelligence Survey

The Multiple Intelligence Survey (MIS) was developed to identify the Multiple Intelligences conceptualized by Howard Gardner (Sreenidhi S K, Tay Chinyi Helena, 2017). Multiple intelligence surveys are designed to be used in learning situations to provide self-report information (Joyce A. McClellan, Gary J. Conti, 2008) to help students in the metacognitive process reflect on how they learn.

This study makes use of traditional steps in instrument development to create a valid and reliable process for identifying a person's multiple intelligences. Establish validity for items based on Howard Gardner's conceptualization of Multiple Intelligences.

The most important type of validity is construct validity (Joyce A. McClellan, Gary J. Conti, 2008) the degree to which the test reflects the constructs that are intended to be measured. Construct validity relates to what the instrument actually measures.

Results and Discussion

The results of the first multiple intelligence test become an indicator of the subject's intelligence and become a reference for designing STEAM measures in accordance with the subject's multiple intelligence conditions which theoretically can improve certain intelligence constructs.

Table 1. The Average Score of the Intelligence Construct of the Subjects of the First Test Results.

Number of test	Logical Matematic	Verbal Linguistic	Musical	Visual	Bodily Kinestetic	Intrapersonal	Interpersonal	Naturalistic	Existential	Mean
Mean of first exam result	26,84	28,23	30,29	24,87	27,68	28,61	26,42	30,55	30,26	28,19

The results of the first multiple intelligence test in Table 1 show the state of intelligence of the subjects in the research class where the natural construct is the highest with a score of 30.55 while the lowest is the visual construct with a score of 24.61. The average score of multiple subjects' intelligence in the class is 28.19 an indication of the importance of appropriate action to improve the multiple intelligence of subjects.

The results of the second multiple intelligence test in Table 2 function to measure the construct of the subject's intelligence after experiencing the first cycle of action and serve as evaluation material for improvement, quality improvement, and frequency of action in the next cycle.

Table 2. The Average Score of the Intelligence Construct of the Subjects of the Second Test Result.

Number of test	Logical Matematic	Verbal Linguistic	Musical	Visual	Bodily Kinestetic	Intrapersonal	Interpersonal	Naturalistic	Existential	Mean
Mean of second exam result	26,84	28,90	30,65	25,65	27,90	30,06	27,55	31,42	31,42	28,93

The results of the second multiple intelligence test in Table 2 show the condition of the subject's intelligence after experiencing action based on the first intelligence test. The construct of visual intelligence with the lowest score of 25.65, while the construct of the highest intelligence is the natural and existential construct with a

score of 31.42 and an average score of multiple intelligences of 28.93. The results of the second multiple intelligence test indicate that action should be continued because the performance indicators set earlier have not been met.

The results of the third multiple intelligence test in Table 3 serve to measure the construct of the subject's intelligence after experiencing cycle 1, cycle 2 action and serve as evaluation material for improvement, quality improvement, frequency of action in the next cycle or the cycle stops if performance indicators are met.

Table 3 The average score of the intelligence construct of the research subjects on the results of the third test.

Number of test	Logical Matematic	Verbal Linguistic	Musical	Visual	Bodily Kinestetic	Intrapersonal	Interpersonal	Naturalistic	Existential	Mean
Mean of third exam result	27,84	29,52	31,13	26,26	28,42	30,42	28,26	31,81	31,74	29,49

The results of the third multiple intelligence test in Table 3. show the condition of the subject's intelligence after experiencing the action of cycle 1, cycle 2. The lowest intelligence construct was visual with a score of 26.26 and the highest score of natural constructs 31.81. Average subject intelligence 29.49.

The results of the third multiple intelligence test indicate that the performance indicators set earlier have been met and the next action or skill is stopped.

Based on the scores of the results of tests 1 to test 3, the average score for the increase in the construct of multiple intelligences in subjects is shown in Table 4 below:

Table 4. Average Score of Improvement in Test Results 1 to Test 3

Persentase Skor Tes	Logical Matematic	Verbal Linguistic	Musical	Visual	Bodily Kinestetic	Intrapersonal	Interpersonal	Naturalistic	Existential	Mean
T2-T1	-	0,68	0,35	0,77	0,23	1,45	1,13	0,87	1,16	0,74
T3-T2	1,00	0,61	0,48	0,61	0,52	0,35	0,71	0,39	0,32	0,56
T3-T1	1,00	1,29	0,84	1,39	0,74	1,81	1,84	1,26	1,48	1,29

The average increase in multiple intelligence scores from test 1 to test 2 by subtracting the results of test 2 from test 1 is 0.74. The average increase in multiple intelligence scores on tests 2 to 3 by subtracting the results of test 3 from test 2 is 0.56. The average increase in test scores 1 to 3 by subtracting test scores 3 from test 1 is 1.29.

The percentage increase in the multiple intelligence constructs of the research class subjects is shown in Table 5. as follows:

Table 5. Percentage of change, increase in average score of multiple intelligences of test 1-test 3 subjects (%).

Persentase Skor Tes	Logical Matematic	Verbal Linguistic	Musical	Visual	Bodily Kinestetic	Intrapersonal	Interpersonal	Naturalistic	Existential	Mean
T2-T1	-	2,40	1,17	3,11	0,82	5,07	4,27	2,85	3,84	2,62
T3-T2	3,73	2,12	1,58	2,39	1,85	1,18	2,58	1,23	1,03	1,96
T3-T1	3,73	4,57	2,77	5,58	2,68	6,31	6,96	4,12	4,90	4,62

The percentage increase in the intelligence construct of test 1 to test 2 is obtained by subtracting the average percentage of test 2 from test 1 by 2.62%.

The increase in the multiple intelligences construct from test 2 to test 3 is obtained by subtracting the average percentage of test 3 from test 2 by 1.96. The percentage increase in the construct of intelligence test 1 to test 3 is obtained by subtracting the average percentage of test 3 with test 1 of 4.62%.
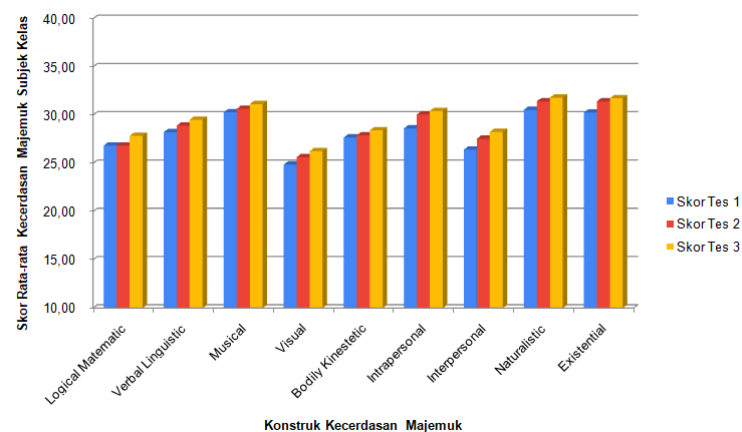

Figure 1. Graph of Average Compound Intelligence Score of Test Subjects 1-Test 3.

Figure 1 is a graph of the mean score of multiple intelligences of subjects based on tests 1 to test 3 which shows that all intelligence construct scores have increased from test 1 to test 3. In particular, the average mathematical logic construct from test 1 to test 2 does not experience increase which causes action and the cycle to continue. The natural intelligence construct average score occupies the highest score while the lowest score is the visual intelligence construct.
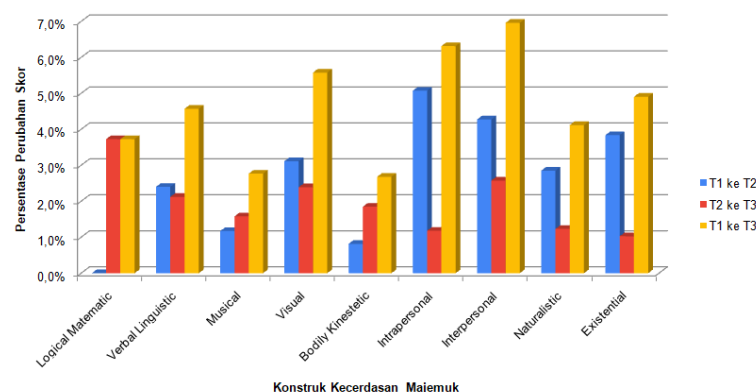

Figure 2. Graph of the percentage change in the average score of the intelligence constructs of test subjects 1-3.

Figure 2 is a graph of the percentage change in the mean score of the subject's intelligence construct based on test 1 to test 3. All intelligence constructs have increased based on the results of tests 1 to test 3. The construct of interpersonal intelligence has the highest increase where the average percentage increase is 6,96% and the kinesthetic intelligence construct experienced the lowest increase where the average percentage increase was 2.68%.

Conclusion

The STEAM (Science, Technology, Engineering, Arts and Mathematic) learning approach is a solution to preparing subject competencies that are in line with the competency needs of the 21st century and proven to be able to increase the multiple intelligences of grade X TKJ students of SMK Kristen Tagari Rantepao.

Actions taken in classroom action research are a form of the STEAM learning approach which aims to improve the subject's multiple intelligences with data facts based on multiple intelligence tests which are carried out three times as follows: 1) The average change in the construct of multiple intelligences subjects has increased> = 0.1 and meets the performance indicators where test 1 to test 2 is 0.74 test 2 to test 3 is 0.56 and test 1 to test 3 is 1.29; 2) The average percentage change in multiple intelligence construct scores >= 1% and fulfills the performance indicators where test 1 to test 2 is 2.62%, test 2 to test 3 is 1.96% and test 1 to test 3 is 4.62%.

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