5th ICRIEMS Proceedings
Published by Faculty Of Mathematics And Natural Sciences
Yogyakarta State University, ISBN 978-602-74529-3-0

The Influence Of Technological Pedagogical And Content Knowledge Approach On Scientific Literacy And Social Skills

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Abstract. The purpose of this study is to determine the effects of Technological Pedagogical and Content Knowledge (TPACK) approach to scientific literacy and social skills of students. The research was a quasy experiment on design of pretest and posttest control group. The samples used were 1st and 2nd class and had total by 62 students. The sampling technique is cluster random sampling with the 1st class of 11th grade of natural science as the control class and the 2nd class of 11th grade of natural science as the experimental class. The treatment given to the experimental class was learning the rate of reaction by using TPACK approach with discovery learning models, while that of the control class was learning rate of reaction by using teacher-center approach with direct instructional model. Data were collected by the essay test of scientific literacy, questionnaire of social skills and the observation sheet of social skills. The essay test of scientific literacy including scientific content (knowledge), scientific process (competencies), and scientific context. Social skill questionnaire and observation sheet including understanding of science, development of intellectual skill and communication, development of character and positive attitude. Reliability of scientific literacy essay test is good realibility. Data analysis technique used was MANOVA. The results showed that TPACK approach effected to scientific literacy and social skills one of public senior high school in Bantul regency.

Keywords: scientific literacy; social skills; TPACK approach

INTRODUCTION

The curriculum released in 2013 formulated that learning process should be able to develop the attitudes, knowledge and skill [1]. It has purpose to prepare Indonesian to have the ability to live as individuals and citizen who are godly, productive, creative, innovative and affective and give contribution to the society, nation, state and world civilization. Chemistry learning process should be implemented by many integrating aspects such as attitude, knowledge and skill [2] in order to develop scientific literacy and social skills of students so the goal of the curriculum 2013 and the national education can be achieved. In chemistry learning process or other scientific subjects, students not only are limitedly given factual knowledge, but they should also be trained to explore and implement their ideas related to science [3].

Currently there are many schools that implement the learning process with teacher centered in which students receive the information from teachers and teachers do not encourage them to gain knowledge by themselves.

Consequently, students tend to be passive and have less ability to work in team. Additionally, they get less encouragement to solve problem that becomes the subject of learning, use scientific ability to scientifically explain the phenomen, and collect information and scientific evidence. As a result their motivation and achievement of scientific literacy stay low. The scientific literacy ability of Indonesia in 2006, 2009 and 2012 was ranked 50th of 57 participating countries, 60th of 65 participating countries, 64th of 65 participating countries respectively [4]. [5] explained that knowledge of science of Asian students stay low but their interest and desire to learn are high. It is caused by implementing the traditional teaching method, little activity and interaction in the class and the lack of emphasis on the application of science or knowledge.

One of the methods to improve scientific literacy skill is to apply TPACK approach in the learning process. TPACK approach is a learning approach that combines content, pedagogy and technology [6_9]. TPACK is an approach that has principle that learning is the basis to broaden knowledge, understand scientific investigation, implement effective teaching methods for science [10]. TPACK approach implemented with the model that can train students to independently gain new knowledge but it still gives teachers occasion to provide guidance. One of model that can be used is discovery learning model. In this model, teachers do not present the teaching material in the final form, but students are encouraged to acquire their knowledge and construct it in order to accumulate new knowledge [11-14].

TPACK approach with discovery learning models encourages students to solve problem which is the subject of learning by integrating technology, pedagogy and knowledge content. Learning by using TPACK approach stimullated scientific literacy, which is the ability to explain scientific phenomena and collect information as well as scientific evidence to solve problem scientifically, and increased the social skills. This was supported by the results of research [7] explaining that TPACK significantly affected to improvement of academic value of studenst of teaching physics.

Scientific literacy is the ability to aplly science to identify questions and draw conclusions based on scientific evidence [15_19]. Ability used is the ability to master scientific content (knowledge), scientific process (competencies), scientific context and attitude [16,20,4]. Learning scientific literacy and technology is built by learning the constructivism principles previously [21]. High scientific literacy will be followed by increasing social skills. Scientific literacy is closely related to the student's social skill including the understanding of science, development of intellectual skill and communication, development of character and positive attitude, achievement of the objectives in socio-scientific education and the ability to make decisions scientifically [17]. Scientific literacy relates with skill in communicating with others [22]. Students are required to be able to aplly science in daily life to benefit student's life. Social skills can be drilled in the chemistry learn. It is shown in good cooperation, enthusiasm for completing the task, good communication skill in group discussion and the respect for others's opinions [23].

Learning the rate of reaction by using TPACK approaches with discovery learning model can develop not only scientific literacy but also social skills such as the ability to work in team, respect each other and communicate. One of chemistry learning materials in 11th grade is the rate of reaction. In learning process of the rate of reaction discussed about the phenomenon of rate of reaction in daily life, the concept of rate of reaction, designing and experimenting the rate of reaction factors. On the material of rate of reaction there are many opportunities for student to develop scientific literacy and social skills.

Such studies may or may not reach different conclutions. In other science materials may be able to occur different or similar conclusions. As in result studies [7] that TPACK affected to physics. The more opportunities for student to trace scientific literacy and social skill in the learning process so scientific literacy and social skills students well.

This study aims to covering the effect of TPACK approach with discovery learning models to scientific literacy and social skills one of public senior high school in Bantul regency. According to the aim of the study, the following research questions try to be answered. In contrast to traditional teaching methods:

1. Does the TPACK approach with discovery learning models affect the scientific literacy and social skills students?
2. Does the TPACK approach with discovery learning models affect the scientific literacy students?

3. Does the TPACK approach with discovery learning models affect the social skills students?

METHODS

Research Design

Type of the research was quasy experiment. The research design applies pretest-posttest control group [24]. The samples used were 1st and 2nd class and had total by 62 students. The sampling technique is cluster random sampling with the 1st class of 11th grade of natural science as the control class and the 2nd class of 11th grade of natural science as the experimental class. In the experimental class, student were treated with TPACK approach application with discovery learning model while that of the control class was learning the rate of reaction by using teacher-center approach with direct instructional model.

Data Colection

Data in this study were the result of the essay test of scientific literacy, questionnaire of social skills and the observation sheet of social skills. The instruments used in this study were pretest about scientific literacy consisting of 8 problems, questionnaire of social skills consisting of 20 statements and observation sheets of social skills filled out by two observers.

Data Analysis

The data were collected from the results of pretest and posttest of scientific literacy and social skills. The increase of pretest and posttest results of student were analyzed by using gain scores. Data analysis techniques in this study were a multivariate analysis with MANOVA technique at significance level of 0.05 and Rasch model analysis by applying Ministep. Analysis using Statistical Product and Service Solutions (SPSS) was used to answer hypotheses, while the Rasch analysis was used to determine the scientific literacy indicators which most affected TPACK approach, the ability level of students, and the level of difficulty of test. Before MANOVA multivariate analysis using SPSS was done, the assumption consisting of normality and homogeneity of pretest and posttest data and the correlation between the dependent variables must be met.

RESULTS AND DISCUSSION

Improvement of Scientific Literacy and Social Skills

Data of scientific literacy and social skills from control and experimental class included pretest and posttest data. The increased scientific literacy and social skills of students was shown in Gain value from each class and can be seen on the Figure 1.

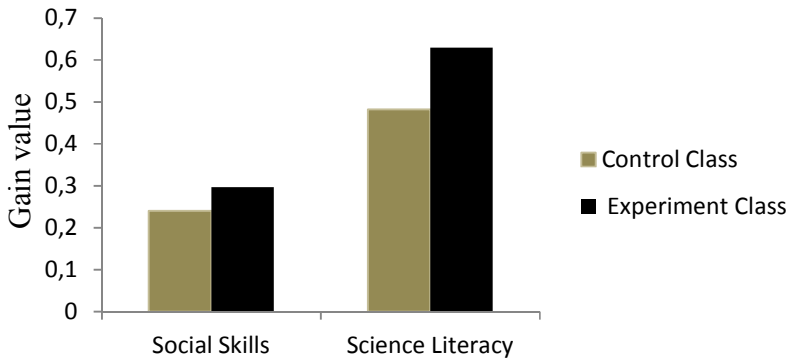

Fig 1. Improvement of The Value of Scientifical Literacy and Social Skills

Influence of TPACK Approach to Scientific Literacy and Social Skills

Hypothesis test was done by using MANOVA. After correlation test had been fulfilled, MANOVA test was administered. The results of hypothesis test was shown in the significance value of Hotteling's Trace by 0.000. Hypothesis test results showed that significant value was less than the value of α (0.05) in which meant that H_0 was rejected. It can be concluded that at the significance 0.05 there was significant effect on implementation of TPACK approach to scientific literacy and social skills of students of 11th grade of natural science classes in one of public senior high school in Bantul regency. The MANOVA test results were presented on Table 1.

Table 1. Results of MANOVA Test

Effect		Value	F	Hypothesis df	Error df	Sig
Intercept	Hotelling,s Trace	17.016	5.020E2[a]	2.000	59.000	.000
Approach	Hotelling,s Trace	.297	8.751[a]	2.000	59.000	.000

Partial Test of TPACK Approach to Scientific Literacy and Social Skills

Test MANOVA showed not only all the test results but also the result of the partial test. The value of partial test showed the significance value of scientific literacy (sig.=0.00) was less than the α value. It can be concluded that the TPACK approach effected students' scientific literacy. On the other hand, the value of the significance value of social skills (sig.=0.137) was bigger than the α value. It can be concluded that the TPACK approach had no influence on the students' social skills. Test results are presented on Table 2.

Table 2. Results of MANOVA Partial Test

Source	Dependent	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Scientific Literacy	.343[a]	1	.343	17.708	.000
	Social Skills	.049[a]	1	.049	2.276	.137
Approach	Scientific Literacy	.343	1	.343	17.708	.000
	Social Skills	.049	1	.049	2.276	.137

The Most Influential Indicators of Scientific Literacy Toward TPACK Approach

Analysis result using Rasch model with Ministep showed that the most influential indicator of scientific literacy toward TPACK approach with discovery learning model was scientific proses indicator. The results of the analysis can be seen from the variable map. Based on the variable map, it can be found information about the students' abilities and the level of difficulty of the test. The abilities of the students were shown on the left side while the difficulty level was shown on the right side.

Based on the variable map,the abilities of students in experimental class spread equally. At the most difficult question, the students who had code P01 and P04 could solve the problem. In addition, all students could complete the easiest questions, so it shows that there was no student who needed special treatment in learning. It can be seen from the variabel map that question on E1, E4 and E13 were the easiest problems for students of experimental class, then majority of students could answer them correctly. Questions on E1, E4 and E13 represented indicator of scientific literacy which was aspect of the scientific process. Then in that case, the material of reaction rate was the most influential indicator toward TPACK approach.

Discussion

The implementation of the learning process were done 4 times for in the control class and experiment class. The learning process in the control class was held based on RPP (Rencana Pelaksanaan Pembelajaran) and worksheets that were arranged to use teacher centered learning and followed rules in KI (Kompetensi Inti) and KD (Kompetensi Dasar) based on K-13, while experiment in the experiment class was conducted with RPP and worksheets applicating TPACK approaches with discovery-learning model based on K-13. Before the rate of reaction material was delivered in the class, two classes, control and experimental class, were given quiz about scientific literacy and questionnaire about social skills. And at the end of class, they were given final quiz. During the learning process, two observers observed the social skills of students and the all activities in the classes were documented via video recording.

Effect of TPACK approach to scientific literacy and social skills can be seen from the results of MANOVA test. Before it was analyzed by MANOVA test, the typical assumption of normality, homogeneity and correlation had to be met. Normality test results of pretest and posttest data showed normal distribution. Homogeneity test results indicated the data had homogeneous variances. Correlation test results showed that scientific literacy significantly correlated with social skills. In accordance with the opinion of [17] scientific literacy is closely related to social skills of students including the understanding of science, development of intellectual skill and communication, development of character and positive attitude, achievement of the objectives in socio-scientific education, and the ability to make decisions scientifically.

MANOVA test results indicated that significance value is smaller than the value of α so it can be concluded that at the 0.05 significance level TPACK approach affected scientific literacy and social skills of students of public senior high school in Bantul regency. TPACK approach is one approach that focuses on technology, pedagogy and materials [6,25,26]. TPACK approach with the discovery learning model is learning process with discovery learning step combined with the technology in the form of animations, simulations and virtual labs as learning media and resources. Learning involving pedagogy and knowledge content by using technology can improve students' conceptual understanding [8]. This is also consistent with the results of the studies of [27-30].

TPACK approach with discovery learning model is constructivism learning model and contextual approach. Learning of scientific literacy and technology is the learning process built by the constructivism principles in which student's comprehension depends on his thinking process when he gets involved with learning experience and it is associated with his previous understanding concept [21]. The purpose of implementation of TPACK learning framework is to students to do simulations interactively by applying learning media-based animation in order to comprehend the concept and solve the daily problem. TPACK approach with discovery learning model is learning materials combined with the technology such as animation programs, simulations, and virtual labs as media and learning resources.

In the experiment class, the material combined with the TPACK approach encourageds students to solve problem became the subject of learning by integrating technology, pedagogy and content knowledge and to trained students' scientific literacy. It is the ability to use science for scientifically explaining scientific phenomena, and gathering information and scientific evidence in problem solving. The learning process in experimental class was conducted in laboratory. Integrated learning theory with more practicals made students construct comprehension well. Students were stimulated to find, try, and build their concept during learning process. After they found the concept sought, they would discuss and get explanation from teacher to develop their understanding. The stimulant of working in team induced students to do social actions such as respect of their friends and it gave equal comprehension among

students. Additionally students could collaborate more actively [31].

In the experimental class, learning process was done with syntax repetition by TPACK approach 7 times. At the first meeting, the learning proses spent time more longer because students stayed unfamiliar to TPACK approach with discovery learning model. As a result, students needed more time to identify the problem based on the phenomenon that was practiced. It was concluded by analyzing their worksheets and there were just 32% of students who answered the problems in worksheet at the stage of problem identification.

After the second meeting, the students started to adapt to follow the learning syntax. Consequently they could identify the problem, explain the phenomena based on the concept of the rate of reaction, collect information and scientific evidence to solve problem in daily life. The longer students adapted to follow the learning process by using TPACK approach with discovery learning models. It was detected by 98% of students answering questions on the worksheet correctly at the fourth meeting. Furthermore, the questionnaire about student's interst showed students tended to be active, enthusiastic and fun during the learning process by applying TPACK approach. It can be seen on the Figure 2.

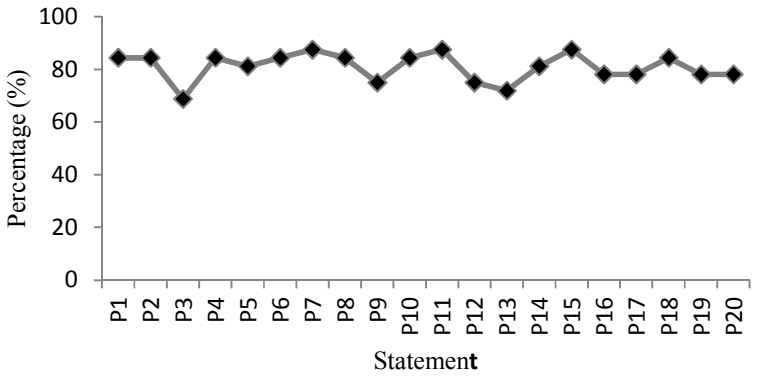

Fig 2. Graph Interests Against Student Learning

The questionnaire about students' interest averagely showed 87% of students was more active, happy and enthusiastic during learning the rate of reaction by using TPACK approach that involveds the examples of chemical phenomena in daily life. TPACK is an approach having principle that learning process is the basis to develop knowledge, understand scientific investigation, so it is the appropriate teaching method for science [10].

Scientific literacy is important in the principles of lifelong learning and motivates them to learn everything and apply it in daily life. In accordance with the study of [32], it said that the learning involving scientific literacy is effective to improve students' understanding of the concept and easier to remember factual information and apply it. In other words, by applying the method, students can improve not only scientific literacy but also social skills. This had something in common with the study of [33] which stateds that the development of scientific literacy of students was also accompanied by the development of students' attitude such as being active to ask and answer questions about the issue of natural science, active to respond friend's opinion on the about issue of natural science, activ during practicum, honest to collect the observational data and responsible to do the tasks during the practicum.

In the control class, the rate of reaction was held by implementing the teacher center approach with direct instructional model. The learning process was dominated by the teacher, and the students just became the passive participants who gave attention to the teacher and made the notes. Teachers gave students the chance to discuss and answer questions from him. Moreover, students worked in group during the practicum and they discussed to answers the teacher's questions. Thereby, scientific literacy of students in the learning process did not improve well because they got less training to observe and identify phenomena related to the rate of reaction in daily life, so their scientific literacy and social skills did not develop properly.

Generally, TPACK approach with discovery learning model affected scientific literacy and social skills. However, the partial test results using MANOVA showed that the treatment did not give effect for social skills. Although implementation of TPACK approach improved the scientific literacy of student, it did not affected their social skills. The value of scientific literacy and social skill showed the improvement of social skills in experimental class did not have significant difference with control class. It was cause by same activities given both classes during learning process such as doing discussion and practicum. Furthermore, the fokus of the learning process applying the treatment was contextual and constructivist learning. Learning process in the experimental class, was focused by using the TPACK approach with discovery learning model which is model of constructivism learning and contextual approach. Although the students did discussion, they could not fully interact with their peers during the class so their social skill did not develop well.

The results of the Rasch analysis showed that the most influential scientific literacy indicator toward TPACK approach was process aspect of scientific literacy. Aspect of scientific literacy were content, process and context of science [4]. Indicators of science process aspect included identifying scientific questions, identifying problems of the phenomenon about the rate of reaction and the rate of reaction factors, describing or interpreting phenomena about the rate of reaction, explaining the phenomena of rate of reaction factors, applying the theory of rate of reaction r to explain the phenomenon of that in daily life, and using scientific evidences to get conclusions.

During learning TPACK approach with discovery learning, students were demanded to construct their understading so they could adapt to identify the problem with scientific phenomenon or news, explain, and solve the daily life problem or phenomena associated with the rate of reaction concept. Consequently, their literacy of process aspect could develop. Arends [34] supported this condition with statement that learning focusing on activities including identifying problems and discussing in groups can develop their skill to thoughtfully think and socialize. The high achievement of scientific literacy of student was induced by his ability to construct and connect his knowledge with the application in daily life. The opinion of [17] expressed the same condition that science would be easy to learn when it was related with the phenomenan in human life.

CONCLUSIONS

TPACK approach with discovery learning models had significant impact on the scientific literacy and social skill students of public senior high school in Bantul regency. In experiment class, student had stimulated to observe the chemical phenomena, analyze the concept of rate of reaction in daily activity, design and conducted the experiment on the rate of reaction factor and apply the concept of rate of reaction in daily life. So, learning process the rate of reaction by using TPACK approaches with discovery learning model can develop not only scientific literacy but also social skills such as the ability to work in team, respect each other and communicate. Future studies may TPACK approach with discovery learning model can be applied to other science subjects.

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