How Does Teacher's TPACK Affect Student's Activity?

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Abstract—**The ability of teachers to integrate technology into learning is quite important in facing the rapid technological progress in the era of industrial revolution 4.0. These technological advances need to be followed by the development of learning that can support these changes. Therefore, science teacher needs to be accompanied by an excellent competency, namely TPACK (Technological Pedagogical and Content Knowledge). The purpose of this study was to see the impact of the implementation of TPACK design in teaching and learning activities carried out by the teacher to students learning activities. Descriptive methods are applied to obtain data on teacher TPACK abilities and their implementation using TPACK instruments, and student activity observation sheets. Participant of this study is three science teachers. The ability of TPACK teachers who have high to lowest abilities are teachers A, B and C. Likewise with its relation to students as seen from student learning activities and outcomes. Consecutive activities with the percentage of activity 86%, 80% and 50%. Because the teacher's TPACK ability and its relation to students have the same pattern, ie the better the TPACK ability of the teacher, the activities of the students being taught are also more active. So it can be concluded that the ability of TPACK teachers has a relationship to student activities.**

Keywords: TPACK, descriptive study, teacher competencies, student learning activities

I. INTRODUCTION

In the era of the industrial revolution 4.0 teachers were required to have ability in integrating technology into learning [1]. Education with technology has many pathways to move forward [2]. This is also supported by various studies which show that the level of teacher knowledge has an impact on the use of technology in learning [3].

Shulman has introduced a teacher knowledge framework related to pedagogical and content knowledge called PCK (Pedagogical Content Knowledge) [4]. However, the rapid development of technology in learning certainly requires an expansion in understanding teacher's knowledge framework to a new framework that includes technological knowledge called Technological Pedagogical and Content Knowledge (TPACK).

TPACK is the integration of technological knowledge, pedagogy and content [5]. TPACK can be used as a reference for the integration of a learning model [6,7]. The application of this learning takes into account attitudes and self-efficacy towards TPACK [8]. One example is the development of TPACK-based models using augmented reality [9].

Previous studies have not explained yet how the integration of technology, pedagogy and content are integrated [10]. TPACK competence is basically a professional framework owned by a teacher. The results showed that teachers generally had a good TPACK competency profile [11]. The teacher understands conceptually how learning and technology integration should be done. Therefore the technology chosen should not stand alone or be used separately, but must be used in conjunction with a sequence of learning activities that give students various opportunities to learn and practice learning content [12,13]. This study specifically analyzes the relationship between teacher competency and student activity.

Vygotsky's theory suggests that others who are more knowledgeable including teachers and peers, can help in student development [14]. The theory shows that one of the determining factors in student success in learning is teacher involvement. Because the teacher can create a learning environment that matches the characteristics of the content through the selection of models / methods / learning approaches. The criteria for teachers who can accommodate students' needs well are teachers who master the concepts and then convey them with good pedagogical practices and by using appropriate technological assistance. These criteria are closely related to TPACK, besides that TPACK can also be measured and determined its value between one teacher and another teacher. Research conducted by Tesyaf shows that 75% of students are actively involved in Focus Group Discussion (FGD) activities when compared to regular presentation and demonstration activities [15]. So that the selection of teaching strategies also affect student activities. Therefore, this study empirically proved the relationship between the TPACK teachers ability and student learning activities.

II. METHODS

A. Research Design

This study uses a qualitative approach with descriptive methods [16]. The choice of research methods is adjusted to the objectives. This study aims to describe student learning activities when implementing the TPACK strategy on global warming content. Before implementing the TPACK strategy on global warming in the classroom, an analysis of the answers from the TPACK questionnaire is needed for determine the TPACK capabilities of the teacher. At the time of implementation, student activities were observed. So based on the data obtained the relationship between the ability of the TPACK teacher of science and student learning activities can be analyzed descriptively.

B. Participant and Location

The selection of participants was done on using the convenience sampling method. The sample selection method is based on the availability of elements and the ease of getting them. The convenience sampling method was carried out because this study used one school and only three teachers were willing to be studied. Participants in this study were science teachers at junior high school level in Sidrap district, South Sulawesi. Table 1 is background information on the science teacher.

TABLE I. LIST OF PARTICIPANT

Teacher's Code	Age (Years)	Educational Background	Teaching Experience
Teacher A	24	Physics Education	2 years
Teacher B	33	Biology Education	10 years
Teacher C	21	Physics Education	< 1 year

C. Instruments

- Student activity observation sheets are used to obtain information in the form of student activities throughout the learning.

- The TPACK questionnaire is used to see the teacher's perception of their TPACK abilities. The trick is to provide answers to each item based on the attitude rating given. The instrument used is a standard instrument from Shmidt consisting of 54 question items [17].

III. RESULTS AND DISCUSSION

A. Teacher's TPACK Ability

The purpose of this study is to prove empirically the relationship between the teacher's TPACK ability with student learning activities. This study used three classes, each class taught by one teacher who has TPACK ability at a certain level. The discussions of the results begin with teachers have incorporated technology into learning. The ability of TPACK teachers has been analyzed with an instrument in which the teacher answers the instrument by putting a check mark. The

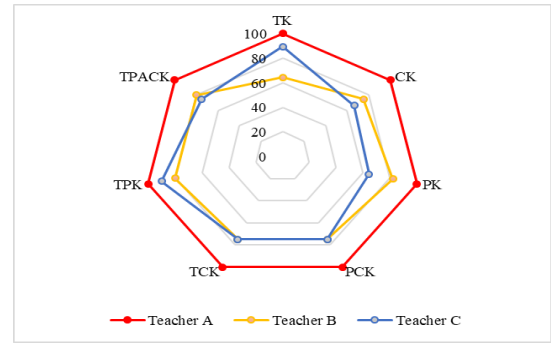science teacher's perception of their TPACK ability can be seen in Figure 1.

Fig. 1. Teacher's TPACK diagram.

Teacher's TPACK analysis is based on the TPACK framework. Figure 1 shows the different trends in each TPACK sub-indicator. Based on figure 1, science teachers begin to incorporate technology components into their learning. However, every teacher has a tendency towards some TPACK frameworks. Figure 1 is made in the form of heptagon (regular hexagon), because with such a form it can make it easier to see the tendency of the TPACK ability that teachers have on global warming content. For example, Teacher A has a maximum value in each TPACK framework because the value touches the number 100 in each corner. That is because, TPACK teacher A's ability is assumed to be ideal in this study. The selection of learning methods, devices and technology used has been validated beforehand by experts. So that the deeper discussion is only teacher B and Teacher C.

1) Technological Knowledge (TK): The results of the analysis showed that teacher B had lower technological knowledge than teacher C. Teacher C followed technological developments and was able to learn technology easily. If it is related to the age of the teacher, this is because teacher C is still 21 years old so that he is still very often in touch with technology. This is consistent with research conducted by Elizabeth W.B. et al which show that demographic variables such as age are variables that significantly influence attitudes and interests in technology [18]. Teacher B, who is 35 years old has lower technological knowledge. It was also discussed in the study of Vaportzis E et al., showing that adults have cost-related anxiety, lack of confidence and guidance and are skeptical about using technology [19]. In addition, the age factor has an influence on the teacher's interest in using technology [20].

Teacher B has not been able to solve the technical problems he experienced himself. Although teacher B attended more training than teacher C, the ability to use technology still requires practice. Teacher B should understand information technology broadly to use it productively in the classroom, to recognize when information technology can hinder or achieve goals and continually adapt to changes in information and communication. Technological developments can be followed

by joining an ICT workshop in accordance with the occupied field of study.

If it is associated with learning, it is not certain that the ability of Teacher C is more applicable than Teacher B. Although teacher C has adequate technological abilities, not all technologies are suitable for use. Technology capability does not guarantee teacher success in the classroom. This means that teachers also need the ability to match concepts and technologies chosen [21]. This is important because learning by using technology will trigger an active learning environment for students [22].

2) Pedagogical Knowledge (PK): Figure 1 shows that teacher B's pedagogical knowledge is higher than teacher C. This is because teacher B has previously taught at the school compared to teacher C where Teacher B has more than 10 years of teaching experience. So that teacher B is more accustomed to assessing student performance in class and is able to adjust his teaching to what is currently understood by students or not. Teacher B also has many opportunities to test one method and another. This is consistent with the results of research conducted by Diana et al. that the pedagogical ability of teachers is influenced by teaching experience [23]. The long teaching experience provides many opportunities for teachers to reflect on the learning undertaken. While teacher C has low pedagogical ability because he does not have much time or opportunity to apply what he has gained in the classroom.

Teacher B has a longer teaching experience than Teacher C. Teacher's teaching experience influences pedagogical knowledge. Pedagogical knowledge is divided into two, namely pedagogical knowledge as knowledge and as a skill [24]. Pedagogical knowledge as knowledge is not affected by teacher professionalism training while pedagogical knowledge as skill is influenced by the professionalism training.

Pedagogical knowledge of teachers greatly influences student activity in the classroom [25]. Active learning shows knowledge of the principles of how people learn, practical knowledge of teaching strategies and behavior and knowledge related to the classroom [26]. Some of the efforts that teachers can make in developing student learning activities in teaching are motivating students or using interesting learning media [27]. These efforts again depend on how well the teacher's pedagogical knowledge is. So that both public and private schools ensure that teachers have good pedagogical knowledge.

3) Content Knowledge (CK): Based on Figure 1, it is clear that Teacher B's content knowledge is higher than Teacher C. Teacher B has enough knowledge to teach Global Warming, accustomed to scientific thinking and know what strategies he will do when he will find out about Global Warming while Teacher C is not accustomed using scientific thinking. Content knowledge itself is easily measured using tests [28]. Measurement of content knowledge can be done separately with other components, but the results can still be linked [29].

Teacher B and teacher C's content is different due to several factors. Knowledge gained is no longer influenced by gender factors, but rather personality, ways of organizing knowledge, techniques and factors that students are taught [30,31]. Gender factors only affect career satisfaction as a teacher [32]. If related to the results obtained, the factors described previously can develop along with the length of teaching experience each teacher has. Thus, teacher B has more content knowledge than teacher C.

Mastery of the teacher's content does not affect the attitude of the teacher in teaching it. Thus, content knowledge cannot be used to predict pedagogical content knowledge [33]. But Davidowitz and Potgieter's research shows that content knowledge is a prerequisite for designing learning designs, which are also part of PCK [34]. Content knowledge is very important because teachers' ability to teach cannot be adequately assessed by observing their teaching without referring to the content being taught [35].

4) Technological Pedagogical and Content Knowledge (TPACK): Figure 1 indicates that teacher B tends to have a higher TPACK than teacher C. This is because teacher B has had a longer teaching experience than teacher C. All types of knowledge contained in the TPACK model are significantly and are strongly related to self-belief efficacy in education Internet use.

There are many methods to improve teacher TPACK, one of them is by practicing using a collaborative project tell [36]. The more often the teacher does the project, the greater the teacher's desire to improve his ability to use technology, thus impacting on the development of their TPACK. In the study, the findings show that teachers who understand TPACK will have higher self-efficacy towards internet use and hence better integration habits around us [37].

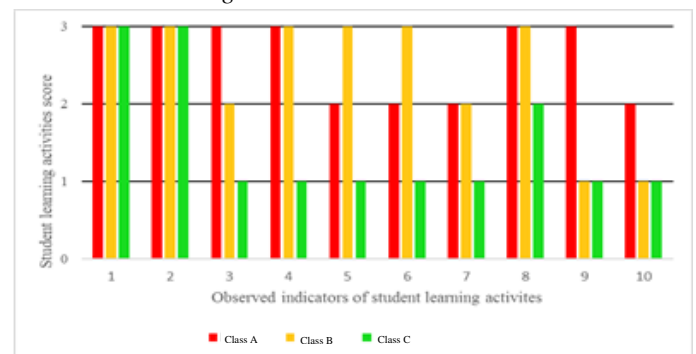*B. Student Learning Activities*

Fig. 2. Student learning activities diagram.

Figure 2 shows the comparison of student activities between classes taught by teacher A, teacher B and teacher C. Consecutively the percentage of students' activeness from class A to class C in class was 86%, 80% and 50%. Class A has the highest percentage of activeness because the model or method used by teacher A requires students to carry out various activities in the class. Likewise with teacher B, while the class taught by teacher C has the lowest percentage because in the implementation of learning Teacher C uses the lecture method.

Concentration is one of the important things in classroom management. Without attention, the information transfer process will not run properly so the results are less than optimal. If students' attention is not focused on learning, then it is likely that students are not able to capture or get the correct perception of the subject being studied.

Attention is a process of learning in which students choose and respond to the many stimuli received. Student attention can be obtained by increasing student motivation through the relevance of the subject and describing the context to be taught with enthusiasm [38]. Student attention also refers to the willingness, needs, desires and coercion of students to participate in, and be successful in, the learning process. Student attention is the centralization of concentration, energy and psychic energy in the face of an object, in this case the attention of students in the learning process in class [39].

In the first aspect, the concentration of students in all classes shows the maximum score. The results of observation show that each teacher has a successful way of focusing student attention. Not only that, students also understand the focus of the topics discussed that day.

Teacher A chooses to focus students' attention by showing real videos. At the first meeting Teacher A showed a video of someone who could still garden even though winter was ongoing and continued with the question why it could happen. Students are drawn into their curiosity so that they focus on trying to think and answer Teacher's questions A. The choice of video media is due to the ease of access, form and provision of demonstrations to convey the main message [40]. Teacher B also does the same thing, using videos and questions. The video used by teacher B is not real, but still attracts students' attention. After showing the video, teacher B asks students about climate change that is increasingly erratic. It also succeeded in making students think and try to answer. The selection of questions used by teacher B is quite good because the questions are very closely related to student life, which is about the climate which is certainly felt by every student. While teacher C begins his learning by displaying pictures related to the phenomenon of global warming. Although not very communicative, students can understand the purpose of the picture displayed by teacher C. So that students' attention can also be focused on learning.

Learning objectives are the results of a learning that states what is expected to be known, done and understood by students at the end of the learning process or sequence [41]. Submission of learning objectives by teachers to students is one important phase in every learning. The teacher uses any model, strategy, or approach, so one of the stages always includes a phase of delivering the learning objectives. Even this phase is always delivered at the beginning of learning. This phase is not just a mandatory phase. Students should be told that by understanding what learning objectives in a learning will be able to estimate the sequence of learning activities that will be followed. Students should know, through the stated learning objectives contained teacher expectations about knowledge, attitudes, or skills desired by the teacher for them to master.

Based on observations, all three classes showed that most students listened to the learning objectives. The way to deliver the learning objectives of the three teachers is the same, which is delivered directly through PowerPoint. Such delivery methods are quite effective because they can be directly seen by students. The position of the three differences is Teacher A does not ask students to record the learning objectives, while teacher's B and C ask students to take notes.

The third aspect observed during the learning process is students receive information about the activities carried out. Receiving information in class includes matters that are review, both concepts and formulas that are considered important [42]. This can be seen from how students listen to or carry out instructions from the teacher. Based on observations, students in class A showed activity in receiving information. They are able to do virtual simulations as instructed by Teacher A. While in class B students are quite active on this activity. Class B students are sometimes still mistaken in carrying out the global warming practicum. This means that students do not apply what the teacher says or practice steps on the worksheet. There are several groups that use different jars and put towels into jars at different times. However, teacher B facilitates students by helping to correct errors that occur. Class C shows less activity on this aspect. Based on observations teacher C did not instruct what to do next after conveying the learning objectives. Teacher C takes over the class and starts explaining the notion of global warming.

The fourth phase is the phase where students make observations in accordance with the worksheet. Observation is a method of collecting data [43]. Events, people, and objects can be used as opportunities for students to practice observing and studying their environment. Student observations in each class are different [44]. In class A students observe the movement of photons across molecules of greenhouse gases, while class B observes changes in temperature in the jar based on a certain time interval. In class C this phase is not observed because teacher C does not carry out practical activities.

The fifth phase is the phase of observation and recording. This phase is almost the same as the previous phase. However, here is how students can represent what they have observed. Class A students show less active in this activity. This is demonstrated by how students fill in the worksheets observed from the photon earlier. Teacher A deliberately leaves the observations blank, so students make their own observations table. But students still ask the teacher's help to be directed to make the table. So Teacher A only makes a table format and lets students fill the table according to observations. Meanwhile class B shows good activity in this phase. They are able to make their own observation tables and fill in accordance with the results obtained. While class C did not show good results in this phase, because it did not carry out the experiment.

The sixth phase is the phase of students working together to interpret and predict the results of observations. Interpretation is the activity of students to combine a result from the analysis of various questions. The interpretation made by students is very simple [45]. They only interpret trends from tables or graphs they make.

Class A shows sufficient activity to interpret the virtual simulations that they do. This is because they have not been able to find a relationship between wavelengths and greenhouse gases. They still need the help of teacher A to interpret. Whereas class B shows good activity in this phase. They are able to determine the tendency of rising temperatures in closed jars. Class C shows that activity is not good at this phase because they do not carry out the practicum,

The seventh phase is how students present the results obtained. In this phase class A and class B show quite active results. This is because the time available is very limited so it is limited to only one group that presents the results. Actually, this phase is quite important because in addition to understanding students on concepts, it also helps students hone other abilities, namely how to communicate and appreciate friends who are expressing their opinions. In this process students are not fully fluent in expressing their opinions. They still need teachers to guide them to argue. Discussion or presentation activities such as one meeting are provided so that all groups can present the results obtained.

The eighth phase is students and teachers draw conclusions from observations. Drawing conclusions together is important to do so as not to cause misconceptions to students. Although students have drawn the conclusions written on the worksheet, in this phase Teacher A explained again from the beginning of the activity to the end of the activity. Whereas teacher B only emphasized that the activities they carried out had similar characteristics with how the process of global warming occurred. Teacher C also concludes the end of learning, but the conclusion is not based on observation.

The ninth phase is students reviewing the results of learning activities. This phase is closely related to the previous phase. After students and teachers draw conclusions from the observations, the teacher reviews the activities. Of the three classes only class A does this phase. Teacher A's way to get students to review again is to ask students to create a mind map based on what has been practiced. That way Teacher A gets a lot of information about how broad and how deep the student's understanding is.

The tenth phase is strengthening the concept. Teacher A gives feedback on the mind map created by students, while at the same time providing reinforcement of concepts.

IV. Conclusion

This study has found that generally the ability of the TPACK of science teachers to teach Global Warming materials is different for each teacher. Things that influence this difference are age and teaching experience of teachers. Younger teachers more often come into contact with technology because older teachers have anxiety or insecurity when using technology. Meanwhile, the length of teaching experience influences the teacher's ability to manage the class or the subjects that will be delivered. The learning carried out by each teacher has a bearing on student learning activities

Consecutively, it was also shown that the percentage of student activity from class A to class C in the class of 86%, 80% and 50%. Class A has the highest percentage of activeness because the model or method used by teacher A requires students to carry out various activities in the class. Likewise, while the class taught by teacher C has the lowest percentage because in the implementation of learning Teacher C uses the lecture method. The choice of method used by the teacher influences the activeness of students in the class.

The ability of TPACK teachers who have high to lowest abilities are teachers A, B and C. Likewise with its relation to students as seen from student learning activities and outcomes. Consecutive activities with the percentage of activity 86%, 80% and 50%. Because the teacher's TPACK ability and its relation to students have the same pattern, ie the better the TPACK ability of the teacher, the activities of the students being taught are also more active. So it can be concluded that the ability of TPACK teachers has a relationship to student activities.

The present study, however, makes several noteworthy contributions to teacher's competencies. An advanced program is needed to develop the ability of teachers to integrate basic knowledge in implementing learning into a full TPACK framework. The follow-up program can be in the form of a seminar or training that addresses the importance of TPACK knowledge for teachers. After that, following the training, mentors should continue to supervise periodically the teachers, to ensure teachers continue to carry out learning activities in accordance with the material received during the training.

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