Developing Instrument to Evaluate the Technological Content Knowledge (TCK) Application of Biology’s Teacher

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Abstract. Technological Content Knowledge (TCK) is an integration of technology in a learning that based on the material that is being taught. The aim of this research is to develop observation instrument for measuring how the application of TCK of biology in Senior High School during the class. The type of this research is Design and Development Research (D&DR) that based on the development model of Peffers with the steps: 1) problem identification, 2) describe the objectives, 3) design and develop the artifact, 4) test the artifact, 5) evaluate testing result, 6) communicate the testing result. Instrument validity involved judgment from expert while empirical validity was analyzed by using biserial correlation. Instrument reliability uses inter-rater reliability and analyzed by using interclass correlation coefficient (ICC). Result of empirical validity shows that from 12 TCK evaluation items, two of them are not valid. While for the reliability, instruments that have been made are reliable with the ICC as much as 0.921.

Keywords: TCK, Observation Instrument, Biology Teacher, Senior High School

1. Introduction
The Government of Republik Indonesia has acknowledged that teacher is a profession, as it is mentioned in Undang-Undang No.14 Tahun 2005. The act is a distinct law in which teacher is a profession that requires skill, responsibility and loyalty. To become a professional teacher, teachers must know their own selves and actualize themselves in accordance with the guide to become professional teacher. Professional teacher is a person who has passed a teacher education program, get a certificate from the state and has experience in teaching in big classes. Professional teacher can take all responsibility that are given and must have stable and mature personality¹.

Teacher is a professional educator with main tasks to educate, teach, guide, drive, train, determine and evaluate the every student – from early childhood education, formal education, elementary grade and high school². The government has also formulated four types of teacher’s competency in the view of national education policy as it is stated in The Explanation of³ about National Education Standard, i.e. competencies of pedagogy, personality, social and professional. Basically, competence is a description about what can be done by someone inside work and what kind of form of that work that can be shown⁴.

Along with the rapid development of technology in the 21st century, teacher not only must have competencies like what have been explained previously but also competence in teaching the material by using technology. That is because the process of teaching and learning in the present time reflecting...
the development of integration between computer and technology application in the curriculum. The idea of integrating learning material and technology has been around since there was an increasing in demand from students to utilize technology. In accordance with that, the knowledge of technology and content have become an integrated part of education program. The integration between technology and learning material is known as Technological Content Knowledge (TCK) which is a part from a whole component called Technological Pedagogical and Content Knowledge (TPACK). TAPCK gives a new direction in thinking for teachers to solve common problem in class. Therefore, the TPACK can be used to build teacher’s competence in school. The integration of technology in teaching is viewed as a solution for globalization that is marked by the rapid development of Information Technology (IT). The technology can help the teacher in carrying on their task – like the internet that allows them to get newest information about education, teaching strategy and the development of science that match with their study field.

The application of TCK in the teaching process actually must be done by teachers because in the standard of Kerangka Kualifikasi Nasional Indonesia (KKNI), they are in level 7. In this level, they must be able to manage resources under their responsibility and evaluate comprehensively their own work by using science, technology, and art to produce steps of organization strategic development. To improve the ability in application of technology in the teaching process, teacher must follow the teacher education program. However, in the research that was conducted by [5], although the teacher education program aims for preparing the teacher in the utilization of technology in the class, in fact the teacher training program still not able to improve the mastery of technology for teaching. As the consequence, the usage of technology in the teaching is not effective.

There have been discovered some researches that were conducted to evaluate teacher’s performance, but these evaluations don’t lead specifically toward the integration of teaching material content by using technology while teacher’s performance observation during teaching is still rare. This is because there are still few instruments in the form of observation sheet that is used to measure teacher’s ability, especially the TCK ability of biology teacher in Senior High School. Instruments for measuring TCK that are found mostly are questionnaires. Despite of that, the observation sheet is considered more capable to measure teacher’s performance because the researcher can observe the teacher right on the place, so that the result data is factual data, can be trusted and not fake. Based on the explanations, a development of instrument for measuring the application of TCK by teacher in class is needed.

2. Materials and Methods
2.1. Materials
2.1.1. Teacher

The teacher is a component that affects the quality of process and result of study. The main task for a teacher is to educate, teach, guide, direct, train, judge and evaluate the students. In carrying on their duty, the teachers apply skills that accomplish the standard of quality or certain norm that are gotten from profession education [6]. As the component that determine the success of learning, in order to be able to teach and carrying on their job well, the teacher must have high competence [7]. One of the determining factors of qualified education process is a professional teacher. The requirement to become a professional teachers are, the teacher must know their own selves and actualize themselves under the guide of professional teacher [8].

Professional teacher is the one who has skill, responsibility, and loyalty, supported by strong professional ethic. Therefore, a teacher must have qualification of competences such as intellectual, social, spiritual, personality and moral [9]. Professional teachers know their own selves as a person who is called to assist the student in studying. Teachers must search continuously about how the the student must study. The teachers must study diligently during their free time in their duty. Becoming a professional teacher is not an easy work if we don’t want to call it difficult, especially when seeing the very worse quality of teachers in all their aspects [10].
Teachers can be called professional if they have some competences that relate to the teaching field. The competence basically is a description about what can be done by someone inside work and what kind of form of that work which can be shown [3]. The teacher’s competence regarded by many people as a reflection whether the educator (teacher) is professional or not, even the teacher’s competence has great effect toward the success of student’s accomplishment [11]. Based on the research conducted by [12] at Bulukumba about professionality of teacher, it can be concluded that teacher’s high professionality will raise the learning quality, vice versa, if the professionality is low, the learning quality will be just the same. The main point of teaching activity and teacher’s devotion is in the student. This message encourages the teacher to know more about the condition of student in every level. Beside that, teacher’s success also depends on mastery of teaching material; the way in employing the approach, suitable strategy and resource support; adequate device and media for teaching. An educator must always motivate the students to study diligently, to face the difficulties without grumbling and to deal with limitations as a motivation of change. Motivating in teaching is definitely an obligation. With the motivation, the students will feel that they are regarded and trusted. Based on the explanation, it can be inferred that the teacher must have good competences, one of them is Technological Content Knowledge (TCK).

2.1.2. Technological Content Knowledge (TCK)
TCK is a teacher’s ability in integrating technology and teaching material that will be taught to the student. The teacher must be able to use technology inside learning activity. TCK’s great influence is the knowledge about teaching material that must be supported by technology to ease the students in understanding the material. The IT development is one of the characteristic of the 21st century. The technology development has effect in the change of paradigm of education. Education paradigm in the 21st century focuses on the development and the mastery of technology aspect in learning. The innovation that must be done in education is the teacher must be able to utilize technology to improve the learning.

Based on the idea of [13] about TPACK, TCK becomes one of the main part for achieving a complete TPACK. Two main bases TPK are Technological Knowledge (TK) and Content Knowledge (CK). TK follows the teacher’s ability in utilizing technology to improve the learning quality, while CK is a teacher’s ability in mastery of teaching material. The knowledge of material characteristic or content is an important thing in teaching because the teachers can teach the material if they are really know the characteristic of the material. The utilization of technology in presenting the material can transform an abstract material to become concrete and can be easily understood by the students [14].

As that has been explained, TCK is a part to form the component of TPACK. So, TCK is very important to be mastered by the teacher, regarding the fact that to reach a good TPACK, the teacher must have mastered TCK. TPACK scheme that was explained by [13] consist of three main components (TK, PK, and CK) which are interacting each other and create other components: Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK) and Pedagogical Content Knowledge (PCK). TPACK is a needed knowledge for teacher to integrate technology into the teaching of certain material which become a whole set. The teacher must have understanding toward complex interaction between PK, CK, and TK by the way of teaching certain material employing pedagogy method and suitable technology [15].

2.2. Method
2.2.1. Research Design
The type of this research is Design and Development Research (D&DR) which follows and modifies the development model of Peffers (2007) with the steps: 1) problem identification, 2) describe the objectives, 3) design and develop the artifact, 4) test the artifact, 5) evaluate testing result, 6) communicate the testing result. The problem raised in this study is the continued development of science and technology in the 21st century that must be addressed by teachers to develop their teaching abilities. Therefore, this research was carried out with the aim of producing an instrument that can
measure how teachers are capable of teaching in the classroom (the ability to apply TCK). The product
design and development was done by developing a prototype of the instrument, in this case, the
researcher also prepared some supporting component like the framework of the developed instrument.
The validation was done to know the flaw of the product. The validation involved two experts who are
competent in instrument development. The testing was conducted to know the result of the product
usage that has been validated by experts. The result of the test would be used to view the empirical
validity level of the instrument that has been made. Revision was done to correct the errors. Instrument
testing data was used as a guide for revision by maintaining valid items and eliminate items that are
not valid. Observation instrument that was developed was used to observe the learning process in
class. Observation instrument consist of some statement items that relates to TCK. The
instrument testing was conducted through some phases: choosing the test subject, the conduct of test
and analysis of testing result. The instrument testing will be conducted on July to August, 2019. The
provided time for the testing of observation sheet instrument will follow the class hour of the teachers
because in this case, the researcher observing directly how the teachers are teaching in class. The test
will take some teachers from some Senior High School in Central Java and Daerah Istimewa
Yogyakarta as samples. The city of Surakarta will become the sample from Central Java while Sleman
District as the sample from Daerah Istimewa Yogyakarta.

2.2.2. Research Instrument
The instrument that is used for the purpose of fulfilling the face validity by judging from experts was
formed as questionnaire. The questionnaire was used by the experts to evaluate construction and
language aspects of the observation sheet that was made by the researcher. In this case, the evaluation
from the experts was ranged using Likert scale 1-4. The evaluation would used to improve the TCK
observation instrument that has been developed.

2.2.3. Data Analysis
The data that is used in this research is data about validity and reliability of the developed TCK
instrument. Prior to the testing, the instrument was given to the expert validators to know whether the
instrument is appropriate to be used for observing teacher’s ability in applying TCK during class. In
this case, the researcher got suggestions from the experts about the developed observation sheet. Based
on the suggestions from the experts, items that didn’t meet requirements of content were revised so
that the content validity become good. Instrument that has been revised will be empirically tested so
that its validity and reliability can be known. Presentation range of expert’s judgement result can be
calculated using this formula \[16\]

\[
Validity(Y) = \frac{\text{total validation score from experts}}{\text{total maximum score}} \times 100\%
\]

| No | Score (%) | Validity Criteria |
|----|-----------|-------------------|
| 1  | 85.01–100.00 | Quite Valid       |
| 2  | 70.01–85.00  | Valid             |
| 3  | 50.01–70.00  | Less Valid        |
| 4  | 01.00–50.00  | Not Valid         |

Table 1. Validity criteria

After validation by involving experts, the next phase is determining how the empirical validity of
the instrument will be developed. The data that is used to get empirical validity is test result data. To
know the empirical validity, biserial correlation analysis is used which follows the analysis model
from \[17\]. To know the reliability of developed instrument, inter-rater reliability is used that will be
analyzed by using Interclass Correlation Coefficient (ICC). In this case, the researcher involves four persons as raters in the testing.

3. Results and Discussion

3.1. Result

3.1.1. Experts’ Judgement

Validity result based on the judgement of the expert can be seen on following table.

| ITEM | SCORE (%) | INFORMATION | ITEM | SCORE (%) | INFORMATION |
|------|-----------|-------------|------|-----------|-------------|
| 1    | 30        | 75          | Valid | 1         | 30          | 75          | Valid |
| 2    | 30        | 75          | Valid | 2         | 30          | 75          | Valid |
| 3    | 30        | 75          | Valid | 3         | 30          | 75          | Valid |
| 4    | 40        | 100         | Quite Valid | 4 | 30 | 75 | Valid |
| 5    | 30        | 75          | Valid | 5         | 30          | 75          | Valid |
| 6    | 30        | 75          | Valid | 6         | 30          | 75          | Valid |
| 7    | 30        | 75          | Valid | 7         | 30          | 75          | Valid |
| 8    | 40        | 100         | Quite Valid | 8 | 40 | 100 | Quite Valid |
| 9    | 40        | 100         | Quite Valid | 9 | 40 | 100 | Quite Valid |
| 10   | 40        | 100         | Quite Valid | 10 | 40 | 100 | Quite Valid |
| 11   | 40        | 100         | Quite Valid | 11 | 40 | 100 | Quite Valid |
| 12   | 40        | 100         | Quite Valid | 12 | 40 | 100 | Quite Valid |

3.1.2. Empirical Validity

Empirical validity is calculated after the instrument testing and analysis using the biserial correlation following [17]. The result is as follows.

| INPUT | OUTPUT |
|-------|--------|
| Item  | r-bis  | P    | r-bis  |
| 1     | 0.73   | 0.64 | 0.93   |
| 2     | 0.96   | 0.36 | 1.23   |
| 3     | 0.88   | 0.45 | 1.11   |
| 4     | 0.85   | 0.27 | 1.14   |
| 5     | 0.85   | 0.27 | 1.14   |
| 6     | 0.50   | 0.45 | 0.62   |
| 7     | 0.96   | 0.36 | 1.23   |
| 8     | 0.74   | 0.36 | 0.95   |
| 9     | 0.96   | 0.36 | 1.23   |
| 10    | 0.80   | 0.27 | 1.08   |
| 11    | 0.80   | 0.27 | 1.08   |
| 12    | #DIV/0! | 0.00 | #DIV/0! |

3.1.3. Instrument Reliability

Instrument reliability was analyzed by using SPSS program with Interclass Correlation Coefficient (ICC). The result is as follows.
Table 4. Reliability

| Intraclass Correlation Coefficient | 95% Confidence Interval | F Test with True Value 0 |
|------------------------------------|-------------------------|-------------------------|
| Intraclass Correlation Lower Bound | Upper Bound Value df1 df2 Sig |
| Single Measures 0.921b | 0.817 | 0.975 | 47.457 | 10 | 30 | .000 |
| Average Measures 0.979c | 0.947 | 0.994 | 47.457 | 10 | 30 | .000 |

3.2. Discussion

To get contextual appropriateness of the instrument, a validation must be done previously by involving two experts who can be called judgement experts for fulfillment of face validity. In this extent, the experts give an evaluation toward the instrument that has been made by researcher, from the aspects of language and construction. The experts will evaluate every statement items that will be used by researcher to observe TCK application of biology teacher in class. From this experts’ judgement, the researchers got suggestion to add more statement to the instrument. At first, 11 items for observing the TCK application were made, but the experts suggested to add an item that related to TCK. The researcher then did a revision in order to be re-examined by the experts. From the analysis result, it can be inferred that from all items that have been made, all are valid (table 2). Thus, the developed instrument can be used for testing.

After the instrument testing, the acquired data will be used to check the empirical validity of the instrument. Validity can mean as the measurement accuracy aspect. A valid measurement device not only can give accurate data but also must be able to give an accurate insight of the data. Empirical validity is calculated by using biserial correlation analysis through Microsoft Excel program which follows the analysis model from [17]. Biserial correlation is used to identify the correlation of total item in a scale with dichotomy form with value range between 1 and 0. The biserial analysis is used to test validity rate from every statement item. Based on the analysis, different results are acquired from every item. From 12 items, two of them are not valid (table 3.). The items that are not valid are number 6 and 12. The validity can be seen in r-p.bis column (point-biserial correlation koefficient) in the biserial correlation analysis. The r-p.bis value will be compared with r table value with significance rate 0.05 (error rate 5%) which can be seen in picture 1.

Because the test subject (teachers) are 11 persons, the analysis was done by comparing the value in df=9 (11-2) with significance rate 0.05. In df=9 column and significance rate 0.05, the r table is 0.6021. The r table value then compared to r-p.bis from every item. If the r-p.bis value is greater than the r table value, it can be inferred that the item in the instrument is valid. But if the r-p.bis value is less than the r table value, the item is not valid.

![Figure 1. r Table](image-url)
Reliability is something that is believed, persistent, consistent, reliable and stable. Reliability in other word is a series of measurements and measuring device which have consistence if the measurement with the device is done consecutively. For the reliability check, the choice is inter-rater reliability consistence check. Reliability check which involves raters usually called inter-rater agreement or inter-rater reliability. In this extent, four raters were involved in the instrument testing. Correlation Coefficient in the ICC was used to determine the reliability between two raters or more. Based on the analysis, the ICC value is 0.921 which means the instrument is reliable. Reliability range is stated by coefficient in which the number ranges from 0.0 to 1.0. The more the reliability nears to 1.0, suffice to say that the instrument that has been arranged has high reliability.

4. Conclusion
The developed TCK instrument results in a final product in form of observation sheet with 10 valid statement items. While for the reliability of the instrument, the ICC value is 0.921 which means that the instrument is reliable. This valid and reliable TCK instrument can be used to observe the TCK application of biology teacher.

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