The Development of Teaching Materials Based on Theory Didactical Situation and Technology in Facing the Era of Society 5.0

Aneu Pebrianti(✉), Suhendra, and Eyus Sudihartinih

Indonesia University of Education, Bandung, Indonesia
aneupebrianti@upi.edu

Abstract. Social literacy and humanitarian literacy characterize society 5.0 as an effort to optimize technology to solve social problems. According to this perspective, technology is not a machine but an integral part of life in solving problems. This research aimed to optimize the role of technology in the learning process by developing technology-based teaching materials on the topic of circles. The research methodology used was development research. Preliminary data was collected through a literature study. The pilot test was conducted on elementary school students in Bandung, West Java, Indonesia with an evaluation instrument in the form of a test. The teaching materials developed in the form of student worksheet that referred to the Theory of Didactical Situation (TDS), so students could actively construct knowledge by completing the missions provided. Test results after students used teaching materials showed good criteria. The research conclusion shows that technology-based teaching materials on the topic of circles using TDS theory can be a solution to construct students' understanding of mathematical concepts and optimize the use of technology in the Society 5.0 era.

Keywords: society 5.0 · TDS · teaching materials · technology

1 Introduction

The development of technology from time to the time has been progressing massively. This momentum produces a new perception of life among humans with a technology called Society 5.0, where humans synergize and live side by side comfortably with technology such as the internet of things (IoT), artificial intelligence (AI), and robots [1]. Therefore, the innovation of technology contributes to mankind's life and increasing their life quality [2].

Society 5.0 is a continuation revolution of Industry 4.0. Compared to the industrial era 4.0, the main characteristic of Society 5.0 is prioritizing social literacy and the literacy of humanity. In a more advanced times, technology has become a solution to social problems and creates sustainability [3]. In other words, technology is not only a machine but also a part of integrated life to solve problems in everyday life. The education sector is one of the sectors that gave rise to many educational innovations

F. Nurhasanah and R. S. Padmi (Eds.): ISMEI 2022, AHSSEH 9, pp. 56–66, 2023.
https://doi.org/10.2991/978-94-6463-220-0_7

that are integrated with technology. Therefore, incorporating technology in education is expected to improve the quality of education including human resources in it, especially in supporting teachers to construct student understanding through the development of appropriate teaching materials.

Teaching materials are an important component to support teaching and learning process [4] because they include learning theories, teaching and learning methods, and assessments that have been systematically developed to achieve learning objectives. However, the utilization of technology to be integrated into learning materials has not been optimal [5]. There are many challenges in integrating learning with technology, such as lack of understanding of the use of learning applications and low confidence in using technology [6, 7]. Although the government has made a global design to facilitate the development of technology infrastructure and networks for educational institutions in Indonesia [8], more innovation is still needed to enable teachers to adapt to using technology.

The process of teacher adaptation to technology requires greater effort, as the majority of educators are not used to integrating learning with technology. Based on research, only 20% of teachers are experienced in creating interactive learning media [9]. In addition, another study mentioned that there are some teachers who have not been able to utilize ICT facilities in schools for learning media because they do not have the competence to develop ICT-based learning materials [10].

On the other hand, studies on the use of technology in developing learning materials have been carried out, for example in developing interactive learning materials by utilising video editing and Corel Draw [11], developing the use of technology during learning in interactive learning materials in electrical materials [12], and many other innovations in the use of technology in learning. Therefore, it is necessary to develop technology-based teaching materials that can be constructed and used by teachers, one of which is through the power point application.

Microsoft PowerPoint is an application that is familiar to teachers, and almost all teachers have used the application. Making teaching materials using the PowerPoint application has been widely done [13–15], which shows that using PowerPoint improve the ability of teachers to construct teaching materials. However, from several studies that have been conducted, there has been no research to create PowerPoint-based teaching materials based on Didactical Situation Theory.

The Theory of Didactical Situation (TDS) allows students to formulate and validate concepts [16]. In addition, findings show that using student worksheets based on TDS can help students discover statistical concepts, as well as support the students to understand and solve mathematical problems [17]. TDS provides a systemic framework for investigating the teaching and learning process of mathematics and supports didactical design [18]. Didactic situations can review the learning process that students can understand and support didactic design on materials [19].

Based on this background, this study aims to present an alternative solution by utilizing technology in the learning process, namely the creation of PowerPoint-based teaching materials and integrated with Didactical Situation Theory in order to increase the role of technology in learning mathematics in schools.

2 Method

This research used the satges development research methods of Plomp and Nieveen [20], namely investigative studies, making prototypes (prototype phase), and evaluating the use of prototypes. At the investigation stage, a needs analysis was carried out in the learning process related to the topic of circle to be integrated with technology so as to produce appropriate alternative solutions. Furthermore, the prototype design was carried out based on the stages of knowledge construction according to Brousseau, namely the action situation, formulation, validation, and institutionalization. To review the prototypes made, this study involved content experts and media experts to carry out validation, based on the criteria in the following Table 1:

To evaluate the use of prototypes, the teaching materials were trialed with grade 6 students. The criteria for schools in trials were accustomed to using devices in the learning process. The approach used was a case study. Data collection techniques employed triangulation in the form of tests and interviews. The test given to students was formed based on the cognitive dimension of Bloom's cognitive taxonomy. Bloom's taxonomy states that there are six levels of student intelligence, namely: remember (C1), understand (C2), apply (C3), analyse (C4), evaluate (C5), create (C6). However, the cognitive level used in making test instruments to evaluate students' abilities only reaches C4. This was intended to explore students' abilities after using interactive multimedia teaching materials [21]. However, this test instrument was not validated beforehand. To calculate the percentage of students' correct answers, we used Eq. (1).

$$\frac{the\ correct\ answer\ for\ all\ students\ of\ type\ n}{total\ number\ of\ correct\ answers} \times 100\% \quad (1)$$

The analysis process was carried out by reading it repeatedly until the results were obtained which were used as a source for evaluating and revising the prototype that had been tested.

Table 1. Criteria Validation Prototype Teaching Materials

Score Range	Category
$\bar{x} > Mi + 1{,}5\ SBi$	Very valid
$Mi + 0.5\ SBi < \bar{x} < Mi + 1{,}5\ SBi$	Valid
$Mi - 0{,}5SBi < \bar{x} < Mi + 0{,}5\ SBi$	Average
$Mi - 1{,}5SBi < \bar{x} > Mi - 0{,}5\ SBi$	Hardly valid
$\bar{x} < Mi - 1{,}5\ SBi$	Not valid

Description:

$\bar{x} = \frac{1}{2}$ (maximum score + minimum score)

$SBi = \frac{1}{6}$ (maximum score – minimum score)

$\bar{x}$: mean ideal score

SBi: deviation ideal standard

3 Result and Discussion

Research results were written into the parts by stages of research, namely results in the investigation stage, the result of the prototype and evaluating the use of prototypes. That result would be explained as follows.

3.1 Results Investigation

The availability of technology-based student worksheets is still lacking due to teachers' and students' perspectives that using technology is complicated and inadequate facilities and infrastructure [10, 22]. To be able to shift towards Society 5.0, transformation is needed to adapt to technology. Therefore, it is imperative for teachers to be skilled in using technology [23]. One of the familiar applications used by teachers is Microsoft PowerPoint [13], as this application is not too complicated to use and is commonly used to present programmes and materials in the classroom by teachers. Considering its simplicity and teachers' familiarity, the author conjectured that it would be easier to provide direction to teachers to create power point-based teaching materials. Therefore, the author designed a sample worksheet that could be modified and be developed by teachers independently and could be used to interact with students.

The teaching material design was constructed based on the Theory of Didactical Situation (TDS). According to Brousseau (1990), through TDS several patterns and innovations could be built to overcome student learning problems. This was because the material provided to students was arranged, so students could be more interactive to carry out their cognitive processes. Based on research that the integration of TDS with teaching materials could help students to understand and solve mathematical problems [17]. This supported student-centred learning that was promoted in Indonesia, where students are active and independent to carry out mental processes in internalising knowledge.

3.2 Results of Prototype

This teaching material was designed in the form of Student Worksheets integrated with technology on the topic of circles. This worksheet was made based on TDS framework to allow students to play actively in constructing their knowledge. The worksheet was designed by including a game feature that is a mission solution. Seven missions needed to be solved by students such as mission 1 (knowing the circle), mission 2 (knowing the radius), mission 3 (knowing the diameter), mission 4 (knowing the arc of circle), mission 5 (knowing the chord of a circle), mission 6 (knowing segment), mission 7 (knowing sector). Figure 1 is the design from the worksheet.

This teaching material was designed with shapes and bright colours to make learning process more interesting [24]. This worksheet was arranged so the students could carry out process construction knowledge based on didactic stages: action, formulation, validation, and institutionalization. Table 2 shows an example of knowledge construction with didactis stages in completing mission 3 (knowing the diameter), as follows.

The stage of TDS would be explained in more details as follow.

Action. In this phase, the student did mental action when given the problem. The student attempted to complete the problem by optimizing their senses. They followed

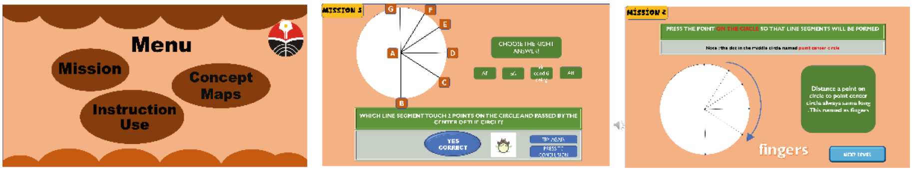

Fig. 1. The worksheets design

Table 2. Construction Knowledge Based on TDS Stage.

Stages didactic	Indicator
Stage action	Student use their sense to interact with a circle
Stage formulation	Student gather all information to plan in details and solve problems
Stage validation	Student produce opinion, have a debate between themselves, find the best solution, and agree with the best strategy to use for solving problem
Stage institutionalization	Student respond and the teacher play a role to connect them with the relevant theory

every instruction given by the media to determine the solution gradually from a given case or mission. Actions to complete the first stage was illustrated in Fig. 2.

Formulation. The second phase was impacted by actions that had been done. Students had a hypothesis or prediction of the future that would be proved the truth. In this step, students guessed the correct statement appropriate with actions/processes that had been conducted. The formulation in the complete problem worksheet was illustrated in Fig. 3.

Validation. On the worksheet would appear statement correct or wrong, as form validation for students. In addition, there was a reinforcing explanation argument for students. Validation in complete problem worksheet was illustrated in Fig. 4.

Institutionalization. In the final phase, the appearance of statements becomes the main feature to support the topic. Institutionalization to complete problem worksheet based on illustrated in Fig. 5.

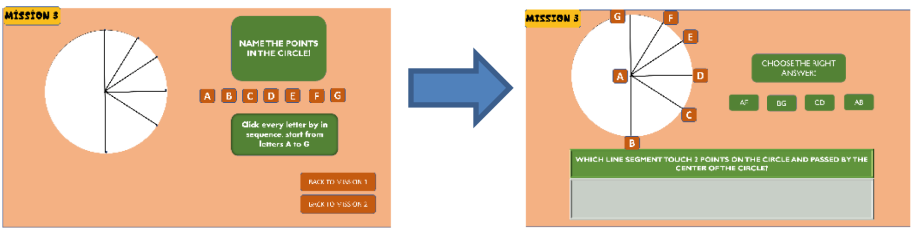

Fig. 2. Action phase, students complete the name of the point on the circle so as to form the radius of the circle

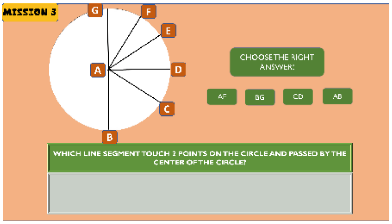

Fig. 3. Action stage, students also answer the question after completing the points on the circle

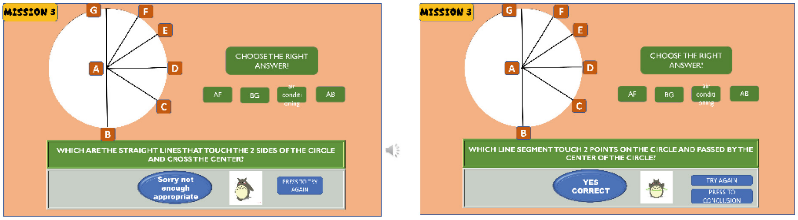

Fig. 4. The validation phases

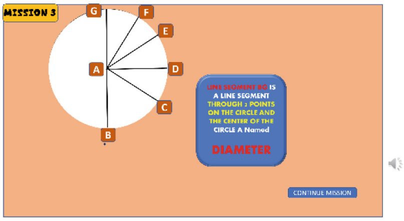

Fig. 5. The institutionalization phases

Institutionalization becomes a bridge to connect the new knowledge to students' prior knowledge. Furthermore, students applied their prior knowledge to solve problems in different contexts. Based on the theory, the worksheet connected the second and third mission, with the question in Fig. 6 as follows.

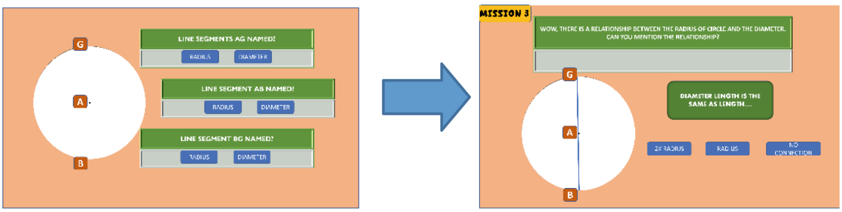

Fig. 6. Another institutionalization phases

To evaluate students' cognitive abilities, questions were made with different levels of difficulty based on Bloom's Taxonomy. Table 3 explained the evaluation questions based on Bloom's Taxonomy, as follows.

Three experts had validated this teaching material, one expert was a lecturer with a mathematics and educational background, while the other expert was a teacher. Each item evaluation had a maximum score of 5 and a minimum score of 1. Table 4 below showed the average result of the validator's assessment of the teaching materials.

Based on the Table 4, the teaching materials which three validators had validated were in the valid category. This validation could be used as a basis for the feasibility of teaching materials to be tested in learning because they had implemented the approach that would be appropriately used and could measure the suitability of teaching materials with existing curriculum standards.

Table 3. Grid Question Evaluation Cognitive.

Question	Tiers of Cognitive	Cognitive Level Indicator	Grid Question	Point
1	C1 (Remember)	Student remember the terms elements of a circle	Given name and picture of circle elements. Student requested for pair name and picture proper	10 x 6 = 60
2	C2 (Understanding)	Student understand the definition of elements of a circle	Given a definition from one element of a circle, student requested for mention name element form circle	10
3	C3 (Application)	Student capable of making a connection between radius and diameter	Given an object shaped known diameter, student requested for count radius of circle	10
4	C4 (Analysis)	Student capable of describing the features of elements of a circle	Given an element circle. Student requested for mention characteristic features from one element of circle	20
Amount of scoring				100

Table 4. Validation of Worksheet

Aspect Evaluation	Total Score	High School	Presentation	Criteria
Contents served	74	90	82	Very valid
Language	60	75	80	Very valid
Worksheet Structure	51	60	85	Very valid
Media Utilization	27	30	90	Very valid

3.3 Result of Evaluating the Use of Prototypes

The school chosen for the implementation should fulfil the criteria: including providing a computer or netbook at the school, or a school that allows students to use mobile phones during learning. Furthermore, there were no more than 20 students in a class, allowing researchers to observe and use technology in depth. Therefore, the research was conducted at a private school in the city of Bandung. The object of research was 6th grade students with 19 students in one class. Students did a prototype trial using a mobile phone. The lesson lasts for 30 min. To evaluate the optimization of teaching materials, students were given a test consisting of 10 questions using the Google form. The 10 questions were divided into three types of questions, namely six matchmaking questions, two short questions, and one long question.

Survey results showed that a majority of students understood the elements of a circle: 87% of students were able to answer match questions correctly, 85% were able to answer short questions correctly, and 55% of students were able to answer by defining or describing elements circle exactly.

3.4 Discussion

Teaching materials are an important aspect of supporting successful learning [4]. In the learning activities carried out during trials, students were active in completing the missions contained in the prototype teaching materials. Teaching materials that are integrated with technology optimize the role of technology in conveying mathematical concepts to students. Furthermore, the use of the TDS framework, which consists of four stages, namely: action, formulation, validation, and institutionalization [16] makes students active in constructing their knowledge. The learning process becomes interactive because students have good abilities and skills in operating the application. This affects their ability to complete missions well [25]. However, some students experienced problems during the lessons due to internet quotas and an unsupported system. This can be anticipated with cooperative learning where students work together to solve worksheets. This can be anticipated with cooperative learning where students work together to solve worksheets. Based on interviews with math teachers, developing teaching materials using PowerPoint can make learning more interesting. However, assistance from the teacher is needed to help students understand the content of the material. Furthermore, the test instrument carried out by students at the end of learning shows good test results. However, because the trial of this teaching material was only carried out once, revisions were still needed [20], for example instructions that were not understood by students, more coordination to make good preparations so that students could prepare quotas or each gadget.

4 Conclusion

The use of technology in the learning process through the creation of teaching materials based on Microsoft PowerPoint and integrated with the Theory of Didactical Situation can optimize the role of technology in learning mathematics in schools. This teaching material is an alternative solution for optimizing technology in the Society 5.0 era. This teaching material is structured to complete the missions provided. During the learning process, students look interactive in completing missions and produce good average test scores. As a recommendation material, because this teaching material is Microsoft PowerPoint based, this can make it easier for teachers to imitate, modify and develop more interactive teaching materials.

References

1. L. Ellitan, "Competing in the Era of Industrial Revolution 4.0 and Society 5.0," J. Maksipreneur Manajemen, Koperasi, dan Entrep., vol. 10, no. 1, p. 1, 2020, doi: https://doi.org/10.30588/jmp.v10i1.657.
2. V. Potočan, M. Mulej, and Z. Nedelko, "Society 5.0: balancing of Industry 4.0, economic advancement and social problems," Kybernetes, vol. 50, no. 3, pp. 794–811, 2021, doi: https://doi.org/10.1108/K-12-2019-0858.
3. U. Al Faruqi, "Survey Paper : Future Service in Industry 5.0," J. Sist. Cerdas, vol. 02, no. 01, pp. 67–79, 2019.
4. M. Malalina and N. Kesumawati, "Development of Computer-Based Interactive Teaching Materials on Circles for Class VIII Junior High School [in Bahasa]," J. Pendidik. Mat., vol. 8, no. 1, pp. 55–70, 2014.
5. W. Wijayanti and I. Zulaeha, "Pengembangan Bahan Ajar Interaktif Kompetensi Memproduksi Teks Prosedur Kompleks yang Bermuatan Kesantunan Bagi Peserta Didik Kelas X SMA/MA," J. Pendidik. Bhs. dan Sastra Indones., vol. 4, no. 2, pp. 94–101, 2015, [Online]. Available: http://journal.unnes.ac.id/sju/index.php/seloka
6. M. Fikri, M. Zaki Ananda, N. Faizah, R. Rahmani, and S. Adelia Elian, "Kendala Dalam Pembelajaran Jarak Jauh Di Masa Pandemi Covid-19: Sebuah Kajian Kritis," J. Educ. Dev. , vol. 9, no. 1, pp. 144–150, 2021, [Online]. Available: https://doi.org/10.1016/jjheduc.2013.06.00
7. Z. H. Putra, "Tantangan dan peluang guru SD dalam pembelajaran matematika berbasis teknologi digital di era revolusi industri 4.0," Pros. Semin. Nas. Pendidik. Guru Sekol. Dasar Fak. Kegur. dan Ilmu Pendidik. Univ. Riau, vol. 1, no. September, pp. 7–19, 2019.
8. BPK, KEPUTUSAN PRESIDEN REPUBLIK INDONESIA NOMOR 6 TAHUN 2001, vol. 2000, no. 1. 2016, pp. 1–23.
9. F. R. Rahim, D. S. Suherman, and M. Murtiani, "Analisis Kompetensi Guru dalam Mempersiapkan Media Pembelajaran Berbasis Teknologi Informasi Era Revolusi Industri 4.0," J. Eksakta Pendidik., vol. 3, no. 2, p. 133, 2019, doi: https://doi.org/10.24036/jep/vol3-iss2/367.

10. D. E. Myori, K. Chaniago, R. Hidayat, F. Eliza, and R. Fadli, "Peningkatan Kompetensi Guru dalam Penguasaan Teknologi Informasi dan Komunikasi melalui Pelatihan Pengembangan Media Pembelajaran Berbasis Android," JTEV (Jurnal Tek. Elektro dan Vokasional), vol. 5, no. 2, p. 102, 2019, doi: https://doi.org/10.24036/jtev.v5i2.106832.
11. M. Mardiana, Y. Isa, and S. Ningsih, "Pengembangan Bahan Ajar Interaktif pada Mata Kuliah Filsafat Pendidikan," JKTP J. Kaji. Teknol. Pendidik., vol. 3, no. 2, pp. 138–148, 2020, doi: https://doi.org/10.17977/um038v3i22020p138.
12. Irwanto, "Pengembangan Bahan Ajar Berbasis Multimedia Interaktif untuk Mata Kuliah Elektronika Daya", Jurnal Pendidikan, Vol. 3, no. 2, pp. 353–368, 2021.
13. N. Nurhidayati, I. Asrori, M. Ahsanuddin, and M. W. Dariyadi, "Pembuatan Media Pembelajaran Berbasis Powerpoint Dan Pemanfaatan Aplikasi Android Untuk Guru Bahasa Arab," J. KARINOV, vol. 2, no. 3, p. 181, 2019, doi: https://doi.org/10.17977/um045v2i3p181-184.
14. W. Warkintin and Y. B. Mulyadi, "Pengembangan Bahan Ajar Berbasis CD Interaktif Power Point Untuk Meningkatkan Hasil Belajar Siswa," Sch. J. Pendidik. dan Kebud., vol. 9, no. 1, pp. 82–92, 2019, doi: https://doi.org/10.24246/j.js.2019.v9.i1.p82-92.
15. N. A. Sakiah and K. N. S. Effendi, "Analisis Kebutuhan Multimedia Interaktif Berbasis PowerPoint Materi Aljabar Pada Pembelajaran Matematika SMP," JP3M (Jurnal Penelit. Pendidik. dan Pengajaran Mat., vol. 7, no. 1, pp. 39–48, 2021, doi: https://doi.org/10.37058/jp3m.v7i1.2623.
16. G. Brousseau, THEORY OF DIDACTICAL SITUATIONS IN MATHEMATICS. 2002.
17. P. Amara and R. Zulkarnaen, "Pengembangan Lembar Kerja Siswa Berbasis Theory of Didactical Situation Dalam Materi Statistika," EduMatSains J. Pendidikan, Mat. dan Sains, vol. 6, no. 2, pp. 317–332, 2022.
18. M. Artigue and M. Bosch, "Networking of Theories as a Research Practice in Mathematics Education," pp. 249–265, 2014. https://doi.org/10.1007/978-3-319-05389-9
19. H. Strømskag, "A methodology for instructional design in mathematics—with the generic and epistemic student at the centre," ZDM - Math. Educ., vol. 49, no. 6, pp. 909–921, 2017, doi: https://doi.org/10.1007/s11858-017-0882-4.
20. T. Plomp and N. Nieveen, An Introduction to Educational Design Research. Netherlands institute, 2007.
21. P. Baxter and S. Jack, "Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers," Qual. Rep., vol. 13, no. 4, pp. 544–559, 2015, doi: https://doi.org/10.46743/2160-3715/2008.1573.
22. S. Ningsih, E. Kuntarto, and A. R. Kurniawan, "Teachers' Problems in Using Information and Communication Technology (Ict) and Its Implications in Elementary Schools," J. PAJAR (Pendidikan dan Pengajaran), vol. 4, no. 3, p. 518, 2020, doi: https://doi.org/10.33578/pjr.v4i3.7964.
23. S. Khodijah, "Telaah Kompetensi Guru di Era Digital dalam Memenuhi Tuntutan Pendidikan Abad Ke-21," Journal of Islamic Education Policy, vol. 3, no. 1. 2018. doi: https://doi.org/10.30984/j.v3i1.860.
24. I. D. Kurniawati and S.- Nita, "Media Pembelajaran Berbasis Multimedia Interaktif Untuk Meningkatkan Pemahaman Konsep Mahasiswa," DoubleClick J. Comput. Inf. Technol., vol. 1, no. 2, p. 68, 2018, doi: https://doi.org/10.25273/doubleclick.v1i2.1540.
25. N. K. Astini, Sari, "Pemanfaatan Teknologi Informasi dalam Pembelajaran Tingkat Sekolah Dasar pada Masa Pandemi Covid-19," J. Lemb. Penjaminan Mutu STKIP Agama Hindu Amlapura, vol. 11, no. 2, pp. 13–25, 2020.