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Design of Teaching Materials of Physics Based on Cognitive Conflict Integrated by Virtual Laboratory on Quantum Phenomenon

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ABSTRACT

Nowadays, Education applies the 2013 curriculum which requires the students to be able to comprehend concepts. However, in reality students' ability to understand concepts is relatively low than average. This happen because there are misconception, and lack of teaching materials made the student hardly studying. The solutions of the issue such as to design teaching materials based on the cognitive conflict models to improve students' conceptual comprehension. The aim of this research such as to design as well as to determine the validity of teaching materials for physics based on cognitive conflict developed by Mufit & Fauzan which consists of 4 syntaxes: activation of preconceptions and misconceptions, presentation of cognitive conflicts, discovery of concepts and similarities, and reflection. In the third syntax, a virtual laboratory is integrated by PhET. This research is included in the type of Design/Development Research using the Plomp model. However, this research is limited to the Preliminary Research and Prototype Phase. The results of the Preliminary Research stage, the researcher found that in learning physics there were still many misconceptions. The results of the Prototype Phase stage, the researcher design teaching materials based on cognitive conflict which were assessed based on validation instruments with a very valid validity level with an average value of the 4 indicators of 0.88. the acquisition of this value, the design of cognitive conflict-based physics teaching materials can be continued at the practicality and effectiveness research stage so that it is feasible to use in learning.

Keywords: Cognitive Conflict; Student Concepts Comprehension; Virtual Laboratory.

I. INTRODUCTION

The development of digital technology has affected every area of human life, not only affected the economic field but also affected the field of education. Education is required to produce quality human resources (Human Resources) so that they are able to face global competition. Therefore, student laborers have the skills to process information by realizing quality learning so that they can face future challenges. To realize quality learning, educators must have good learning skills so that students' abilities can develop.

Good learning skills can be obtained from changing teacher-centered learning activities into the student-centered learning activities.

The current curriculum in Indonesia is applied 2013 curriculum which emphasizes student-centered learning in which the teacher acts as a facilitator. The implementation of the 2013 curriculum can realize quality education, namely realizing the nation's next generation that is productive, creative, innovative, affective, through skills, strengthening attitudes and integrated knowledge. Contextual learning will create more meaningful learning so that students will be more productive and innovative. Contextual learning will encourage students towards active learning. Active learning aims to make students able to comprehend the concept of learning and apply it in daily life. Therefore, contextual learning is very suitable for the above and can improve students' critical thinking skill as well as creative thinking skills.

The lack of application of active learning causes errors in the formation of pre-concepts in studying physics material, especially in micro-materials such as quantum phenomena. This is because the teacher only provides concepts in the abstract and is not observed directly through experiments in the laboratory. In order able to embody experimental learning in school laboratories, teachers must pay attention to completeness of laboratory facilities (such as tools and materials) and infrastructure in the laboratory. However, the implementation of experiments in schools has not been carried out for all physics material, especially physics material which is abstract and cannot be observed directly.

The importance of physics learning objectives requires that the learning process be supported by learning tools that are able to help students comprehend the concepts and principles of physics. Learning tools are the main ingredients in learning process designed by teachers to help learning process. One of the contextual learning tools is teaching materials. The teaching materials can be helpful for teachers in learning activities and help students comprehend the concepts and the principles of physics. Contrary to the ideal situation above, there is a gap between the conditions in the field and what is expected. Conditions that students still find it difficult to comprehend the concepts and the principles of physics. This is obtained from the preliminary research by conducting interviews with some teachers and previous research on students; comprehension to the concepts and principles of physics.

Based on the interviews' results which conducted with 3 teachers from three different schools, namely SHS A, SHS B, and SHS C. The interview process was conducted to determine the learning model used during the physics learning process, experimental activities, and the teaching materials used.

Table 1. *Interview Results of Students' Comprehension of Quantum Phenomenon*

School	Interview Result			
	Learning model	**Experimental Activities**	**Teaching materials**	**Student's Comprehension**
SHS A	Inquiry	Not implemented	Books provided by the government and certain publishers as well as self-made worksheets	Students only memorize formulas and tend to have misconceptions
SHS B	Discourse	Not implemented	Books provided by the government and certain publishers	Students only memorize formulas and tend to have misconceptions
SHS C	Discourse	Not implemented	Books provided by the government and certain publishers	Students only memorize formulas and tend to have misconceptions

Based on Table 1, we can conclude that learning in schools without teaching materials that are integrated with certain learning models makes it difficult for students to comprehend the material and creates misconceptions about quantum phenomena. These things can hinder students' physics comprehension of a concept and principle well. The researcher also asked about students' comprehension

of quantum phenomena. students' comprehension of the material, based on the interviews' results, the average stated that students' comprehension was only how to use formulas without comprehend the concept of quantum phenomena material, so that many misconceptions occurred in the learning process, such as in the light dualism sub-material.

Based on literature review, misconceptions occur in almost all physical materials, including quantum phenomena. From the results of the literature study, the researchers concluded that students' comprehension of quantum phenomena was low, because there were often misconceptions about quantum phenomena. Comprehension of physics concepts especially the photoelectric effect material is still relatively low, due to differences in comprehension perspective [1]. The comprehension of the physics education's concept students on the photoelectric effect material is still relatively low [2]. The percentage of students' misconceptions about the photoelectric effect material is quite high, it's because the material is abstract and cannot be observed directly [3].

From the results of the preliminary research, there is a gap between the conditions in the field and what is expected. The solution to overcome issues is with cognitive conflict-based materials. Teaching materials are arranged based on the syntax of the cognitive conflict-based learning model developed by Mufit & Fauzan. This model has 4 syntaxes, namely: first, activation of preconceptions and misconceptions, second is presentation of cognitive conflicts, the third is discovery of concepts and similarities, and lastly reflection [4]. Learning model based on cognitive conflict is designed to improve concept's comprehension and remediate students' misconceptions, especially on quantum phenomena material.

Cognitive conflict-based learning a model that emphasizes students' comprehension in order to find out conceptual errors through experiences such as practice or experiments and allows students to change misconceptions with concepts that are scientifically proven [5]. Learning based on cognitive conflict strategies is a learning process that can help the students build their own knowledges about concepts that do not conflict with actual scientific concepts [6].

Teaching materials are forms of systematically arranged materials that can assist teachers to carry out the learning activities and enable students to learn [7]. Well teaching materials contain several important components including: learning instructions, competencies to be achieved, learning materials, supporting information's, assignment, work instructions, evaluations, responses to evaluation results [8]. For students, teaching materials are useful to help understand learning materials, both written and unwritten. As for the teacher as a guide to direct students in the learning processes and as a source of material to be given to students.

A virtual laboratory is a series of electronic tools in the form of a computer-based virtual laboratory that can integrate various media components in the form of texts, images, animations, sounds and videos to carry out remote collaboration and other activities [9]. Virtual laboratory has the goal to provide a virtual environment for students with good speed and comfort. The use of virtual laboratories is more effective and more efficient of all materials than real laboratories, because it is not bound by place and time [10].

Cognitive conflict-based teaching materials use the syntax of the CCBL model developed by Mufit & Fauzan. This teaching material is used as a support system in the implementation of cognitive conflict-based learning models. using syntaxes from the CCBL model developed by Mufit & Fauzan. Cognitive conflict-based learning (CCBL) is one step that can determine progress in remediating misconceptions. Because in each CCBL syntax, namely first, activation of preconceptions and misconceptions, second is presentation of cognitive conflicts, the third is discovery of concepts and similarities, and lastly reflection. have advantages, including being able to make oneself aware of the misconceptions it has, creating a level of confidence in discovery of concepts and linkages between concepts and equations, straightening views of the truth of equations with concepts, and knowing the level of comprehension of learning concepts [4]. In addition, cognitive conflict-based teaching materials can overcome discrepancies in the perception of prior knowledge by increasing conceptual comprehension which can reduce students' misconceptions.

In the cognitive conflict-based teaching materials developed by the researchers, it relates to technological developments, namely virtual laboratories. The integration of the virtual laboratory is carried out in the third step of the CCBL syntax, namely when conducting experiments for the discovery of concepts and equations. Virtual laboratory is done because experiments in schools are not possible and can be done anytime and anywhere. The integration of virtual laboratories in cognitive conflict-based

teaching materials is also an effort to train digital literacy skills according to the demands of 21st century learning.

Teaching materials for physic based on cognitive conflict with virtual laboratory integrated are expected to be improving students' conceptual comprehension and remediate misconceptions in learning materials. This teaching material is also expected to have an interaction between teachers, students and the surrounding environment so that learning becomes meaningful. This research aims to produce cognitive conflict-based teaching materials that integrate the Virtual Laboratory on valid quantum phenomena.

II. METHOD

The research's type conducted in this research is Design Research, which is a research method for product development and product validation so that it is feasible to use. A product that has not been tested for feasibility must pass a validity test by a team of experts so that the product is feasible to be tested in the field. Cognitive conflict-based teaching materials were designed using the Plomp Design/Development Research model. There are 3 stages of development that must be carried out, namely: (1) Preliminary Research, namely conducting a needs analysis and reviewing related literature, (2) Development Prototyping Phase, namely the stage of designing solutions from previous research in the form of teaching material design and formative evaluation and revision of prototypes, and (3) the Assessment Phase [11]. However, this research only reached the Development Prototyping Phase.

The first research stage is preliminary research. Preliminary research consists of necessity and context analysis as well as literature reviews. The analysis conducted on educators was to conduct interviews with 3 teachers from different schools. The analysis' results are used for consideration of the development of teaching materials. The questions to be asked in this analysis are: (1) how to apply the physics learning model used in schools, (2) whether the physics learning process uses teaching materials, (3) how students understand the concept of quantum physics. Research by reviewing the literature is carried out after completing a needs analysis, finding issues, and designing the right product as a solution to issues that occur in schools. This is done to examine teaching materials by integrating appropriate learning models so that they can reduce the occurrence of misconceptions in students. This study was conducted on several related scientific articles as well as several reference books. Formative evaluation is carried out by the researcher himself or also called self-evaluation. This evaluation is carried out to provide certainty and confidence that these media or teaching materials can be helpful in learning process. Furthermore, the evaluation of the prototype is continued by a team of experts or is called an expert review. The expert team for the evaluation of the prototype is a Physics lecturer. The evaluation given is in form of responses and any suggestions from the validator lecturers as revision material

The analytical technique used in this research is validation analysis. The validation of the teaching materials that have been developed can be seen from the questionnaires which filled out by the lecturers of the Physics Department, Padang State University. The results of the questionnaire for educators were analyzed descriptively. The self-assessment sheet was measured using a Likert scale. Likert scale is usually used for measure the attitudes, some opinions and some perceptions of a person or group about social events or phenomena [12]. The self-assessment sheet was analyzed using the percentage technique:

$$Score = \frac{Total\ Value}{Maximum\ Value} \times 100\% \qquad (1)$$

The interpretation of the results of the validity analysis that has been carried out could be seen in the table

Table 2. *Interpretation of Validity Analysis Results [12].*

No	Total Score	Criteria
1	0 – 20	Invalid
2	21 – 40	Less Valid
3	41 – 60	Quite Less Valid
4	61 – 80	Valid
5	81- 100	Very Valid

The statistical test carried out by the lecturers in this study was descriptive analysis, presented in the form of graphs. The weighting with the scale determined by Aiken. According to [13] formulate that the smallest rating category is 2 to the highest rating category is 7. This study uses 4 categories with raters/experts. The categories used are as follows.

$$V = \frac{\sum s}{[n(c-1)]} \qquad (2)$$

The Aiken V Index category ranges from 0-1 as shown in table 3.

Table 3*. Rating Index Aiken V [13].*

No	Percentage (%)	Criteria
1.	V ≤ 0,4	Less valid
2.	0,4 < V < 0,8	Valid
3.	V > 0,8	Very valid

Products that have been validated by experts can be known for their validity values. Experts also provide input in the form of suggestions. Suggestions given by experts after the validation process are used to improve the products developed.

III. RESULTS AND DISCUSSION

A. Results

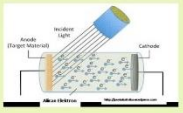
1. Research's Results Preliminary Research Phase

In the preliminary research stage, an initial study of teachers and journal analysis was carried out. The initial study of the teacher was in the form of conducting interviews using an interview guide which aims to find out the issues that are often encountered when carrying out physics learning activities, especially the material for quantum phenomena. The results of interviews with teachers, researchers concluded that learning in schools that do not integrate teaching materials with certain learning models makes it difficult for students to comprehend the material and creates misconceptions about quantum phenomena. The journal analysis' result can be concluded that students' comprehension of quantum phenomena is low, because there are often misconceptions about quantum phenomena. These things can hinder students' comprehension of a concept or principle of physics well.

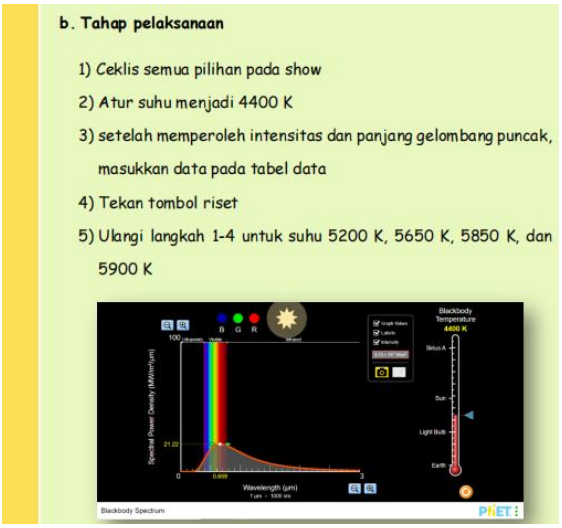
2. Results of the Development or Prototype stage

At the design stage, it aims to design teaching materials of physics based on cognitive conflict in the form of increasing students' comprehension and remediating misconceptions on quantum phenomena. Cognitive conflict-based teaching materials are using the syntax of the cognitive conflict learning model. namely first, activation of preconceptions and misconceptions, second is presentation of cognitive conflicts, the third is discovery of concepts and similarities, and lastly reflection. This teaching material is used as a support system in the implementation of cognitive conflict-based learning models. The appearance of some cognitive conflict-based teaching materials that have been developed is presented in table 4.

Table 4. *Some Views of Cognitive Conflict Based Teaching Materials.*

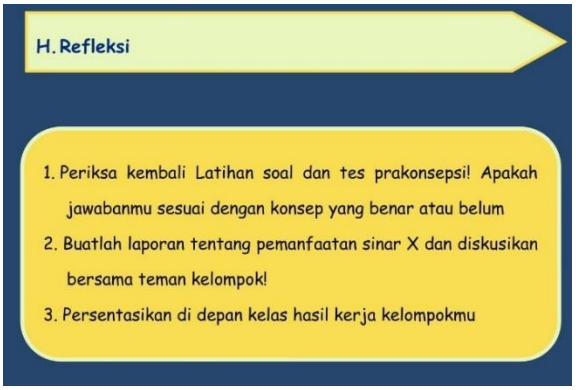
Display Example	Description
1. Cover	
	As we can see that cover of teaching material uses the picture of quantum phenomena 's application, such as solar panel
2. Preconception and Misconception Activation Stage	
2 Fenomena Fotolistrik  https://bisakimia.com/2016/09/01/efek-fotolistrik-pendukung-teori-kuantum-max-planck/ No | Pernyataan | B | S | T a | Cahaya dapat bersifat seperti partikel b | Saat cahaya menumbuk target maka electron akan terlepas c | Cahaya senter bisa mengasilkan listrik dari panel surya	At this stage students are given related statements about the basic concepts of the material to be studied. Students can judge the statement given is true, false or do not know. This stage intends to analyze the students' prior knowledge before starting the lesson by providing a preconception test for students, to determine students' comprehension of the material.
3. Stage of Presentation of Cognitive Conflict	
F. Penyajian Konflik Kognitif Ayo renungkan dan buat hipotesis (jawaban sementara) dari fenomena kuantum berikut. (15 menit) No | Fenomena Kuantum | Hipotesis 1 | Matahari dan bintang lainnya bisa menjadi benda hitam jika dipanaskan terus-menerus. Benda hitam akan menyerap semua radiasi yang lewat di sekitarnya. Mengapa? |	At the stage of presenting cognitive conflict, students are faced with a phenomenon related to quantum phenomena that causes cognitive conflict, and students are required to predict events by providing temporary answers to each question. This stage aims for conceptual conflict to occur in students before making conceptual changes to find new concepts scientifically

4. Concept and Equation Discovery Stage



At the stage of finding concepts and equations, it is carried out through experimental activities and discussions. In this research, experiments can be carried out using a virtual laboratory PhET simulation in finding concepts and similarities about quantum phenomena. This stage aims to achieve a long-lasting conceptual comprehension in the memory of students. The virtual laboratory used in this teaching material is a blackbody spectrum and photoelectric effect

5. Reflection Stage



At the reflection stage, students are asked to present the findings of the third stage in front of the class so that they can be discussed together. The reflection stage aims to conduct class discussions and evaluations to get feedback from comprehension concepts and misconceptions, where the teacher becomes a facilitator to strengthen students' comprehension of concepts and resolve misconceptions.

3. Results of Formative Evaluation and Revised Prototype

Self-evaluation is carried out before the product is validated by expert team, in this evaluation the prototype that has been made is re-examined in detail for completeness by the researcher. If an error is found, the researcher must correct and add the part that is felt to be lacking. The teaching materials developed by the researcher have followed the reference from the Ministry of National Education in 2008 which the teaching materials consist of titles, learning instructions, the competencies to be achieved, a supporting information, assignments, the work steps and lastly the evaluation. The structure of the developed teaching materials is also adapted to the stages of the cognitive conflict model, namely first, activation of preconceptions and misconceptions, second is presentation of cognitive conflicts, the third is discovery of concepts and similarities, and lastly reflection. When the researcher re-examined the teaching materials, several errors were found including, typing errors, images that were not included in the source, and image errors. Every error found has been corrected and complements the things that are felt to be lacking. Each prototype is self-explanatory as are pictures, illustrations and equations. The assessment component in this self-evaluation is the compositions of teaching materials according to the Ministry of National Education in 2008 such as teaching materials according to the CCBL syntax, language and graphics. The following are data's results plot for the grade of each indicator on the component substance of the material, which could be seen in Figure 1.

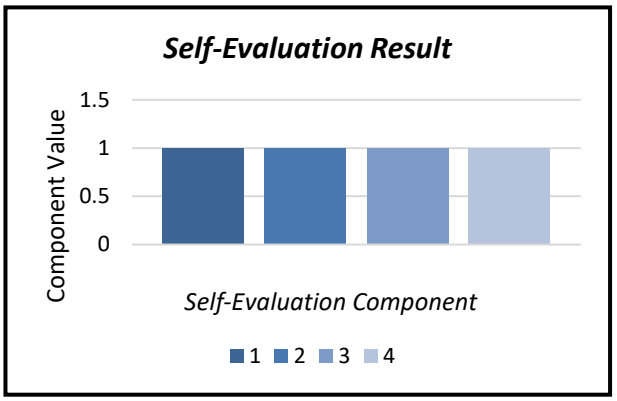


Fig 1. Self-Evaluation Average Results.

As we can see from Figure 1 that the design of teaching materials has completed the Ministry of National Education composition and the teaching materials also follow the syntax of the cognitive conflict-based learning model. The average value of 100 can be said to be very valid.

To get the results of the validity of teaching materials of physics based on cognitive conflict, validity tests were carried out by 3 experts consisting of 3 Physics lecturers, FMIPA UNP. The results of the validation test are carried out in determining the feasibility of the teaching materials design as a reference when revising the teaching materials. The teaching material validation instrument consists of 4 components including the feasibility of content, the presentation, language, and graphics. The results of the plot of the validity of Teaching Materials for each assessment component are shown in Figure 2.

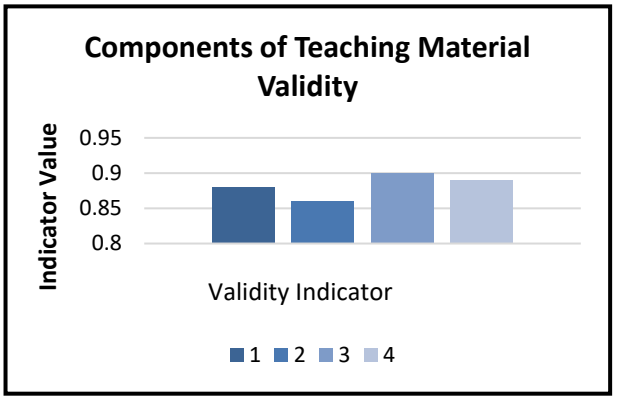


Fig 2. Average Results of Teaching Material Validity.

Based on the picture above, we can conclude that the average grade of each indicator varies in the validation of teaching materials, which ranges between. 0.8 to 0.9. With an overall average value of 0.88. From this value, we can state that the overall component of the teaching materials is in the very valid category. Thus, Cognitive Conflict-Based Teaching Materials Using Virtual Laboratories on Quantum Phenomenon Materials to Improve Students' Concept Comprehension has a very valid level of validity. During the validity evaluation process, there were several suggestions from the experts, so that the teaching materials were revised. Among them are revisions to writing, image layout, narration on images, presentation of questions that are not appropriate.

Table 5. Revision of Teaching Material Prototypes According to Expert

Revision 1. Writing Error

Before Revision	After Revision
10 Radiasi inar X *bremstrahlung* dihasilkan Ketika… a. Ruang kosong di orbital electron diisi electron luar b. Foton mengenai permukaan logam c. Ruang kosong di inti atom terisi d. Electron diperlambat di katode e. Electron dihentikan di anode	9 Radiasi sinar X karakteristik dihasilkan ketika… a. Ruang kosong di orbital elektron diisi elektron luar b. Foton mengenai permukaan logam c. Ruang kosong di inti atom terisi d. Elektron diperlambat di katode e. Elektron dihentikan di anode

In the teaching materials there are still many words that use foreign languages and typing errors. Revisions are made so as not to cause double meaning.

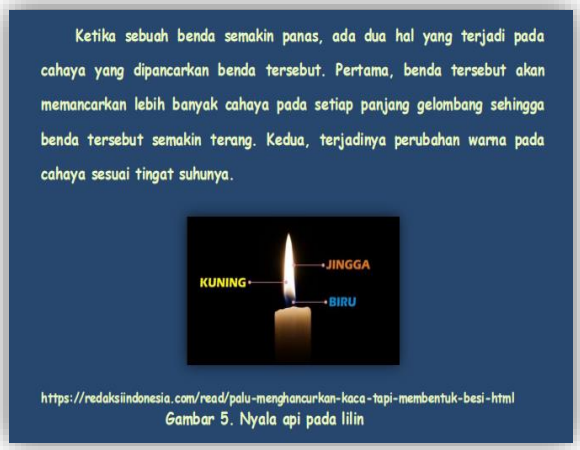
Revision 2. Proper Image Narrative

Before Revision	After Revision
Hukum Pergeseran Wien Seorang pandai menaruh sebatang baja dalam nyala api sambil menempa baja tersebut, ia dapat menilai seberapa panas baja tersebut dengan memperhatikan perubahan warna dari baja tersebut. Pada saat praktikum kimia kamu pernah menggunaka pembakar spiritus sebagai sumber panas, dan kamu perhatikan api spiritus berwarna biru sedangkan lilin yang biasa digunakan menyala dengan warna merah kekuningan.  https://www.youtube.com/watch?v=qjM73TlVkTo Gambar 4. Simulasi besi dipanaskan terus-menerus	Hukum Pergeseran Wien Seorang pandai menaruh sebatang baja dalam nyala api sambil menempa baja tersebut, ia dapat menilai seberapa panas baja tersebut dengan memperhatikan perubahan warna dari baja tersebut. Pada saat praktikum kimia kamu pernah menggunaka pembakar Bunsen asatu spiritus sebagai sumber panas, dan kamu perhatikan api spiritus berwarna biru sedangkan lilin yang biasa digunakan menyala dengan warna merah kekuningan.

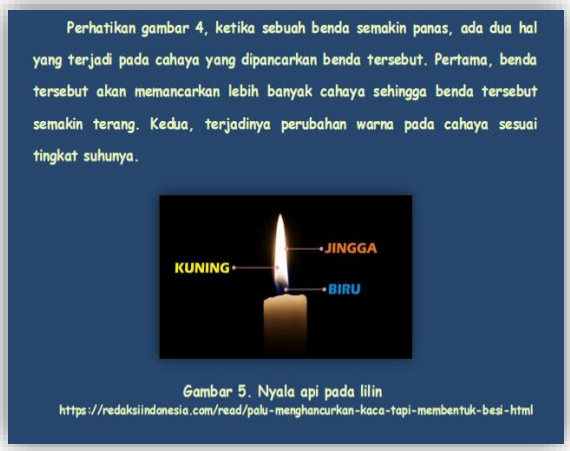
The previous teaching materials did not use pictures in a narrative. Revisions are made so that there is an illustration of the examples presented

Revision 3. Image Layout

Before Revision



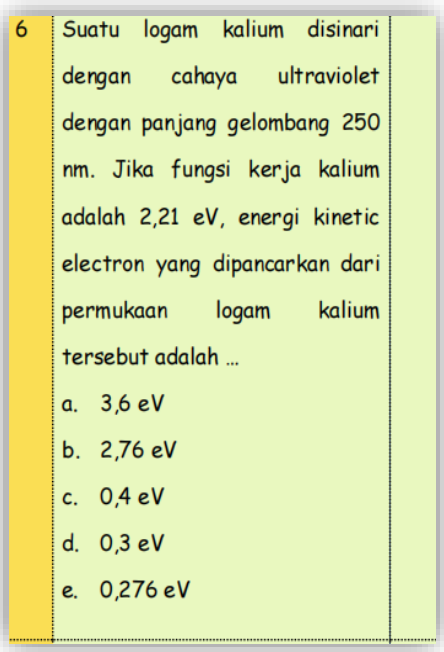
After Revision



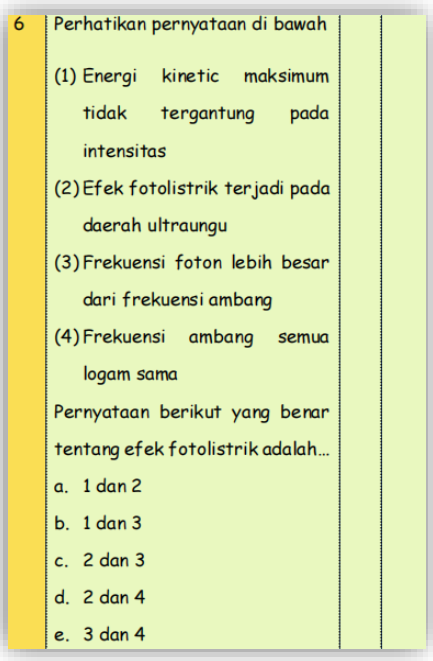
Previously, the layout of the image was not quite right. Revisions were made so that the layout of the images was better and use the image instructions in the narration to make it easier to understand

Revision 4. Presentation of Concept Questions

Before Revision



After Revision



Previously, the evaluation of teaching materials used a matter of counting. Revisions are made so that the evaluation uses concept questions in order to measure the extent of students' comprehension of the quantum phenomena

After the design of the teaching materials has been revised, the teaching materials have been declared by the validator as valid. And teaching materials are feasible to continue on practicality and effectiveness research.

B. Discussion

Design research is a systematic way of designing teaching materials, developing teaching materials and lastly evaluating educational interventions, in this case teaching materials to solve a issue with the aim of advancing education [11]. In this design research, the researcher limits the research only to the validity testing stage, namely the validity of teaching materials. The design of teaching materials for physics based on cognitive conflict has been produced with the characteristics of titles, learning instructions, competencies to be achieved, materials, work steps, summaries and evaluations.

The first phase is Preliminary Research. The initial research was conducted by interviewing teachers and analyzing journals. The results of the interviews concluded that learning in schools has not fully implemented the 2013 curriculum, because teachers still use conventional learning models such as the lecture method. The teaching materials which used in learning processes provided by the government. Indeed, the teaching material do not use learning models and do not use other additional teaching materials, so that experimental activities are not given much attention.

The results of research conducted by [14] on 3 high schools in the city of Padang showed that the students' comprehension of physics concepts was still relatively low. Research states that comprehension of the concept of physics in the photoelectric effect material is still relatively low, due to differences in comprehension views [1]. Students' comprehension of the photoelectric effect material is still low. comprehension of the physics education's concept students on the photoelectric effect material is still relatively low [15]. The percentage of students' misconceptions about the photoelectric effect material is quite high because the material is abstract where the material cannot be observed directly [3].

From the results of interviews and journal analysis, we can conclude that the students' level of comprehension is low and the level of misconceptions about quantum phenomena is high. To be able to overcome this, the author provides a solution design of teaching material for physics based on cognitive conflict. Teaching materials using cognitive conflict syntax developed by Mufit & Fauzan. In the third syntax, cognitive conflict-based teaching materials integrate virtual laboratories by PhET such as blackbody spectrum and photoelectric effect.

In the second stage, namely the Prototype Phase, there are two stages of research. First, the results of self-validation by researchers on teaching materials have met the requirements and conditions that must exist in teaching materials. At this stage the researcher has checked all the components contained in the teaching materials. The components of teaching materials are in accordance with teaching material's guidelines by the Ministry of National Education in 2008. Cognitive conflict-based teaching materials have also completed the syntax of the cognitive-based learning model, namely first, activation of preconceptions and misconceptions, second is presentation of cognitive conflicts, the third is discovery of concepts and similarities, and lastly reflection. Where in the third syntax of teaching materials integrates a virtual laboratory such as blackbody spectrum and photoelectric effect. So that the teaching materials deserve to be validated by experts.

Furthermore, validation is carried out by some experts, based on validation's results, it was obtained that the teaching materials designed were valid. The designed teaching materials are said to be valid because the components related to the teaching materials are correct. The validator must fill out a validation instrument to assess the teaching materials developed. The instrument which is used for determine the product design's validity is to fill out a validation questionnaire sheet by experts. Validity questionnaire sheet includes content feasibility, and presentation feasibility, and language feasibility, and lastly graphic feasibility according to the guidelines from the 2008 Ministry of National Education. If the average grade of validity is above 0.8, the teaching material is declared very strong by Validity Aiken.

In addition to the indicators above, the teaching materials that researchers develop must go through a feasibility test for integrating cognitive conflict-based learning models. In the implementation of designing teaching materials, it is not easy to get decent and perfect results because of the limitations of the researcher. So that advice from some experts is needed to improve the quality and feasibility of teaching materials.

Interactive multimedia of thermodynamics and mechanical waves based on cognitive conflict has a very high level of validity so that it can improve comprehension and remediate students' misconceptions and improve students' literacy skills [16]. The validation's results of interactive multimedia of vector based on cognitive conflict for class X SMA is 0.83 with a very valid category so that it can support the learning process during a pandemic and reveal comprehension and remediate misconceptions [17]. The validation results from cognitive conflict-based learning media on sound waves and light waves have a level of validity with a very valid category so that they can support the learning process during a pandemic and reveal comprehension and remediate misconceptions [17]. The validation results from the E-Book based on cognitive conflict for material of physical quantities related to the concept of force or Newton's Laws I, II, III and their applications are very valid so they can support the learning process during a pandemic and reveal comprehension and remediate misconceptions [19].

The main issue is that causes the low level of comprehension of students' concepts towards learning application of cognitive conflict learning, especially in learning physics. To support the cognitive conflict learning model, cognitive conflict-based teaching materials were developed so that they can be a guide for both teachers and students during the learning process.

Cognitive conflict-based teaching materials that integrate a virtual laboratory on quantum phenomena are considered suitable for improving conceptual comprehension and remediate students' misconceptions, especially the subject of physics. Cognitive conflict-based learning has a higher influence on physics than another subjects, cognitive conflict learning has the highest influence in increasing conceptual comprehension and reducing students' misconceptions, especially in physics learning [20]. Based on validation's results by researchers and experts, and the design of cognitive conflict-based teaching materials using a virtual laboratory on quantum phenomena material to improve students' conceptual comprehension can be stated to be tested at a later stage.

IV. CONCLUSION

Based on research's result and discussions, we can conclude that cognitive conflict teaching materials have been designed consisting of titles, learning instructions, and then competencies to be achieved, materials, and student worksheets, lastly summaries and evaluations. This teaching material uses the syntax of the cognitive conflict-based learning model which consists of 4 syntaxes, namely: firstly, activation of preconceptions and misconceptions, secondly, presentation of cognitive conflicts, and the third is discovery of concepts and similarities, and lastly reflection. In the third syntax, a virtual laboratory is integrated to improve students' comprehension of concepts. This teaching material is designed to improve students' comprehension of physics learning, especially quantum phenomena. The validation results of cognitive conflict-based teaching materials on quantum phenomena have been valid for four assessment indicators, namely content feasibility, and presentation feasibility, and language feasibility, and lastly graphic feasibility.

REFERENCES

[1] Taslidere, E. (2016). Development and use of a three-tier diagnostic test to assess high school students' misconceptions about the photoelectric effect. *Research in Science & Technological Education*, *34*(2), 164–186.

[2] Yildiz, A., & Buyukkasap, E. (2011). The Level of Understanding of the Photoelectric Phenomenon in Prospective Teachers and the Effects of" Writing with Learning" on their Success Rates. *Educational Sciences: Theory and Practice*, *11*(4), 2268–2274.

[3] Habibbulloh, M., Jatmiko, B., & Widodo, W. (2017). Pengembangan perangkat pembelajaran model guided discovery berbasis lab virtual untuk mereduksi miskonsepsi siswa SMK topik efek fotolistrik. *Jurnal Penelitian Fisika Dan Aplikasinya (JPFA)*, *7*(1), 27–43.

[4] Mufit, F., Festiyed, F., Fauzan, A., & Lufri, L. (2018). Impact of learning model based on cognitive conflict toward student's conceptual understanding. *IOP Conference Series: Materials Science and Engineering*, *335*(1), 012072.

[5] Kang, H., Scharmann, L. C., Kang, S., & Noh, T. (2010). *Cognitive conflict and situational interest as factors influencing conceptual change*.

[6] Maulana, P. (2010). Usaha mengurangi terjadinya miskonsepsi fisika melalui pembelajaran dengan pendekatan konflik kognitif. *Jurnal Pendidikan Fisika Indonesia*, *6*(2).

[7] Daryanto, D. (2013). Menyusun modul bahan ajar untuk persiapan guru dalam mengajar. *Yogyakarta: Gava Media*.

[8] Andi, P. (2011). Panduan kreatif membuat bahan ajar inovatif. *Jogjakarta DIVA Pres*.

[9] Yuniarti, F., Dewi, P., & Susanti, R. (2012). Pengembangan virtual laboratory sebagai media pembelajaran berbasis komputer pada materi pembiakan virus. *Journal of Biology Education*, *1*(1).

[10] Shah, B., Pareek, J., Patel, S., & Patel, V. (2019). *Database Virtual Laboratory for Guided Learning*.

[11] Fauzan, A., Plomp, T., & Gravemeijer, K. P. E. (2013). The development of an RME-based geometrycourse for Indonesian primary schools. In *Educational design research-Part B. Illustrative cases* (pp. 159–178). SLO: Netherlands institute for curriculum development.
[12] Riduwan. (2019). *Belajar Mudah Penelitian untuk Guru-Karyawan dan Peneliti Pemula* (J. S. , H. Husdarta, Ed.; Cetakan 11 Jan 2019). Alfabeta.
[13] Aiken, L. R. (1985). Three coefficients for analyzing the reliability and validity of ratings. *Educational and Psychological Measurement*, *45*(1), 131–142.
[14] Mufit, F. (2019). Pengembangan LKS berbasis konflik kognitif terintegrasi literasi baru pada materi fluida untuk siswa kelas XI SMA. *Pillar of Physics Education*, *12*(4).
[15] Mulyanti, R. M., Yulianto, A., & Astuti, B. (2018). Miskonsepsi mahasiswa pendidikan fisika pada materi efek fotolistrik. *Phenomenon: Jurnal Pendidikan MIPA*, *8*(1), 36–45.
[16] Arifin, F. A., & Mufit, F. (2021). Validity and practicality of interactive multimedia based on cognitive conflict integrated new literacy on thermodynamic and mechanical waves material for class xi high school students. *Journal of Physics: Conference Series*, *1876*(1), 012052.
[17] Ilahi, T. D. W., Mufit, F., Hidayati, H., & Afrizon, R. (2021). Disain dan validitas multimedia interaktif berbasis konflik kognitif pada materi vektor untuk kelas X SMA/MA. *Jurnal Penelitian Pembelajaran Fisika*, *12*(2), 182–195.
[18] Saputri, R., Mufit, F., Gusnedi, G., & Sari, S. Y. (2021). Design and validity of cognitive conflict-based teaching materials integrating virtual laboratories to improve concept understanding of waves. *Berkala Ilmiah Pendidikan Fisika*, *9*(3), 244–256.
[19] Pratama, V., Anggraini, S. F., Yusri, H., & Mufit, F. (2021). Disain dan validitas e-modul interaktif berbasis konflik kognitif untuk remediasi miskonsepsi siswa pada konsep gaya. *Jurnal Eksakta Pendidikan (Jep)*, *5*(1), 68–76.
[20] Mufit, F., Asrizal, A., & Puspitasari, R. (2020). Meta-Analysis of the effect of cognitive conflict on physics learning. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *6*(2), 267–278.