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Developing Conceptual Change Text on the States of Matter and Their Changes for Prospective Elementary School Teachers

Anasufi Banawi[1]*, Sulaeman Sulaeman[2], M. Ridwan[3], Wahyu Sopandi[4], Asep Kadarohman[4] and Muhammad Solehuddin[4]

[1]*Department of Madrasah Ibtidaiyah Teacher Education, Faculty of Tarbiyah and Teacher Training, State Islamic Institution Ambon, 97128 Ambon, Moluccas, Indonesia*
[2]*Department of Islamic Journalism, Faculty of Usuluddin and Da'wah, State Islamic Institution Ambon, 97128 Ambon, Moluccas, Indonesia*
[3]*Department of Islamic Civil Law, Faculty of Sharia and Islamic Economics, State Islamic Institution Ambon, 97128 Ambon, Moluccas, Indonesia*
[4]*Department of Elementary Education, School of Postgraduate, Indonesia University of Education, 40154 Bandung, West Java, Indonesia*

ABSTRACT

This research aims to develop a Conceptual Change Text (CCT) for prospective elementary school teachers' understanding of states of matter and their changes through text to fulfill valid, practical, and effective criteria about the Basic Concepts of Science, henceforth *TPK-MP* (*Teks Perubahan Konseptual Materi dan Perubahannya*). This research employs research and development of the 4D model: define, design, develop, and disseminate. The instruments included observation, questionnaire, interview guidelines, validation papers, and concept mastery test. The data obtained were analyzed according to validation, practicality, and effectiveness criteria. The results showed that conceptual change text on states of matter and their changes and CCT developed was valid with an average score of 95.32 (very valid), practical at the score of 3.56 (good), with the students' positive response at 86.74%; and effective in which the conceptual changes were at 57.40% (medium). TPK-MP can improve understanding of concepts and reduce misconceptions about the matter and its changes. It can be used to develop conceptual change text for other science materials. Further research is needed to determine the effectiveness of lectures using TPK-MP as an independent study material.

Keywords: Conceptual changes text (CCT), prospective elementary school teachers, states of matter and their changes

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E-mail addresses:
a.banawi@iainambon.ac.id (Anasufi Banawi)
sulaeman@iainambon.ac.id (Sulaeman Sulaeman)
ridwaniain1968@gmail.com (M.Ridwan)
wsopandi@upi.edu (Wahyu Sopandi)
kadar@upi.edu (Asep Kadarohman)
msolehuddin@upi.edu (Muhammad Solehuddin)
* Corresponding author

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INTRODUCTION

Science is one of the subjects that students learn from the elementary school level (SD/MI). The knowledge of the natural phenomenon and their scientific explanation are essential aspects that students need to know during science lessons (Merino & Sanmarti, 2008; Merritt et al., 2007). Furthermore, the materials studied in science subjects in elementary school are the fundamental knowledge important for biology, physics, and chemistry. Therefore, it is essential to equip the students with a basic understanding of science and free them from misconceptions about studying further.

In a university with Elementary Teacher Education Study Program (PGSD, *Pendidikan Guru Sekolah Dasar*) or Madrasah Ibtidaiyah Teacher Education Study Program (PGMI, *Pendidikan Guru Madrasah Ibtidaiyah*), the topic of states of matter and their changes is learned in the subject of Fundamental Concept of Science (3 or 4 credit semester). Therefore, the students are required to master the concept of science and, later, teach the materials. Knowledge (formal education) and science teachers' experience have influenced how they teach the materials (Chan & Elliot, 2004; Hashweh, 1996). Science not only shows the phenomenon's existence but also highlights its understanding. Therefore, the essential aim of science education is to develop the students thinking ability in certain contexts (Oliveras et al., 2013; Zoller et al., 2000). The teachers need to understand what exists in the student's cognitive structure to develop scientific concepts (Talanquer, 2006). Teachers who possess the ability to teach well can help students understand. Learning depends on the teachers' knowledge of the materials of the current topics. In this case, the primary responsibility lies on the teachers, but it does not mean that the other factors are ignored, such as reference books and other teaching tools (Banawi et al., 2021; Karagöl & Bekmezci, 2015; Lating, 2014).

The results from a few research (Gomez-Zwiep, 2008; Keeley, 2012; Subramaniam & Harrell, 2013; van Garderen et al., 2012) showed that content knowledge of elementary school science teachers had a direct and indirect influence on classroom practices. Besides, the teachers who mastered the content knowledge were more ready to develop the lessons in line with conceptual changes (Heller et al., 2003). Taştan et al. (2008) reported that CCT could improve students' understanding and achievement. Therefore, the content knowledge of prospective science teachers became the predictor of the learning quality and its results. Relations between science teachers' content and professional knowledge determine the teachers' method of teaching certain concepts to help students learn (Subramaniam & Harrell, 2013). Besides, there was a significant relationship between prospective teachers' points of view and attitudes toward their professional teaching (Uyghun & Kunt, 2014). Therefore, the teachers' perspective would influence them in implementing their tasks and roles in their workplace.

Science learning in schools, especially for the students, is typically implemented in specific ways to facilitate the development of their mindset (minds-on) and hands-on (Prasetyo, 2010), and it is expected to consider the constructivism principles (Widodo & Nurhayati, 2005). Elementary school teachers are essential in developing students' understanding of science concepts because they are the classroom teachers. Classroom teachers must deliver almost all the lessons, including Science and other lessons in the class (Banawi et al., 2017; Han & Brown, 2013; Ornstein & Levine, 2008). For this reason, prospective elementary school teachers must be equipped with a good understanding of the materials and their nature. They are expected to guide the students to acquire a scientific conception of states of matter and their nature. The students' correct understanding will become valuable resources when they reach a higher education level. Therefore, a good understanding of the topic will be fundamental when learning chemistry. As understood, the objects learned in chemistry are about the material (nature, structure, and composition) and their changes (Chang, 2010; Geller, 2003). Therefore, a good concept of understanding the object, substance, and particle will be the resource to understand the science lesson (Johnson, 1998).

However, ironically, the results of previous research illustrate that the basic science concepts have not been fully understood by teachers, including the idea of states of matter and their changes (Banawi et al., 2017, 2018; Jaelani, 2015; Sopandi et al., 2017). At the previous level (Elementary School, Junior High School, and Senior High School), the research participants attended lessons that discussed the states of matter and their changes and participated in the science group lectures (Basic Science Concepts and Elementary School Science Learning).

The description above concludes that the provision of material mastery on states of matter and their changes requires more effort, both aimed at teachers and prospective elementary school teachers. Education in the university is one of the critical stages in providing direction for students' future. Therefore, students must be assisted, and the solutions must be tailored according to the problems and needs of the students (Karagöl & Bekmezci, 2015). Thus, when teaching, teachers must conduct diagnostics to help identify and facilitate learning needs and improve students' learning (LaFrance, 1994).

Material sorting in teaching is essential because teaching materials can be used as a reference and source of information for students in learning. The content of the discussion scope is not only to make many pages and increase production costs, but it is necessary to sort out the material by selecting which are important and which are just additional knowledge (Hadiyanti & Widodo, 2015). Many ways can improve students' mastery of concepts, including using a conceptual change approach strategy.

Conceptual Change Text (CCT) is an alternative strategy that can be selected to improve students' understanding through existing stages by using concrete examples and scientific explanations of the material discussed (Guzzetti et al., 1997; Ozkan & Selcuk, 2015). Lesson planning and presenting students' misconceptions about certain materials or teaching materials will assist teachers in delivering a more meaningful learning process, including the states of matter and their changes. Unfortunately, there are few conceptual change texts related to science material. Further, conceptual change text for this concept has yet to be available, which is the reason that underlies the need for this research to be carried out—even though there are systematic examples of conceptual change text (Syuhendri, 2017).

In response to this, the author developed a conceptual change text for prospective elementary school teacher students, i.e., the Conceptual Change Text–Material and Changes (*Teks Perubahan Konseptual–Materi dan Perubahannya*, henceforth *TPK-MP*). It is important to prepare elementary school science teachers who can reform their teaching (Kier & Lee, 2016). Furthermore, a strategy for planting the right concepts is needed to replace the old concepts in teaching because misconceptions are difficult to correct even though they have followed formal education (Yürük & Eroğlu, 2016). Therefore, teachers must be ready with a good understanding and make reasonable plans to deliver teaching materials to improve students' understanding and learning outcomes. In line with that, Utari (2010) states that the process of debriefing prospective science teachers needs to be considered and improved. Therefore, this paper raises the problem, i.e., how to develop the *TPK-MP* that can improve prospective primary teachers' concept understanding and meet the valid, practical, and effective criteria.

LITERATURE REVIEW

One strategy to approach a concept change is the Conceptual Change Text (CCT). In conceptual change texts, students are explicitly asked to provide predictions for a situation and then misconceptions and scientific explanations of the problem (Aydin, 2012; Balci, 2006; Chambers & Andre, 1997; Özmen & Naseriazar, 2018; Şahin & Çepni, 2011). Conceptual change texts determine students' misconceptions, clarify their reasons, and explain why they are wrong using concrete examples (Guzzetti et al., 1997; Ozkan & Selcuk, 2015). CCT can be integrated with the Predict-Observe-Explain (POE) technique (Ültay et al., 2015).

In the CCT, there need to be stages of conceptual change (Setyaningrum & Sopandi, 2015). There are several forms of CCT: three, four, and five elements or stages. The three elements include (1) identifying misconceptions in students through asking questions, (2) presenting students' alternative concepts and scientific explanations, and (3) presenting scientific concepts with examples (Aydin, 2012; Cetingul & Geban, 2011; Demircioglu, 2009; Özmen, 2007; Ültay et al., 2015). The four elements are (1) identification of students' prior knowledge through presenting a phenomenon, (2) presenting the limitations of concepts that students have that do not apply to certain phenomena, (3) presenting evidence, and (4) presenting scientific concepts that can explain the phenomena previously presented (Beerenwinkel et al., 2011; Setyaningrum & Sopandi, 2015). The five elements include (1) identification of possible student errors, such as pictures and questions where students are asked to write down the answers, (2) a table presentation of common misconceptions and wrong answers, such as moody emoticons, (3) serving correct answers with explanations in the form of text or text explanations with videos, accurate answer tables with smiling emoticons, (4) student assessments and opinions about the content of reading, and (5) follow-up questions or situations and problems new (Çepni & Çil, 2010; Ozkan & Selcuk, 2015). The Material and Changes CCT model developed in this study synthesizes the above models. The synthesis results of the CCT model are used as an accompanying element in the process of changing concepts (from misconceptions to true conceptions), as until now, there is no standard form of conceptual change text (Setyaningrum & Sopandi, 2015).

METHODS

Model Development

This research used Borg and Gall's (1989) Research and Development model and was summarized into Four-D: define, design, develop, and disseminate (Thiagrajan et al., 1974). However, this research did not reach dissemination. Therefore, preliminary studies and small-scale trials were conducted in one of the PGSD study programs in West Java involving one class with 45 students. For the comprehensive test, the participants were fourth-semester students in the PGSD study program in the Moluccas, applying two classes (33 and 30 students, respectively). The location was selected because the study program had never conducted similar research.

Procedure

The research procedure is as follows. First, define the activities carried out include (1) a literature study related to relevant learning theories, teaching materials, circulating CCT forms, relevant research results, and related regulations in higher education (Permenristekdikti Nomor 44/2015 concerning National Standards for Higher Education, SNPT) (Menristekdikti, 2015), (2) field studies by observing lecture activities in class, and (3) needs analysis through distributing questionnaires and interviews to students and lecturers. Then, the design includes (1) designing CCT on the states of matter and their changes, which could improve students' conceptual mastery according to the results of previous research, (2) writing the CCT on the states of matter and their changes framework adapted to the research that had been carried out, and (3) making the first CCT on the states of matter and their changes product and its validation sheet. Developing activities are as follows: (1) expert validation of the CCT on the states of matter and their changes; (2) improvement of the initial product, improvement and rewriting CCT on the states of matter and their changes, (3) small-scale feasibility trial, (4) product revision based on the results of trials and discussions with validators, (5) wide scale feasibility test, (6) analysis of improving student learning outcomes on the material being studied, (7) significant product improvements, and (8) rewriting CCT on the states of matter and their changes as the final product. The final product is a product that is socialized and can be widely used (Ghufron et al., 2007). The flow or procedure of development research is shown in Figure 1.

Data Collection

Research instruments were in the form of tests and non-tests. The test was carried out at the beginning (pretest) and the end of the lecture (posttest). Non-test consisted of observation sheets, questionnaires, a list of interview questions for lecturers and students, and validation sheets.

Data Analysis

Quantitative and qualitative techniques were used for data analysis according to the type of data obtained. Furthermore, it was concluded in a detailed description (Sulastri et al., 2022) and was directed to answer the research questions above. The model criteria (CCT on the states of matter and their changes) were developed to fulfill validity, practicality, and effectiveness (Nieeven, 1999). Validity was by looking at the percentage of validation scores. Validation (TPK-MP) by three validators

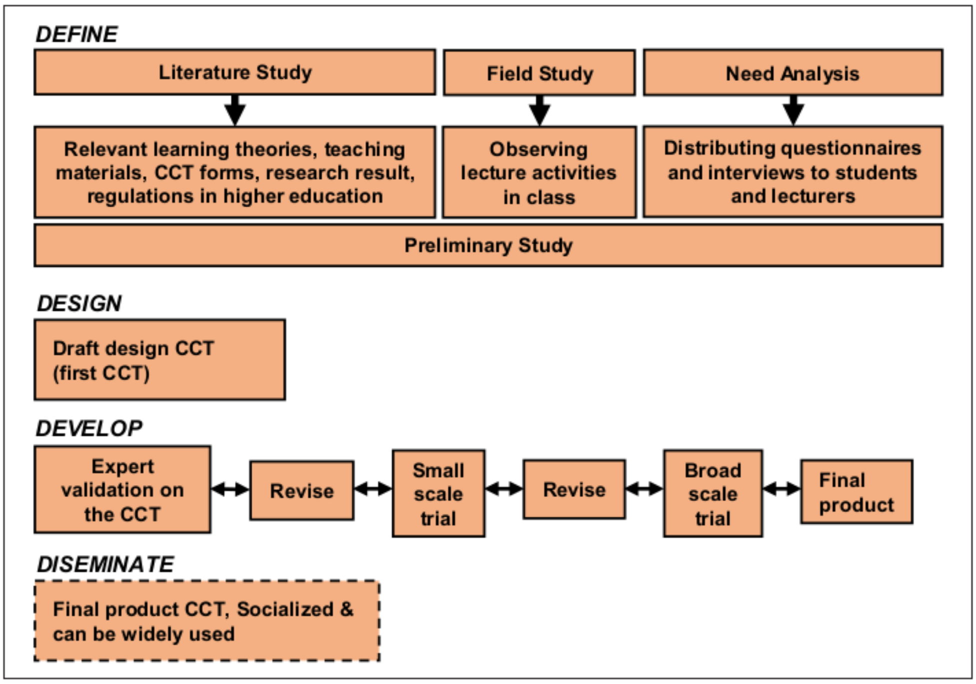

Figure 1. CCT research and development flow

uses a validation sheet covering aspects: characteristics, presentation, and scope of CCT. These aspects are assessed by giving a score (4, 3, 2, 1) and giving notes. For example, the characteristics of CCT include the presented text that reveals misconceptions in students, raises dissatisfaction, cognitive conflict, intelligible, plausible, and fruitful conditions. Practicality by looking at the score of the implementation of the model in the classroom, and effectiveness by looking at the positive responses of students and learning outcomes (Lestari et al., 2015). The normalized gain formula from Meltzer (2002) was used to calculate the increase in students' understanding. Normalized gain = (posttest score–pretest score)/(maximum possible score–pretest score). With the N-gain category, namely: Low ($g < 0.30$), Moderate ($0.30 \leq g < 0.70$), and High ($g \geq 0.70$).

The validity of expert validation (involving one chemist, one chemical education expert, and one guidance and counseling expert) employed the following formula. Validity = (total validation score of 3 validators/maximum total score) x 100%. Matching the validity criteria (Akbar, 2013 as quoted in Fatmawati, 2016), namely: Invalid (01.00–50.00%), Less valid (50.01–70%); Quite valid (70.01–85.00%); and Very valid (85.01–100%). The formula calculated the implementation of the Semester Study Plan (RPS). RPS implementation value = (total score obtained)/(number of items assessed). Furthermore, the values obtained were classified, namely: Very less (0.0–1.5), Less (1.6–2.5), Good (2.6–3.5), and Very good (3.6–4.0). Student response analysis was conducted by looking at the percentage score from filling out the questionnaire. The responses are considered positive in learning if the percentage gets closer to one hundred percent (Prasetyo et al., 2007, as cited in Fatmawati, 2016). Classification of learning outcomes (cognitive) is very low, low, high, and very high (Mardapi, 2008) with a range of scores: Very low (0–20); Low (21–40); Medium (41–60); Heigh (61–80); and Very high (81–100). The summary of the instruments and data analysis techniques is shown in Table 1 below.

Table 1
Instrument and data analysis technique

No.	Aspects	Activity	Resource	Analysis Technique
1	Validity of instrument	*judgment expert*	Instrument validation results by three experts	Percentage, criteria matching, detailed description
2	Practicality	Implementation in class	Implementation questionnaire, observation sheet, interview results (student responses)	RPS implementation score, criteria matching, detailed description
3	Effectivity	Pretest, Post-test	Pretest and posttest scores of students in the experimental and control group	N-gain scores, descriptive statistics, inferential statistics (two ways Anova) matching the classification of learning outcomes.

RESULTS

Preliminary Study

The development began with a preliminary, and six pieces of information were obtained. First, there were two forms of reading materials related to the states of matter and their changes: independent study materials or dictating and training modules for the classroom teacher for Science published by the Ministry of Education and Culture (Pusat Pengembangan Profesi Pendidik, 2012). Second, the results of previous research illustrated that the concept of science, including the concept of states of matter and their changes, has not been fully understood by teachers and prospective teachers well (Banawi et al., 2017, 2018; Jaelani, 2015; Sopandi et al., 2017). Therefore, it was necessary to improve this understanding. Third, conceptual change theory, constructivism theory, social learning theory, and POE strategies could be utilized in the development. Fourth, CCT on the states of matter and their changes in equipment needed to be harmonized with higher education regulations (Permenristekdikti Nomor 44/2015 concerning SNPT). Fifth, the results of the field study revealed that there were teaching materials for Basic Science Concepts in which they explained the states of matter and their changes within the duration of one meeting. However, no unique reading material, such as CCT, was on the states of matter and their changes. Therefore, of course, this was an opportunity for the CCT to be made. Sixth, the needs analysis results using a need assessment questionnaire show that the teaching materials provided by the lecturers had helped the students to learn certain concepts (64.43%) but had not been maximized (100%). In addition, the results of student and lecturer interviews show a need for the students and lecturers to teach materials that could provide sound knowledge on the concept of states of matter and their changes.

Until now, there is no standard form of conceptual change text (Setyaningrum & Sopandi, 2015). However, there are four things in CCT: (1) the existence of phenomena that are presented to determine students' prior knowledge and misconceptions, (2) the situation is presented to show that the student's concept is not following the existing phenomena, (3) proving the wrong concept from students, and (4) the existence of scientific concepts that are presented to explain the phenomena discussed. The preliminary research results were then used as material in designing the draft of the product (Hanif, 2020).

The draft of CCT on the states of matter and their changes (TPK-MP) was a synthesis of several forms of CCT. The discussion covered four topics: discontinuous properties of matter, dynamic properties of particles, particle properties, and changes in the shape of objects. The contents for each topic presentation included (1) presenting questions that supported the occurrence of cognitive conflicts. The students were asked to write answers to the questions on the sheet provided, (2) presentation of the misunderstanding table with negative emotions, (3) the content of the material was accompanied by the presentation of correct examples or activities and concepts, (4) student's assessment of the content of the reading text that was appropriate/not and the writing of student's personal opinion, (5) follow-up questions to test students' understanding, and (6) the presentation of the correct answer table with smiley emoticons.

The design of CCT on the states of matter and their changes (TPK-MP) was embodied in the initial printed form of Draft-1. Three validators or experts validated the draft. One improvement note was related to the order in which the four topics' indicators were presented. Some of the validation results are summarized in Table 2.

The mean score of the states of matter and their changes (TPK-MP) validation is described in the previous section (data analysis). Based on the validity criteria, the Draft-1 result met the valid criteria. However, according to the notes and suggestions from the validator, revisions were made to the draft to obtain Draft-2, which could be used for small-scale testing (Rudibyni et al., 2020).

Trials of Small Scale

Small-scale trials were carried out in one class (45 students) and were carried out in 4 meetings. In addition, one observer was involved in observing lecture activities. Several notes on the trial results include the student's understanding of specific topics that needed to be strengthened and emphasized in the CCT on the states of matter, their changes and the reading materials. Reading materials are required to be distributed to students after the initial test for reading assignments. Furthermore, improvements were made, including its presentation, to increase the final test score and N-gain from the previous (0.40). The average of each element is then matched with the categories or criteria in the data analysis section. Several test results are summarized in Table 3.

Trials of Broad Scale

The existing improvement notes were used to revise Draft-2 to obtain Draft-3 for wide-scale testing. The comprehensive test was

Table 2
Validity of CCT on the states of matter and their changes

Material	Average	Category
CCT on the states of matter and their changes	95.32	Very valid
1. Characteristics Text of Conceptual Changes	94.05	Very valid
2. Material presented	92.59	Very valid
3. Content coverage:	99.31	Very valid
a. Suitability	100	Very valid
b. Scope	97.92	Very valid
c. Depth	100	Very valid

Table 3
Trials of small-scale CCT on the states of matter and their changes

No.	Materials	Average	Category
1	Learning completion	3.93	Very good
2	Learning assessment	3.52	Good
3	Students' response	87.50%	Positive
4	Learning outcome		
	a. Final score test	69.04	High
	b. N-gain	0.40	Medium
	c. Conception Changes	55.16%	Medium

carried out in two classes: experimental (33 students) and control (30 students), with 4 meetings in each class. In addition, three observers were involved in observing lecture activities. Some of the results of large-scale trials are summarized in Table 4.

The practicality was analyzed from the results of the observation sheet by looking at the score of the lecture implementation and the lecture's assessment. Table 4 shows that the average score for each aspect is 4.00 (outstanding category) and 3.56 (the suitable type). Thus, based on Nieveen's (1999) criteria, the CCT on the states of matter and their changes in Draft-3 met the practicality criteria because lecturers could use it in classroom learning.

The effectiveness of CCT on the states of matter and their changes (TKP-MP) model used in learning needs to be assessed.

Table 4
Trials of broad-scale of CCT on the states of matter and their changes

No.	Materials	Average	Category
1	Learning completion	4.00	
2	Learning assessment	3.56	Good
3	Students' response	86.74	Positive
4	Learning outcome		
	a. Initial test (experiment)	24.11	Low
	b. Initial test (control)	22.79	Low
	c. A score of the final test (Experiment)	43.09	Medium
	d. A score of the final test (control)	26.84	Low
	e. N-gain (experiment)	0.26	Low
	f. N-gain (control)	0.20	Low
	g. Conception Changes (experiment)	57.40%	Medium

The effectiveness was done by looking at the test results (pretest and posttest) and interviews. The final test results of the experimental class showed a score of 43.09 (Medium category). This value was 18.98 points higher than the initial test, with an average N-gain of 0.26 (Low category). According to the results of statistical tests (two ways ANOVA) using SPSS software version 20, the experimental group's increased understanding (N-gain) was significantly different ($p = 0.001$) from the control group's increased understanding. The experimental class learning outcomes category was moderate based on the classification of cognitive abilities made by Mardapi (2008). The score of the practical class was higher when compared to the control. Interviews with randomly selected students were conducted at the end of the lecture to determine the response to the developed CCT on the states of matter and their changes. From the interviews, information was obtained that CCT on the states of matter and their changes supports students' understanding. The following are some of the results of the interviews (Table 5).

Thus, the developed CCT on the states of matter and their changes met the effectiveness criteria to improve the students' understanding. It was evident that the developed CCT on the states of matter and their changes (Draft-3) could improve the student's learning outcomes and a positive response from students and had fulfilled all existing aspects, namely validity, practicality, and effectiveness.

Table 5
Some results of interviews with students

Researcher	:	*Question-1*	*Did this course reduce your scientific fallacies?*
		Question-2	*Does the course Materials and Its Changes using Conceptual Change Text improve your mastery of concepts?*
		Question-3	*From your experience, what activities are not possible in this lecture?*
Student-1	:	*Answer-1*	*Much less when talking about the wrong concept.*
		Answer-2	*Yes. Mastery of concepts can be increased.*
		Answer -3	*All activities are still possible to be carried out.*
Student-2	:	*Answer-1*	*Yes. My confusion about the concept of science diminished.*
		Answer-2	*Yes, through this course, I can improve my concept mastery of materials and their changes.*
		Answer-3	*All activities can be carried out.*
Student-3	:	*Answer-1*	*Much less.*
		Answer-2	*Yes. I get improvement from this course.*
		Answer-3	*Mastering all materials.*

DISCUSSION

Based on the research and development carried out, the Conceptual Change Textbook–Matter and Its Change (TPK-MP) has been tested valid, practical, and effective for improving the understanding of prospective elementary school teachers. The book can be used as reading material to strengthen students' understanding of the basic science concepts in the *PGSD* (Primary School Teacher Education) or *PGMI* (Islamic Primary School Teacher Education) Study Programs. It is in accordance with the results of previous research (Dewi, Sudiatmika & Wiratma, 2019) using a modified development model resulting in science learning tools about matter classification and its changes that are valid, practical, and effective. The resulting CCT can be an example of developing CCT in other science materials. CCT is valid and practical in remediating misconceptions and effectively increasing students' understanding of concepts.

Teachers practically use CCT in classes with many students, where teachers are likely to deal with only some misconceptions and each individual. Teachers can use CCT as additional teaching material and ask students to read it (several times) during lessons or outside class hours (Caroline et al., 2018; Syuhendri et al., 2021). TPK-MP is a moment of study and educational practice for prospective elementary school teacher students. The learning activities they have gone through are learning experiences (Hasim, 2019). The understanding given through reading materials is expected to equip students with the substance of science teaching materials with better knowledge of prerequisites and learning strategies. Understanding the prerequisite concepts is the basis for understanding the next concept (Johnson, 1998; Oktaviana, 2017). The good experiences they get are a provision for them so that they are expected to be able to imitate and apply the learning that has been experienced before in other situations. The study results indicate that educators tend to imitate and apply learning that has been experienced before in the workplace so that they will apply their professional knowledge and good experience in teaching science practice to students in the future (Chan & Elliott, 2004; Hashweh, 1996; Subramaniam & Harrell, 2013).

Like a development product, besides having advantages, it also has limitations (Sari et al., 2019). The resulting CCT on the states of matter and their changes has several limitations, such as the activities carried out are only aimed at improving the prospective elementary school teacher students' concept mastery, and not all the material discussed in the book can be mastered by all students. There is also the possibility of information bias among the students because the control and experimental groups are in the same study program. In addition, the experimental activities, or activities in the CCT on the states of matter and their changes, require the support of practicum equipment according to the number and needs of students and lecturers.

One of the weaknesses of CCT on the states of matter and their changes in its implementation is that not all students can master the concepts discussed in the book well. Therefore, it is necessary to sort out the material; the material that students have not mastered is further strengthened and discussed more deeply to overcome this. The content of reading materials must be sorted out to separate those which are important and need to be presented from those which are just additional knowledge (Hadiyanti & Widodo, 2015; Kurniansyah & Irianto, 2021). In addition, implementing CCT on the states of matter and their changes takes a long time. Dual Modes programs can be used to overcome this problem. Lectures combine scheduled face-to-face and independent learning by studying the text at home (Kadarohman & Nurihsan, 2008; Wardani et al., 2019). The limitations of practicum equipment can be overcome through the presentation of practicum or laboratory activities in the form of learning videos, as it can save observation time and minimize the use of tools/materials on a large scale (Izzania & Widhihastuti, 2020). Efforts to avoid information bias among students can be made through a blinding system, not telling the research subjects (student groups) to which group they belong. The blinding process is applied in research to prevent bias (Sapeni et al., 2020). In addition, the control and experimental groups are in the same study program and accreditation level but in different locations.

CCT on the states of matter and their changes is a conceptual change approach strategy to increase students' understanding of the material and its changes. In the text, there are concrete examples to (1) convince students that they have misunderstandings about scientific facts in the material discussed, (2) remediate misconceptions, and (3) provide scientific explanations of existing situations (Guzzetti et al., 1997;

Ozkan & Selcuk, 2015; Syuhendri et al., 2021). Conceptual change does not come entirely from reading the text alone but also from the reader's interaction with the textual information in the reading. The construction of meaning occurs when the information presented in the text is related to their knowledge and/or through the modification of knowledge by students (Adi & Oktaviani, 2018). Through the use of CCT on the states of matter and their changes, there is a process of conceptual change as a series of assimilation and accommodation processes for the students. The process of conceptual change starts with the process of assimilation and then accommodation. For the accommodation process toward conceptual change to occur, four supporting conditions are needed: dissatisfaction, intelligible, plausible, and fruitful (DIPF) (Okotcha, 2018; Posner et al., 1982; Rohmah & Virtayanti, 2021; Syuhendri et al., 2019).

Lecturers must act as mediators and facilitators to support the concept change process. This role can be realized in learning with a constructivist approach, as follows: (1) expressing students' initial conceptions by asking them to express their opinions about a concept, (2) facilitating group discussions so that there is cognitive conflict and motivation to seek explanations of opinion differences, (3) assisting students in constructing their conceptions, (4) directing and providing opportunities for students to apply their conceptual understanding (Saguni, 2019). In addition, CCT on the states of matter and their changes in its application can be integrated with other models, strategies, or learning methods, such as Predict-Observe-Explain (POE), Refutation Text, and the Read-Answer-Discuss-Explain-Create (RADEC) Learning Model, to name a few.

It is reasonable considering that the text of conceptual change begins with a predictive question, where students predict answers with their existing knowledge. Predictions made by students are supported by an appropriate observation activity, followed by students explaining answers related to scientific questions (Ültay et al., 2015). Refutation text was chosen considering that there is a significant relationship between reading activities (reading comprehension) with science learning achievement and attitude (Celikten et al., 2012; Thacker et al., 2020). The RADEC learning model is proposed to be integrated with the CCT on the states of matter and their changes, considering that there are reading and other stages that support the creation of concept changes. This learning model can improve the quality of the process and learning outcomes (Siregar et al., 2020; Sopandi et al., 2019; Sukardi et al., 2021).

Therefore, further research that can be carried out can be related to other topics in science; different research subjects; learning outcomes, e.g., related to critical thinking skills and creative thinking; and or the form of presentation of TPK-MP for elementary school teachers through in-on model training (Slameto et al., 2017).

CONCLUSION

TPK-MP, developed using research and development methods, meets the criteria of being practical, valid, and effective in increasing concepts mastery of prospective elementary school teachers on the topic of matter and its change. However, like product development, apart from having advantages, it also has limitations. To improve the concept mastery of prospective elementary school teachers, TPK-MP can be used as material for lectures on Basic Science Concepts in the *PGSD* and *PGMI* Study Programs. However, this research also implies that further research is needed to determine the effectiveness of lectures in a dual-mode system that uses TPK-MP as an independent study material.

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