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The Provision of Conceptual Change Text for Reducing Students' Misconceptions in The Physics Learning of Light During the Pandemic Covid-19

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ABSTRACT
Conceptual change is seen as a powerful teaching approach for developing 21st century skills. To determine the usefulness of delivering a conceptual change text for fostering conceptual change regarding light in physics learning at home during the pandemic, a quasi-experimental design was adopted, with one group pre-and posttesting. The participants are 23 eighth-grade students from SMPN 2 Ledo Bengkayang, a public secondary school in the rural region, who were recruited using an intact group random selection technique. A diagnostic test was provided, which included nine multiple-choice items and two distractors, as well as supporting arguments. This study discovered that students' beliefs regarding light and the process of vision vary significantly. After treatment, pupils' misunderstandings were reduced by 26.80%. After receiving the CCT, students had a considerable conceptual shift, and the CCT's effectiveness was sufficient (gain mean = 0.58). To get more effective results, CCT should be used in conjunction with any other teaching approach or model. A scientific teacher should exemplify a conceptual transformation method in the classroom.

INTRODUCTION

The conceptual restructuring that enables students to create alternative explanations congruent with scientific ideas is one of the essential instructional strategies in learning science to anticipate the twenty-first century [1] [2]. Students at all levels, from preschool to college, participate in education with a variety of common sense but inaccurate interpretations of scientific principles [3] [4]. These misconceptions are widely investigated in many disciplines and can be produced through the interpretation of occurrences that occur and include the surrounding environment [5]. Some of these beliefs are ingrained deeper than others, making them more resistant to change, long-lasting, universal, and impeding future learning [6] [7] [8]. Because the nature of misconceptions makes traditional and rote learning difficult to change [9], conceptual reform tactics must be adopted. In research domains, efforts to discover and correct students' misconceptions are still popular [10] [11]. Studies on students' and teachers' conceptions are among the most important areas of scientific education research because (mis)conceptions play an active role in teaching and learning [12]. As a result, in physics education, detecting students' misconceptions and restructuring of ideas is critical [13].

Light and sight are two basic scientific notions, especially in physics [14]. Understanding these principles is essential for students to learn physics effectively. As a result, researchers in various nations have concentrated on students' perceptions of light and sight. Armağan [15], for example, undertook a comparative study of students' misconceptions about light in New Zealand, Western Australia, France, Sweden, and the United States three decades ago. Several line drawings illustrating objects such as a candle, a heater, and the moon were used to quiz 349 children (10-15 years old) regarding their understanding of light. The majority of children believed that light does not travel at all, and that the distance traveled by light was determined by whether it was visible or not.

The study by Uzun et al. [16] involved a number of the participants, including 30 eighth grade primary school students, 26 eleventh grade secondary school students, and 42 student teachers (all from Turkey) concluded that they were unable to explain light-related phenomena in scientific terms and had misconceptions about light, light sources, and the sight process. Rochim et al. [17] also found that amount of 31% of the eighth grade students at SMPN 7 Kediri were unable to correctly sketch light traveling when the eye perceives an object. According to von Aufschnaiter and Rogge [18], many students believed that in order to perceive something, one must stare at it numerous times and that one cannot see anything on the back of one's head. As indicated previously, several studies have found that students at all levels, from primary to university, and from all nations, have misconceptions regarding light and sight. The research found that the majority of individuals had varying degrees of light misunderstanding, implying that their light misunderstandings remained. Science teachers in schools dealing with a variety of genuine learning situations and environments should diminish or eradicate these myths. Hanson and Seheri-Jele [19] argued that identifying students' misconceptions allows teachers to plot and plan an instructional intervention. For achieving optimal learning in physics, T. Tokuhama-Espinosa identified five pillars, as cited Demkanin et al. [20], that can be complementary to models of learning teacher used. These five pillars--symbols, patterns, order, categories and relationships are stimuli should be used in orderly way.

From the preliminary survey test consists of 3 items of sight process and formation of the image on the plan mirror administered to 13 eighth grade students of SMPN 2 Ledo Bengkayang, it was found the most misconceptions are: (1) All (100%) students believed that seeing is an active eye process in which light travels from the eye to an object; (2) the majority (95%) of students believed that the image of the object on the plane mirror is accurate; and (3) the majority (90%) of students believed that the image of an object is on the (plan) mirror. This study focuses to reduce these misconceptions. The majority of students have trouble reading and comprehending physics textbooks. The physics teacher's preferred, and often only, learning approach in class is rote learning (memorization). The accomplishment of minimum mastery standards is simply overemphasized in classroom physics (KKM). Moreover, during pandemic Covid-19, in the academic year 2020/2021, there was no offline (face-to-face), only online teaching-learning process at the school. Some educational practitioners argued that these conditions enable many students will experience loss of learning. In addition, the school is located in a rural region and lacked instructional facilities. The internet connections often are not working well. Due to these obstacles, online learning could not be implemented. However, the students were asked to get the teacher-tasks directly at the school. These actual learning contexts and environments triggered us to overcome the problem by designing a conceptual change text (CCT) used to reduce the students' misconceptions about light sources and sight process.

CCTs (Conceptual Change Texts) are scientific texts that are designed to confront and correct learner misconceptions. They differ from standard textbooks in that they encourage students to consider their thinking and identify any errors in their mental models. Only knowledge is included in traditional writings [21]. In contrast to refutation texts [22], which are also often used to promote conceptual change, CCT is a simpler and easier method for teachers to assess students' understanding and interest in a subject topic. According to Çaycı [23], conceptual change texts include questions that activate learners' initial concepts (knowledge), current misconceptions, and explanations, case studies, examples, visuals such as images and/or pictures, and scientific explanations that show what the relevant misconceptions are. As a result, conceptual change texts can be said to adhere to the qualities of conceptual change principles. By participating in CCT in this study, students were enable to feel some dissatisfaction with their previous notions, the intelligibility of a new thought, the first plausibility of a new conception, and the fruitfulness of a new conception. Posner et al. [24] argued that these are four prerequisites for conceptual change. In light of the circumstances, the use of CCT in this study was thought to be totally reasonable for overcoming obstacles and promoting conceptual change.

There have been a number of previous research on the implementation of CCT for reducing the students' misconception in physics learning. For example, Hesti et al. [25] found that using CCT might minimize 19,6 percent of students' misconceptions about direct current electricity. The overall effect size for CCTs was assessed as 1.18 (in high category). CCTs have proven to be more successful than traditional training in this regard. This outcome is congruent with the findings of Anam et al. [26], who used a one-group pre-and posttest design and found that before CCT treatment, the majority of elementary teachers had misconceptions about how metal particles grow when heated. The teachers' verbal and visual representation increases dramatically after receiving the treatment, and their verbal and visual representation reaches 100%. Sukmawati et al. [27] developed teaching materials based on conceptual change text (CCT) on redox materials for basic chemicals on the redox idea in their R & D research. They found that the CCT might help senior high school students get an 85 mean score in chemistry. Balci et al. [28] investigated the effects of the 5E Learning cycle combined with conceptual change texts and traditional instructions on 8th-grade students' understanding of photosynthesis and respiration in plants. After the treatment, they found that the experimental and control groups had statistically significant variations in attitudes toward science and test scores. Based on the tracing investigation, we discovered that providing CCTs is quite rational for minimizing misconceptions about light and the process, notably in the pandemic Covid-19.

The study's main purpose was to assess how effective serving the CCT was at decreasing students' preconceptions about light and the visual process. The objectives of this study are to: (1) describe the conception profile of students before and after serving of CTT in the pandemic Covid-19 period and its reduction; (2) analyze the significance of students' conceptual changes after serving of CTT learning; and (3) investigate the extent of effectiveness to which serving of CTT in the pandemic Covid-19 period reduced students' misconceptions.

METHOD

A one-group pretest-posttest design was used in this quasi-experimental study [29]. During the 2020/2021 academic year, the study's target populatiom was all eighth-grade students at SMPN 2 Ledo in Bengkayang District, West Kalimantan, Indonesia, who held misconceptions about light and sight. The sample of 23 children from class VIII-A was chosen using an intact group random selection approach. The diagnostic test consists of 9 multiple-choice items with two distractors and reasons that support the results on the parallel Pretest and Posttest (each with a 45-minute time limit). The diagnostic test consists of four indicators: (1) explaining the concept of the (natural and artificial) source of light, which consists of 1 item (*number 1*); (2) explaining the concept of perfect and diffuse reflection of an object which consists of 1 item (*number 2*); (3) explaining the process of sight an object which consists of 2 items (*number 3 and number 4)*; (4) sketching the diagram of sight which consists of 1 item (*number 5*), and (5) explaining the properties of the image of plan mirror which consists of 3 items (*number 6, number 7 and number 8*), and (6) sketching the formation of the virtual image of plan mirror which consists of 1 item (*number 9*).

Two instructional nterventions with one set of CCT each were given to the students for the take-home individual learning material was regarded as the treatments. The pretest was given a week before the first learning of the subject matter (first intervention). A week after the second intervention, the immediate posttest was given. The item numbers on the diagnostic exam were randomly replaced to prevent data bias. The diagnostic test employing Kruder-Richardson (KR-21) had an empirical test reliability of 0.63. (in sufficient category). The validity of CCT was determined by expert assessment, which included the material's applicability for scientists' concepts, the problem's suitability for the recognized misperception, language clarity, and text presentation. The text of the refutation was deemed to be appropriate (average total score between raters was 3.59; in high category).

There will be no teaching-learning process (online and offline) during the pandemic Covid-19 era (2020/2021 academic year) due to the school's rural location, poor internet connections, and the fact that the majority of pupils do not own a computer or smartphone. There was no offline (face-to-face) or online teaching-learning process at the school during the pandemic Covid-19. Individually, the students learned from their households. They requested to come to school on school days to obtain teacher assignments depending on the lesson plans.

Based on the barriers mentioned above, the stages of this study regarding the giving CCT are described as follows:

- A week before the first treatment, all the students involved in this study were asked to attend a school for administering the Pretest, with an allocation of 45 minutes (nine items of a diagnostic test). They used a masker and were separated at a distance of 1 meters long.
- *First*, the teacher asked students to get the first CCT (CCT-1) individually at school. The teacher distributed the copied CCT-1 to every student. They were asked to learn individually or collaboratively the material seriously at their home. They also were asked to answer the questions of the worksheet based on the simple experiment they executed. The material for conducting the experiment is very familiar, available in their surroundings, and well-recognized by the students, e.g., an ex-noodles box, a bright flower or another object, and a knife. No laboratory apparatuses were needed.
- *Second*, after completing the task of CCT-1, then the teacher asked students to get the second CCT (CCT-2) individually at school. The teacher distributed the copied CCT-2 to every student. Again, they were asked to learn individually or collaboratively the material seriously at their home. They also were also asked to answer the questions of the worksheet based on the second simple experiment they did. They just prepare a plan mirror, a plastic ruler, and a candle. Again, no laboratory apparatuses were needed.
- A week after their last treatment, all students were requested to return to school for the posttest, which was scheduled for 45 minutes (nine items of a diagnostic test). They requested the use of a masker and were separated by 1 meters.

The structure of the CCT developed in this study has three main sections (referred to Çaycı [22], Posner et al. [23], and Anam et al. [25]). The first section elicited students' prior conception. The students posed a problem they should answer (*elicitation of ideas*). The second section contained some scientific explanations about the concept the student read. Then, the students are guided to conduct a simple experiment by using a worksheet. The experiment enables students to structure their (mis)conceptions or ideas that are not consistent with the scientific concepts and show what relevant misconceptions are *(restructuring of ideas*). In the last section, some novel problems were provided that should be explained or answered (*application of ideas*).

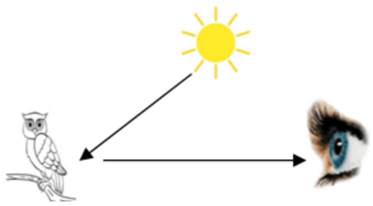
The profile of conception was determined using a simple percentage calculation, and descriptive statistics were employed to reduce misconceptions. The relevance of conceptual change (changes in students' thoughts that were previously misconceptions into new conceptions that are better in line with scientific principles) was investigated using the McNemar test of nonparametric statistics [30]. The gain mean's value and classification are used to assess the treatment's efficacy of Durlak [31].

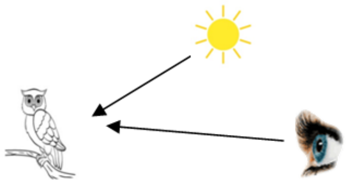
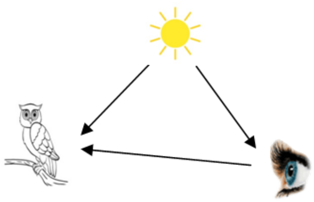
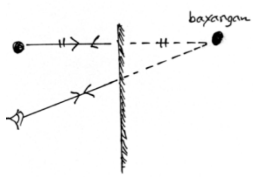
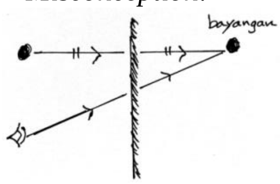
RESULTS AND DISCUSSIONS

Profiles of Students' Conception and Reduction of Misconceptions

The pre- and post-test profiles of students' perceptions of light and the visual process, as well as the decrease of misunderstandings, are shown in Table 1. It was determined that some students' conceptions were scientifically valid, while others were designated as misconceptions, based on the study of the answers (reasons) about the students' notions of the concepts. The profiles of students' conceptions and reduction of misconceptions about light is shown in Table 1.

Table 1. The Profiles of Students' Conceptions and Reduction of Misconceptions about Light

Students' conceptions	Pretest (n=23)		Posttest (n=23)		Reduction (%)
	n	%	n	%	
Indicator 1					
• *Consistent with the scientific concept:* An object is known as a (natural or artificial) source of light if it emits the light by itself.	5	21.74	21	91.30	-
• *Misconception:* The only one source of light object is the sun.	18	78.26	2	8.69	69.57
Indicator 2					
• *Consistent with the scientific concept:* Light travels in the straight direction. When a beam of light strike a rough surface, not a mirror, it will reflect the rays to all directions (a diffuse reflection will oocur)	6	26.08	17	79.49	-
• *Misconception:* When a beam of light strike an object, it will reflect the rays to only one straight direction (that make a shadow).	12	52.17	5	21.74	30.43
• *Misconception:* Light does not travel at all and it will absorb the rays that make an object become heater.	5	26.74	1	4.25	22.49
Indicator 3					
• *Consistent with the scientific concept:* We can see an object because there is a source of light strikes an object and the object will reflect it reaching our eyes.	10	21.74	34	73.91	-
• *Misconception:* We can see an object because eye emits a ray (beam of light) reaching the object. So, we still can see an object in a fulldarkness room.	28	60.86	9	19.56	41.30
• *Misconception:* Light does not travel at all and it will absorb the rays that make an object become heater.	8	17.39	3	6.52	10.87
Indicator 4					
• *Consistent with the scientific concept:* 	5	21.74	18	78.26	-

Students' conceptions	Pretest (n=23)		Posttest (n=23)		Reduction (%)
	n	%	n	%	
• *Misconception:* We can see an object because our eyes emit light strikes an object. 	11	47.83	3	13.04	34.79
• *Misconception:* 	7	30.43	2	8.70	21.73
Indicator 5					
• *Consistent with the scientific concept:* The image of an object of plan mirror has equal size to the object, has equal distance to the object from the mirror, virtual, and upright.	19	27.54	40	57.97	-
• *Misconception:* The image of an object of plan mirror located on the mirror and real (because we can see the image).	27	39.13	12	17.39	21.74
• *Misconception :* The image of an object of plan mirror is real and upright.	23	33.33	17	24.64	8.69
Indicator 6					
• *Consistent with the scientific concept:* 	*3*	13.04	7	30.43	-
• *Misconception:* 	14	60.87	12	52.17	8.70

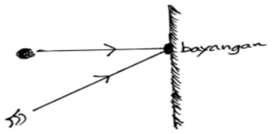
Students' conceptions	Pretest (n=23)		Posttest (n=23)		Reduction (%)
	n	%	n	%	
• *Misconception:* 	6	20.09	4	17.39	2.70
Average of misconception	-	42.46	-	17.64	24.82

Table 1 shows the number (%) of students who hold the scientific belief that "an object is known as a (natural or artificial) source of light if it emits light by itself". *For indicator 1*, there were 18 (78.26 percent) students who had the misunderstanding about a source of light before the treatment (in pretest). They assumed that the sun was the only source of light (a natural object). There were only 2 (8.69 percent) left after learning at home using the CCT (at posttest). This conclusion was similarly consistent with Heywood's findings [32] demonstrated that students were aware of light and related phenomena but lacked a thorough comprehension of them. The participants, particularly the primary children, believed that the moon was a source of light when it came to the question of the light source. Although the concept of a source of light was taught in 5th grade elementary school, most students had misconceptions. This conclusion is consistent with the characteristics of misconception, which are change-resistant and long-lasting.

For indicator 2, the number (%) of students who have a scientific notion can be shown "Light moves in one way only. When a beam of light strikes an object that is not a mirror, the rays are reflected in all directions (diffuse reflection) ", Prior to intervention (in pretest), 17 pupils (78.91%) were found to have misunderstandings. However, after learning at home with the CCT, it was discovered that 6 (25.99%) of the misconceptions remained. The percentage of misconceptions has decreased by 52.92 percent. According to Lestari et al.[33], amount of 5 (16.67%) elementary pupils had a misperception about whether diffuse reflection happens on plain white paper. The pupils in the Thailand high school study also showed major misconceptions about the direction of light propagation, how light refracts at an interface, and how to calculate the position of an image, even after teaching [33]. According to several studies, the majority of elementary students believed that "the distance the light moved from the candle would depend on whether it was day or night" and that "light cannot spread during the day" [16].

For indications 3 and 4, the number (%) of students who believe "We can see an object because a source of light strikes an object and the object reflects it when it reaches our eyes" can be observed. Pretest revealed that 36 (78.25 percent) of pupils had misconceptions. They assumed that we can see an object because the eye emits a ray (light) that reaches it, and that we can perceive an item even in complete darkness. Another misunderstanding is that the light of eight (17.39 percent) pupils does not travel at all, and it absorbs the rays that cause an object to become a warmer. However, after learning at home with the CCT, it was discovered that 12 (26.08 percent) of the misconceptions remained. The percentage of misconceptions has decreased by 52.17 percent. Because of these misunderstandings, the drawing they make of the visual process contradicts scientific beliefs. In the Pretest and Posttest, it was discovered that 18 (78.26 percent) and 5 (21.74 percent) pupils, respectively, had a diagram of a process of sight that was contradictory with scientific ideas. This conclusion is consistent with the findings of Osborne (1980), as stated by Anam et al. [25], who discovered 349 students (10-15-year-olds) assumed tha light does not travel very far, hence the distance traveled by light was determined by whether it was day or night. According to Kuczmann [35], misconceptions can cause problems and prevent students from learning more about natural scientific courses. They are founded on irrational and superficial considerations.

For indications 5 and 6, the number (%) of students who believe that "the image of an object in a plan mirror has the same size as the object, has the same distance from the mirror as the object, is virtual, and upright" can be shown. In pretest, it was discovered that 50 (72.43 percent) of students' beliefs contradict scientific beliefs. The students said that the picture of a plan mirror object is located on the mirror and that the image is real (because we can see the image). In the posttest, this profile of misconceptions decreased to 29.03 percent. This investigation also demonstrated that not all pupils correctly depicted the seeing process. Even if their drawings were correct, the majority of secondary school pupils (77 percent) were unable to explain the visual process in an appropriate manner [31]. According to their pictures and descriptions of the sight process, these inaccuracies were "light goes out from the eyes to the object in the process of seeing" and "light goes out from the eyes to a source in the process of sight." Another prevalent misconception is that light moves from a light source to an object that we can see. In this explanation, participants ignored the light reflected from the object reaching the eyes. Teachers needed opportunities to develop their content-specific knowledge in science, technology, and physics in order to assist them in properly teaching key ideas and overcoming misconceptions [36]. This finding is also relevant to the findings of Kaltakci-Gurel et al. [36], who found that 13 (25%) of students had difficulty with the ray model, the role of the observer in natural and virtual image formation and observation processes, and the role of the screen in image formation and observation processes in three different universities across Turkey. Because of these misunderstandings, they created a sketch of the virtual image generation in a plan mirror that was incompatible with scientific concepts.

In the pretest and posttest, it was discovered that 20 (80.96 percent) and 16 (69.56 percent) students' ideas of a process of sight of the virtual image of plan mirror were inconsistent with scientific conceptions, respectively. According to Favale and Bondani [38], most senior high school students have misconceptions concerning ray tracing, image generation in reflection, and refraction.These misunderstandings are ubiquitous and appear to be based on some incorrect beliefs and explanatory models that are not corrected by curricular courses at school. They also discovered some false explanations for the phenomenon in textbooks and on the internet. The majority of inaccuracies arise in the accompanying explanatory pictures.

This study found that not all students who precisely sketched the sight process could describe it in a meaningful and scientific manner. According to their pictures and descriptions of the sight process, these inaccuracies were "light goes out from the eyes to the object in the proc This was further supported by Heywood's [31] findings, which indicated that even when students were asked to justify and explain their positions, they were unable to formulate scientifically acceptable responses, despite selecting or sketching the proper scientific depiction of the visual process. Participants in the study made assumptions about how they saw. The majority of primary school children (77%) accurately depicted the process of sight, as did half of science student teachers (50%) and the majority of physics student teachers (79%) Despite the fact that their drawings were accurate, the seeing process was not well described to the majority of secondary students.ess of seeing" and "light goes out from the eyes to a source in the process of sight."

The findings of this investigation, as shown in Table 1, revealed that some forms of light misunderstanding still exist. This makes sense, given that some beliefs are difficult to alter or resistant to change. Students' associative thinking, which is influenced by daily events, might lead to misunderstandings. Incorrect intuition might lead to misunderstandings. Students share thoughts regarding the plan mirror image based on their inner sentiments rather than reasoning. The findings of this investigation, as shown in Table 1, revealed that some forms of light misunderstanding still exist. This makes sense, given that some beliefs are difficult to alter or resistant to change [16][22]. Students' associative thinking, which is influenced by daily events, might lead to misunderstandings [38]. Incorrect intuition might lead to misunderstandings. Students share thoughts regarding the plan mirror image based on their inner sentiments rather than reasoning. One of the reasons for these outcomes could be the teaching style used throughout their school years, thus new teaching tactics to enhance significant learning would need to be proposed. According to Chi [35], a refutation or conceptual modification text can fix a single incorrect thought. Misconceptions, according to Kuczmann [34], are linked to the structure of knowledge. Misconceptions can also be formed when the root of the inaccuracy is the incorrect assessment of facts. These examples demonstrate how different approaches to physical problems can lead to incorrect conclusions. These examples demonstrate how different approaches to physical problems can lead to incorrect conclusions. As a result, the ability to ask a meaningful question about a situation is critical. Good questions focus our attention on the core of the problem, while bad questions divert our attention away from it.

Students' Conceptual Change and Effectiveness of CCT

The McNemar test was used to investigate the impact of CCTs on students' conceptual changes regarding light and visual process. Table 2 shows the preparation and results. The total frequencies of couple conceptions on the pretest and posttest are shown in Table 2. For example, cell A (-,+) represents the number of students who had a misconception on the pretest but were able to correct it on the posttest. On the pretest and posttest, Cell B (+,+) represents the number of students who have a conception that is consistent with the scientist's conception. On the pretest and posttest, cell C (-,-) represents the number of pupils who have a misconception. Cell D (+,-) indicates the number of students who had a pre-test conception that was compatible with the scientist's notion and then had a post-test misperception. So, in Table 2, score 13 indicates that 13 students had a misperception on the pretest but were consistent with the scientist conception on the posttest. Score 3 explains that on the pretest and posttest, three students had conceptions that are consistent with the scientist's conception. The preparation (cells) and results of McNemar test is shown in Table 2.

It was concluded from Table 2, χ_o^2 (83.06)>χ_{table}^2(3.84), that students had a considerable conceptual change or reorganization of concepts about light and sight after receiving the CCT. Furthermore, g = (24.82/42.46) = 0.58 is the average value of the whole major gain (in the sufficient category). It was also determined that the CCT's effectiveness in eliminating pupils' preconceptions about light fell into the adequate category. The findings of this study also revealed that there was a considerable reduction in student misunderstandings (26.80%). The findings of this study are consistent with Armağan et al.[15], meta-analysis's of 42 published papers published between 1995 and 2010, which found that the overall effect size for CCTs was assessed to be 1.18. According to Cohen's criteria, this is a large impact size. CCTs were discovered to be extremely effective in increasing pupils' academic progress. Furthermore, no statistically significant differences were discovered in terms of the kind of assessment instrument, study origin, topic matter, style of instruction, school level, sample size, type of instrument, publication date, or treatment length. In the context of energy in chemical reactions, Kirik et al. [39] discovered a statistically significant mean difference between the experimental and control groups in terms of students' CCT total mean scores. As a result, this research found that conceptual change text training improves comprehension and achievement. To analyze conceptual change text, Rohmah and Virtayanti [40] utilized a one-group pretest-posttest design with 18 students. With an effectiveness percentage of 97.76 percent, they found that it was successful in eliminating acid-base misunderstandings.

Table 2. Preparation (Cells) and Results of McNemar Test

Indicators			**Pretest** -	**Pretest** +	χ_o^2
1. Explain the concept of (natural and artificial) source of light	*Posttest*	+	13	3	11.07
		-	7	0	
2. Explain the concept of perfect and diffuse reflection of an object	*Posttest*	+	15	5	10.56
		-	2	1	
3. Explain the process of sight an object (*two items*)	*Posttest*	+	26	4	18.89
		-	14	2	
4. Sketch a diagram of the process of sight.	*Posttest*	+	18	3	16.05
		-	2	0	

Indicators			Pretest -	Pretest +	χ_o^2
5. Explain the properties of image of plan mirror and sketching the formation of virtual image of plan mirror (*three items*)	*Posttest*	+	28	10	12.97
		-	25	6	
6. Sketch a diagram of the formation of virtual image of plan mirror.	*Posttest*	+	5	2	3.20
		-	16	0	
Total	*Posttest*	+	109	27	83.06
		-	66	9	

χ^2_{table} = *3.84*

The misconceptions of 28 (60.86) students were that the eye emits a ray (light beam) that reaches the target, and so we can perceive an item in full darkness. They believed that the image of a plan mirror object on the mirror was real since they could see it. Another common misunderstanding or ambiguous explanation is that light passes from a light source to an item, and we see the object. Participants ignored the light reflected from the object reaching the eyes in this explanation.

These misunderstandings, according to Treagust [38], can be generated by students' association thinking and incorrect intuition impacted by daily experiences. Without thinking rationally, students intuitively share opinions regarding the picture of a plan mirror based on their inner sensations. These beliefs are resistant to change, can endure a lifetime, are universal, and prevent further learning [6] [16] [23]. Furthermore, it is important to remember that even when conceptual shift occurs, learners do not fully relinquish their former beliefs. As a result, conceptual change is not assured nor always a conclusion. Teachers should not be discouraged if their initial attempts to assist conceptual shift are not entirely effective, but rather view the process as ongoing and dynamic. The literature indicated that light was a challenging notion to grasp [41] and this was also the case in this study. This indicated that science, technology, and physics teachers needed opportunities to expand their content-specific pedagogical skills in order to effectively teach certain ideas and address misconceptions. Clinical interviews could be used to elicit extensive information about the students' perceptions of light and associated topics.

Finally, experts and researchers [43] [44] cited Posner et al. theory, which stated that for conceptual change to occur, four conditions must be met: (1) dissatisfaction with the (initial) conception that is owned (dissatisfaction), (2) the new concept is easier to understand (intelligibility), and (3) the new concept is easier to understand (fruitful). Based on the fundamental theory, we can explain why CCT is effective as a tool for conceptual change because: (1) it eliminates students' initial (mis)conceptions that they used to explain the problem they faced; (2) it presents some learning activities that allow students to construct a new understanding and restructure new ideas in a way that is easy to understand, makes sense, and is coherent; and (3) it allows students to apply the new conceptions. According to Carey [45], one of the various approaches to engage students' first knowledge is to issue a warning about a potentially incorrect initial conception. The text can be better understood if this initial knowledge is activated. Students employ existing content to filter, understand, organize, contemplate, and establish links with new knowledge while reading the CCT [25]. To increase pre-service teachers' achievement in the course of physics, Demkanin & Novotná [46] used scaffolding strategy. They concluded that the use of scaffolding in the process of experiment was much more effective than pure modelling, pure instructing or pure explaining. It also helps to better communication between students and the teacher.

CONCLUSION AND SUGGESTION

The profiles of misconceptions students have about light and sight differ significantly. This study also discovered that after receiving CCT, pupils' preconceptions about light are significantly reduced, and the amount of its effectiveness is sufficient. It means that in order to achieve more effective results for conceptual change, science teachers should combine CCT with another strategy. In schools, a conceptual change plan should be explicitly represented. Teaching physics topics should also emphasize hands-on activities rather than merely academic explanations. In addition to conceptual change strategy, physics could use scaffolding approach, in one particular topic of one course. It is assumed to be more effective compared with pure modelling, pure instructing or pure explaining. It helps to better communication between students and the teacher. This study has limitations because to the presence of unpredictable factors such as CCT readability, students' reading capacity, individual learning from home during the Covid-19 epidemic, and personal motivation in physics. These elements might be considered for investigating further.

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