Journal of Turkish Science Education, 2021, *18*(2), 290-303.
DOI no: 10.36681/tused.2021.66

Journal of Turkish Science Education
http://www.tused.org
© ISSN: 1304-6020

Promoting Students' Conceptual Change by Integrating The 3-2-1 Reading Technique with Refutation Text in The Physics Learning of Buoyancy

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ABSTRACT
Conceptual change is assumed to be a potential teaching pedagogy to prepare the skills for anticipating the 21st century. A quasi-experimental method with pre-and post-test control group design was applied to examine the effectiveness of integrating the 3-2-1 reading technique with refutation text on students' conceptual change of buoyancy. The subjects consist of 39 eleventh grade students of senior high school which was drawn by using intact group random sampling technique. The diagnostic test consisting of nine items of multiple choice with two distractors followed by supporting reasons was administered. The study found various profiles of students' misconceptions of buoyancy. The reduction of students' misconceptions after the treatment was 54.71%. A significant conceptual change of buoyancy occurred among students after the treatment. The extent of effectiveness of the treatment was high (gain mean = 0.82). Science teaching should intentionally model a conceptual change strategy in schools.

ARTICLE INFORMATION
Received:
26.12.2019
Accepted:
15.01.2021

KEYWORDS: *The 3-2-1 reading technique, refutation text, conceptual change.*

Introduction

Exploring students' misunderstandings about how the world really works until they have the opportunity to build alternative explanations is one of the 21st century skills and regarded as a pivotal teaching pedagogy in learning science (Nadelson et al., 2018; Saavedra & Opfer, 2012; Schroeder, 2016).Before participating in teaching and learning activities, students initially have a prior conception (Gunstone & White, 1981; Kendeou & van den Broek, 2007) that can be formed from the interpretation of phenomena that occur and involve the surrounding environment (Coetzee & Imenda, 2005). These alternative conceptions are not in accordance with scientific concepts and are generally called misconceptions (Chi, 2015) and very common in many areas of science. Student misconceptions can be long-lasting, are resistant to change, universal, and inhibit further learning (Suparno, 2013; Lassonde et al., 2016). Given the nature of misconception is difficult to change with traditional and rote learning (Stylos et al., 2008), the use of conceptual change strategies (Posner et al., 1982; Palmer, 2003; Read, 2004) needs to be considered. Efforts to identify and change students' misconceptions are still trending in research fields (Chang & Chang, 2010; Cavas, 2015; Nussbaum et al., 2016). Hanson & Seheri-Jele (2018) argued exploring students' misconceptions enables the teacher to strategize and create a relevant learning context.

Many basic misconceptions contribute to confusion regarding why objects sink and float (Radovanović et al., 2019). Despite its complexity in science, sinking and floating is a phenomenon about which students of almost all grades develop personal theories, using a variety of conceptual elements such as weight, volume, shape, and density, prior to classroom teaching (Palk et al., 2017).

Some previous studies (Harniyati, 2015; Mulyani, 2015) also found a variety of students' misconceptions on static fluids. For example, Harniyati (2015) found that 20 (100%) students considered the greater or narrower the area of the appearance of the vessel, the greater the air hydrostatic pressure would be. Mulyani (2015) reported that 22 (57.89%) students consider that if the density of objects to be greater than the density of liquid substances, then the objects will float. The results of the Besson survey study (2004) using student tests involving 428 secondary school students (Italian and French), 458 prospective teachers (Belgian), and 58 teachers (Italy) also found variations in misconception findings on static fluids concerning density, Archimedes law, and buoyancy.

The preliminary study found that 77 (96.10%) of the total eleventh-grade students were having the minimum mastery criteria (KKM). From the survey test, it was found that students' misconceptions occurred in 3 (three) static fluids material indicators, namely: (1) explaining the effect on hydrostatic pressure; (2) explaining the effect of the volume of the immersed object on the buoyancy force; and (3) regulating the requirements of an object to be able to float and sink. These misconceptions are the target of this study. Most students are also having difficulties in understanding physics textbooks. They have a lack of confidence and quickly forget about the information they have read. Reading comprehension of learning texts is a neglected area in physics curricula. Rote learning (memorization) is the usual, often the only learning strategy, employed by many students at all levels. Learning in the school simply overemphasize the acquisition of subject matter.

Although most of the source of subject matters in schools are presented in textual representations, many learning problems faced by students are related to their inability to properly understand written learning resources (Westwood, 2007). Many students in the schools had difficulties gaining a deep understanding of the text they are reading. Difficulties in understanding textbooks are due to a lack of knowledge about reading and writing (making) notes (Laidlaw et al., 1993; Spiegel & Barufaldi, 1994). Weimer (2014) confirmed that students spend a lot of time reading but do not understand the contents of the reading they read. He recommended a planned intervention to improve students' reading comprehension. In contrast to SQ3R (Survey, Question. Read, Recite, and Review), for instance, the 3-2-1 reading technique is more simple and easy to apply by the teacher to check students’ understanding and interest in a subject matter. Therefore, the application of the 3-2-1 reading technique in this study was regarded as quite rational to overcome the contextual problems by conducting remediation learning.

The expected remediation activities could reduce students' misconceptions of buoyancy in this study are by implementing the 3-2-1 reading strategy. Several previous studies aimed at minimizing students’ misconceptions and testing its effectiveness had been carried out (Alsamadani, 2011; Chi,2005; Putri et al., 2017). Chi (2015) found that the use of the 3-2-1 strategy had a positive effect on students' reading comprehension, and was effective for promoting conceptual change. He suggested that its application should be integrated with the refutation text. Putri et al. (2017) confirmed that it provides an easy way for teachers to check for understanding and to gauge students’ interest in a topic. Sharing 3-2-1 responses is also an effective way to prompt a class discussion or to review material from the previous lesson.

Zygouris-Coe et al. (2005) stated that the 3-2-1 reading strategy was a reading strategy that requires students to participate in summarizing ideas from the text and encourages them to think independently and invite them to engage in the text. The 3-2-1 strategy involves three stages. *First,* from the reading text, students are asked (focused) to find three things (*3 things you discovered*). *Second*, based on these findings, students are then asked to express two interesting things (*2 interesting things*). *Third*, if it is felt or there is a concept that is unclear or not understood, students can ask it through a question (*1 question you still have*). The use of 3-2-1 reading techniques in this study was integrated with the refutation text.

Refutation text is a text that explicitly presents a misconception and then directly refutes it (Sinatra & Broughton, 2011). Refutation text in this study was developed based on the forms of misconception held by students on static fluids and the steps in reading strategies 3-2-1. Based on the misconception, students are likely to find a new (alternative) conception. This counter-conception is elaborated with a more logical explanation based on the conception of the scientist and is intended to make the (new) concept learned by students more intelligible and plausible. Some previous studies revealed that refutation text was effective in facilitating students' conceptual changes (Broughton, Sinatra, & Reynolds, 2010; Schroeder, 2016; Nussbaum et al., 2017). By integrating the refutation text with the 3-2-1 reading techniques carried out in this study, students were enabled to feel some dissatisfaction with their existing conceptions, the intelligibility of a new conception, the initial plausibility of a new conception, and the fruitfulness of a new conception. These are the four conditions for conceptual change (Posner et al.,1982).

From tracing study, the use of the 3-2-1 reading strategy integrated with refutation text aimed at reducing students' misconceptions on static fluids (particularly buoyancy) is far from being fully investigated. The main objective of this study was to examine the effectiveness of applying the 3-2-1 reading strategy integrated with refutation text on the reduction of students' misconceptions on buoyancy. Specifically, the objectives of this study are: (1) to know the conception profile of students before and after the treatment and reduction; (2) to analyze the significance of students' conceptual changes after remediation learning; and (3) to examine the extent of effectiveness of applying the 3-2-1 reading technique integrated with refutation text in reducing students' misconceptions.

Method

This study applied a quasi-experimental method with one group pretest-posttest design (Creswell, 2008). The target population was all students of eleventh-grade of public senior high school (SMAN 10) Pontianak-Indonesia enrolled in the 2015/2016 academic year who have misconceptions on static fluid (buoyancy)based on the survey test earlier taken by 77 students. The sample consisting of 39 students of class XIA was drawn by using an intact group random sampling technique. The diagnostic test on the parallel pretest with the posttest (with an allocation of 45 minutes) each consists of 9 multiple-choice items with two distractors followed by reasons that support the choice of answers. The diagnostic test consists of three indicators: (1) explaining the effect of depth on hydrostatic pressure which consists of 3 items, (2) explaining the effect of the immersed object volume on buoyancy which consists of 3 items, and (3) identifying the conditions for an object to be able to float and sink which consists of 3 items.

The treatment was given for three interventions with 2 x 45 minutes each in a week school day. The pretest was given a week before the first meeting. The immediate post-test was administered a week after the last intervention. To reduce the bias of the data, the item numbers of the diagnostic test were randomly exchanged. The empirical test reliability of the diagnostic test using Kruder-Richardson (KR-21) was 0.63 (insufficient category). The validity of refutation text used an expert judgment validity including the suitability of the material with the concept of scientists, the suitability of the problem with the misconception identified, language clarity, and presentation of the text. It was concluded that refutation text was appropriate (average total score between raters was 3.79; in high category).

The operationalization of the integrating 3-2-1 reading technique with refutation text in the treatments of this study is described below:

- *First,* the teacher asked questions related to the form of students 'misconceptions to be remediated and then provided temporary answers without further explanation to arouse students' curiosity. The teacher introduced the 3-2-1 strategy and explained the benefits of reading using the 3-2-1 strategy. Next, the teacher distributed the 3-2-1 strategy form and refutation text to each student. Students summarized 3 important things found (*3 things you discovered*). When doing this, students were not immediately invited to pay attention to the contents of refutation text in more depth, but were asked to write it in their own words. This was expected to reveal students' misconceptions explicitly. After reading refutation text in depth (slow, pausing, and reviewing), students were expected to be able to find counter conceptions (new concepts that are more scientific as alternatives). This stage is expected to lead to dissatisfaction with the initial conception. In addition, by summarizing the things that are considered important students can more easily understand the concepts learned.

- *Second,* after finding important things in the text, students wrote 2 interesting things (*2 interesting things*). The interesting things referred to at this stage are things that are strange-surprising, reasonable, and useful. This is intended to meet the conditions for conceptual change.
- *Third*, students wrote one question about the contents of the refutation text (*1 question you still have*). At this stage, students posed questions to clarify their understanding of the contents of the refutation text. Through this activity, the weaknesses of understanding (misconceptions) students still have could be identified and corrected in accordance with the form of students' misconceptions.

Data analysis to determine the profile of conception and reduction of misconceptions using descriptive statistics was a simple percentage calculation. Analysis to test the significance of conceptual change (changes in students' conceptions that were previously misconceptions into new conceptions that are more in line with scientific conceptions) used the McNemar test of nonparametric statistics (Siegel, 1997). The extent of the effectiveness of the treatment refers to the value and classification of normalized gain (Savinainen & Scott, 2002).

Findings and Discussions

Profiles of Students' Conception and Reduction of Misconceptions

Profiles of the conceptions and reduction of students' misconceptions about buoyancy in the pretest and posttest are presented in Table 1. Based on the analysis of the answers (reasons) about the conception of students on static fluids(buoyancy) material, it was found there were students' conceptions in accordance with scientific conceptions and which were classified as misconceptions.

Table 1

The Profiles of Students' Conceptions and Reduction of Misconceptions

Students' conceptions	*Pretest*		*Posttest*		Reduction
	n	%	n	%	
Indicator 1 *Consistent with the scientific concept:* Hydrostatic pressure on the same liquid is only determined by the depth and is not influenced by cross-sectional area.	23	58.97%	36	92.30%	-
Misconception: The amount of hydrostatic pressure is influenced by the vessel cross-sectional area.	15	38.46%	2	5.13%	86.67%
Misconception: The more liquid, the greater the hydrostatic pressure.	1	2.56%	1	2.56%	0
Indicator 2 *Consistent with the scientific concept:* The greater the volume of objects immersed in liquid, the greater the buoyancy experienced by objects.	0	0%	31	79.49%	-
Misconception: The greater the volume of objects that are above the surface of the liquid, the greater the buoyancy experienced by the object.	22	56.41%	0	0%	100%
Misconception:					

The more parts of objects that are in liquid, the greater the buoyancy it experiences.	3	7.69%	2	5.13%	33.33%
Misconception: The buoyancy force on an object is affected by the mass of the object.	6	15.38%	3	7.69%	50%
Misconception: The buoyancy force on an object is influenced by the density of the object.	8	20.51%	3	7.69%	62.50%
Indicator 3 *Consistent with the scientific concept:* The buoyancy force of an object is not determined by the mass of the object but is determined by the density of the liquid and the density of the object.	16	41.03%	36	91.31%	-
Misconception: Heavy or light shows a property of density.	23	58.97%	3	7.69%	86.97%
Average of misconception	-	66.67%	-	11.96%	54.71%

From Table 1, for indicator 1, it can be seen the number (percentage) of students who have a conception in accordance with the scientific conception that "hydrostatic pressure on the same liquid is only determined by the depth and is not influenced by cross-sectional area". Before learning remediation (in Pretest) there were 23 (58.97%) students and after learning remediation (at Posttest) there were 36 (92.30%) students. A total of 12 (38.46%) students, before learning, experienced a misconception, because they considered that "the amount of hydrostatic pressure is influenced by the vessel cross-sectional area". The number (frequency) of misconceptions was reduced to 2 (5.13%) students after remediation learning.

The findings of this misconception profile are consistent with the results of previous studies revealed by Harniyati (2015). Students assume the greater the cross-sectional area of the vessel, the greater the hydrostatic pressure, and there is also the opposite opinion, the smaller the cross-sectional area of the vessel, the greater the hydrostatic pressure. This form of misconception can be caused by reasoning or incomplete/erroneous reasoning that arises due to incomplete owned information that causes students to draw erroneous conclusions (Gunstone & White, 1981; Chi, 2005). Another misconception profile found was "the more liquid, the greater the hydrostatic pressure". This study found 1 (2.56%) student before the intervention having misconception and none (0 %) after the treatment. The findings comply with Utami's research (2014). He reported that students thought (thinking) that the amount of liquid would affect the amount of hydrostatic pressure. According to Treagust (2007), this misconception can be caused by their associative thinking which is influenced by daily experience. Experiences that despite different contexts can be associated by students with the concept of hydrostatic pressure, giving rise to a misconception.

For indicator 2 it can be seen the number (percentage) of students who have a conception in accordance with the scientific conception that "the greater the volume of objects immersed in liquid, the greater the buoyancy experienced by objects". This conception is in accordance with the conception of scientists which states that the extent of buoyancy experienced by objects in a fluid is proportional to the density of the fluid, the acceleration of gravity, and the volume of the immersed object ($F_a = \rho_f g V_f$). In the diagnostic test, the type of fluid and the acceleration of gravity are made the same, so that the buoyant force is only influenced by the volume of the immersed object. The greater the part of the immersed object in the fluid, the greater the buoyant force experienced.

Before intervention (in pretest), it is found that 39 (100%) students experienced misconceptions. However, after learning remediation, it is found that 31 (79.49%) students' conceptions were in accordance with scientific conceptions. Before remediation, 22 (56.41%) students experienced misconceptions, because they assumed that "the greater the volume of objects that are above the surface of the liquid, the greater the buoyancy experienced by objects". After remediation learning, this misconception can be reduced so that it becomes entirely (100%) in accordance with scientific conceptions. These findings are consistent with the results of Utami's study (2014). The possibility of misconception can be caused by students' associative thinking that is influenced by daily experiences (Treagust, 2007). For example, pressing a very floating object (the part that appears on a large surface) so that it sinks below the surface of the water feels more difficult than an object that isn't too floating (the part that appears on a small surface). Students associate the difficulty of submerging the object with buoyancy on the object. Or, students might assume the same buoyancy style pattern as the experience of lifting weights, namely; the stronger a person is, the higher he can lift weights. From this experience, students think (assume) that the greater the volume of objects that are above the surface of the liquid, the greater the buoyancy force applied to the liquid objects. Another misconception profile is, before learning, as many as 3 (7.96%) students think it says "the buoyant force on an object is determined by the overall object volume". Students only see the volume of objects as a parameter determining the buoyancy force without considering the floatation of objects in liquid. This misconception can affect because students mistakenly understand the symbol V_f (volume of immersed objects) in the equation$F_a = \rho_f g V_f$ and interpret it as the volume of the whole object. After remediation learning, this misconception can be reduced to 2 students (5.13%) students.

The finding is consistent with the findings of Gunstone and White (1981) that confirmed students often use mathematical equations to explain their predictions incorrectly. This study also found another misconception profile, namely: 'the extent of buoyancy force on an object is affected by the mass of the object ". Some students assumed that the smaller the mass of the object, the greater the buoyancy force, even though the problem did not provide information about the mass of the object. This finding is also in accordance with the results of previous studies by Utami (2014). Misconceptions like these can arise due to wrong intuition. Students spontaneously express ideas about buoyancy based on their inner feelings without thinking rationally. The number (percentage) of students who have this form of misconception before learning is 6 (15.38%) students, while after learning there are 3 students (7.69%). The concept of buoyancy is classified as an abstract concept that is not easy to be observed directly so that it allows many interpretations to occur when studying it (Yin, Tomita & Shavelson, 2008). Lucariello and Naff (2014) state that abstract concepts are very likely to cause misconceptions in students, even in adults.

Finally, for indicator 3 it can be known that before remediation learning, 16 (41.03%) students have a conception that is in accordance with the scientific conception that "the floatation of an object is not determined by the mass of the object, but is determined by the density of the liquid and the density of the object. Whereas after learning, students' conceptions that are in accordance with scientific conceptions become 36 students (91.31%). As many as23 (58.97%) students before learning and 3 (7.69%) students experienced misconceptions, because they thought that large or heavy objects would sink, while small or light objects would float. This finding is in accordance with the form of students' misconceptions expressed by Yin, Tomita, and Shavelson (2008). Misconceptions can be caused by students making several predictions in the form of explanations of observed phenomena, but they are not aware that the model (interpretation) they are making is wrong. From the results obtained, it can be concluded that previous ideas on the concept of density persist at the university level. This is especially critical in the case of students who will be future primary school teachers, where it is essential to master the basic concepts of the science curriculum in order to explain them adequately to their future students and identify their preconceptions. One of the causes of these results may be due to the teaching methodology received throughout their school years, so it would be necessary to propose new teaching strategies to promote truly meaningful learning.

The findings of this study indicate that the reduction of the average percentage of students' misconceptions is 54.71%. The variation in the percentage reduction in misconceptions can occur because the students' misconceptions may still be in the form of single ideas so that they are easier to correct. Meanwhile, the misconceptions that occur because the students are at the mental level of the model, are more difficult to correct. Chi (2005) asserts that a single wrong idea can be corrected through a refutation. Whereas, mental model defects will require some refutation, and severe misconceptions caused by misclassification of information need to be addressed according to a categorical level. The results showed that some forms of misconception still occurred. Of the seven forms of misconception, only one form of misconception can be eliminated thoroughly, while five other forms of conception are still found in some students. This is understandable considering that some misconceptions may be difficult to change or resistant to change (Suparno, 2013; Lassonde et al., 2016).

Students' Conceptual Change

McNemar test was used to examine the students' conceptual change of buoyancy. The preparation and results are shown in Table 2.

Table 2

Preparation (Cells) and Results of McNemar Test

Indicator			*Pretest* -	*Pretest* +	χ^2
1. Explain the effect of depth (*h*) on hydrostatic pressure (*Ph*)	*Posttest*	+	14	22	9.6
		-	2	1	
2. Explain the effect of the volume of the immersed object (V_f) on the buoyancy force (F_a)	*Posttest*	+	31	0	29.03
		-	8	0	
3. Identify the conditions for an object to be able to float, immerse, and sink	*Posttest*	+	20	16	18.05
		-	3	0	
Total	*Posttest*	+	65	38	51.16
		-	13	1	

Note. - : Misconception; + : Consistent with scientific concept ,and χ^2_{table} *= 3.84*

The scores in Table 2 are the total frequencies of couple conceptions on pretest and posttest. For example, the cell (-, +) means the number of students who have a misconception on the pretest and then have consistent with the scientist's conception on the posttest. So, score 14 in Table 2 explains that there are 14 students who have a misconception on the pretest and then have consistent with the scientist conception on the posttest. Again, score 22 explains that there are 22 students who have conceptions consistent with the scientist's conception on pretest and posttest.

From Table 2, becauseχ^2_o (51.16)>χ^2_{table}(3.84), it was concluded that there was a significant conceptual change in students on static fluids after havingbeen given remediation activities using a 3-2-1 reading strategy aided by refutation text. Furthermore, the average value of the total normalized gain*g* = 0.82 (in the high category). The results of this analysis also explained that the reduction of students' misconceptions (5.71%) is significant. It is also concluded that the effectiveness of the 3-2-1 reading strategy integrated with refutation text in reducing students' misconceptions on buoyancy was in the high category. The findings of this study are in line with several previous studies (Alsamadani, 2011; Chi, 2005; Tippett, 2010). which conclude that refutation text is effective for changing misconceptions and improving student learning outcomes. Refutation text is included in the effective, predict, and explain (POE) learning model (classified as the medium) to mediate student misconceptions (Mulyani, 2015). Alsamadani (2011) concluded that the use of 3-2-1 strategies had a positive effect on students' reading comprehension. From a meta-analysis of research results in the field of science applying refutation text, Broughton et al. (2010) conclude: "refutation text as a more effective learning tool in classroom science than traditional text for promoting science learning and conceptual change" (pp. 415).

To explain why refutation text is considered an effective tool in evoking conceptual change, experts and researchers refer to the theory of Posner et al. (1982), which explains that there are four conditions that need to be met in order for conceptual change to occur, namely; (1) there is dissatisfaction with the (initial) conception that is owned (dissatisfaction), (2) the new concept is easier to understand (intelligible), (3) the new concept is more plausible, and (4) the new concept is felt to be useful (fruitful). Nussbaum et al. (2017), for example, explains why reading using refutation text is effective as a tool for conceptual change, because: (1) it contains a metacognitive awareness that the initial conception (knowledge) is incompatible with scientific concepts; (2) presenting information (concept) in a way that is easy to understand, makes sense, is coherent; and (3) consider the nature or characteristics of the information to be presented.

A 3-2-1 prompt helps students structure their responses to a text and provides an easy way for teachers to check for understanding and to gauge students' interest in a topic. Sharing 3-2-1 responses is also an effective way to prompt a class discussion or to review material from the previous lesson (Broughton et al., 2010). In this study, the provision of refutation text considered effective in generating conceptual change can be explained by linking it with the 3-2-1 reading strategy and the terms of conceptual change as follows. *First*, refutation text introduces students' misconceptions. For example, "many people think that the amount of hydrostatic pressure is influenced by the vessel's cross-sectional area". This component is intended to activate students' initial knowledge about the misconceptions experienced. Tippett (2010) states that giving a warning about an initial conception that might be mistaken is one of the many ways to activate students' initial knowledge. Activation of this initial knowledge can produce a better understanding of the text (Kostons & van der Werf, 2015). In reading techniques 3-2-1, activating students' initial knowledge can be raised when students focus on finding three things (3 things you discovered) and expressing two interesting things (2 interesting things) in the text. This reading step-finding and understanding ideas, ideas, or information in the text and the relationship between ideas is considered important for understanding reading texts (Graesser, 2007). To find things or information desired, students use information already owned to filter, interpret, organize, contemplate and build relationships with new information (Snow, et al., 1998).

Second, refutation text explicitly refutes students' misconceptions. For example, "however, this thought or conception is actually wrong". This component can help students realize that their conceptions are wrong. In reading techniques 3-2-1, when students are asked to find three things (3 things you discovered) and express two interesting things (2 interesting things), in themselves (thoughts) they may appear dissatisfied with the conception in the beginning. This dissatisfaction is the basis for the process of conceptual change (Posner et al., 1982). *Third,* refutation text provides an explanation of scientific concepts. This component will cause cognitive conflict because at the same time refutation text presents students' misconceptions and conflicting scientific concepts. In this cognitive conflict situation, students are faced with three choices, including: maintaining the original conception, improving some of the conceptions (conceptual change, or replacing conceptions that are wrong with the new conceptions which are more in line with scientific conceptions). Students who choose to replace their conceptions with new conceptions are those who realize that the new concepts presented are more understandable, reasonable, and useful. When students feel there are things that they have not understood related to the explanation of new things or events or phenomena in daily life, they are asked to ask questions (*1 question you still have*). Asking questions to yourself and looking for answers in the text are cognitive processes and potential conditioning for students to be good readers (Torgesen, 2000; Westwood, 2001).

Considering that reading is an inherent learning activity in every student and subject, the learning process in schools should have an accompanying impact on improving reading skills. Bond et al. (1994) assert: "learning to read and reading to learn should develop together throughout the school years". Barton and Jordan (2001) asserted that reading is a learning activity to understand scientific content. To become citizens of science literacy, students need to be trained to read, write and repeat. Armbruster (1993) argued that reading texts involves the same critical thinking as when conducting "hands-on science" activities. Science and reading have a lot in common in terms of process skills. Although language has vital importance for science literacy, anyone is not free of miscomprehensions, misperceptions, or misconceptions that result from the usage of language (Chrzanowski et al., 2018) while reading a text.

In order to promote the students' conceptual change, Kural and *Kocakülah (2016)* recommended a new model for science teaching that instructors may consider implementing named, *Teaching Model for Hot Conceptual Change* (TMHCC).The teaching model supported by motivational and metacognitive strategies which follow the eight phases of learning syntaxes: (1) Motivating students to learn context; (2) Eliciting students ideas and preconceptions; (3) Overviewing which conceptions or prior knowledge will conflict with the discrepant event; (4) Creating a cognitive conflict; (5) Group work for expressing argumentation; (6) Introducing scientific concept; (7) Transferring new concept to different problems; and (8) Evaluation.

Finally, keep in mind that learners do not completely abandon their prior conceptions even when conceptual change has occurred. So, it means that conceptual change is not guaranteed, nor is it always an endpoint. Teachers should not be discouraged by their initial attempts to facilitate conceptual change if it is not completely successful, and instead consider the conceptual change process as ongoing and dynamic. It was necessary to point out the importance of acknowledging the existence of students' alternative conceptions, the applications of proper methods for their identification, and adequate teaching strategies aimed at overcoming them.

Conclusion and Implication

The profiles of students' misconceptions about buoyancy vary considerably. The study concluded that the students' misconceptions are reduced significantly. In addition, a significant conceptual change occurred and the extent of effectiveness of the 3-2-1 reading technique integrated with the refutation test was in the high category as well. It implies that science teaching should intentionally apply and model a conceptual change strategy in schools. The process for teaching physics concepts should also focus on minds-on activities, not purely theoretical explanations. It is possible to offer some recommendations related to the professional training of the model for teachers regarding promoting conceptual change in teaching-learning physics. These results have limitations due to the availability of uncontrollable factors regarding the level of readability of refutation texts, students' reading ability, and the unsuccessful students remediated as well as personal interest in physics. These factors might be considered for further investigation.

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Appendices

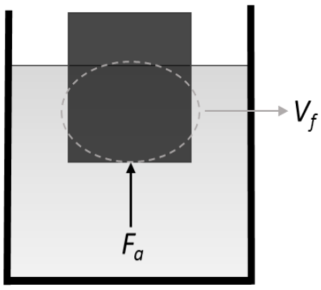
1. An Example of the Refutation Texts Developed in This Study

Buoyancy is the upward force exerted by a fluid on an object that is immersed in it. Some people believe that the more floating an object, the bigger the buoyant force on the object is. They think that objects float because the buoyancy force on the object is large, while objects sink because the buoyancy force on the object is small. However, this thinking is actually wrong. This thinking is different from the concept that is considered true according to scientists.

Consider the floating force equation below.

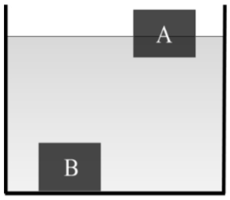
$F_a = \rho_f . g . V_f$

where: F_a = *Buoyancy force*
ρ_f = *Density of fluids*
g = *Gravitation acceleration*
V_f = *Volume of the immersed object*



Based on the buoyancy force equation above, we know that the one that affects the buoyancy that is experienced by objects is the volume of the immersed object *(V_f)*. That is, the more parts of objects that are in a liquid, the greater the buoyancy it experiences.

In some cases, large buoyancy may not necessarily make things float in the liquid. For example, like the case shown in the picture below.

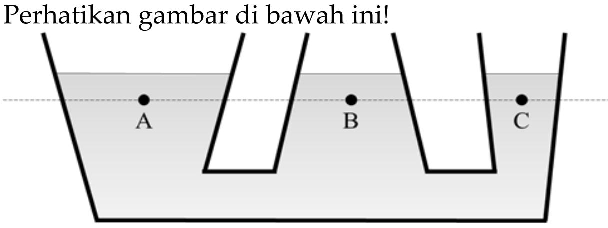


A container containing liquid and in it placed objects A and objects B. Object A has fewer parts immersed than object B. This means the buoyant force on object A is smaller than the buoyant force on object B. However, object A can float because it is made of material that is easy to float (small density), whereas object B is made from materials that are difficult to float (large density) so that although the buoyancy force is bigger, it is not enough to make it float. However, we can say that the buoyant force on object B must be greater than object A, because the volume of object B in liquid is greater than the volume of object A in water. In other words, the greater the volume of objects in the liquid, the greater the buoyancy that the object experiences.

2. A diagnostic Test of Buoyancy Developed in This Study (in Indonesian)

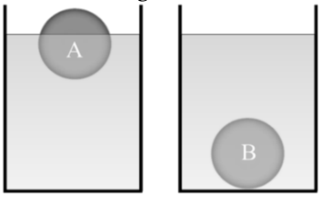
Pilihlah salah satu jawaban yang paling tepat, dengan memberi tanda silang (X) pada huruf A, B, atau C serta berikan alasannya!

1. Perhatikan gambar di bawah ini!



Pada bejana terdapat 3 titik yang berada pada kedalaman yang sama. Apabila zat cair di dalam bejana sejenis, di titik manakah tekanan hidrostatis paling besar?
A. Titik A
B. Titik B
C. Disemua titik sama besar
Alasan: ____

2. Perhatikan gambar di bawah ini!

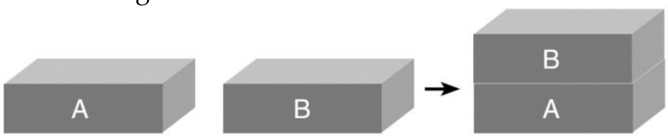


Bola A dan bola B memiliki volume yang sama dan diletakkan pada suatu bejana yang berisi zat cair yang sejenis. Manakah diantara kedua bola yang menerima gaya apung paling besar?

A. Bola A
B. Bola B
C. Dua-duanya sama besar

Alasan: ____

3. Perhatikan gambar di bawah ini!

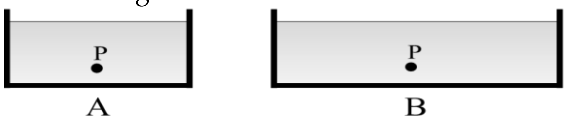


Balok A dan balok B mengapung di air. Misalkan kita lem keduanya dan menempatkan mereka ke dalam air, benda tersebut akan ...

A. Terapung
B. Melayang
C. Tenggelam

Alasan: ____

4. Perhatikan gambar dibawah ini!

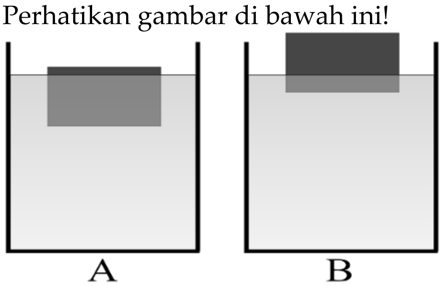


Jika kedua bejana diisi dengan zat cair yang sama, pada bejana manakah tekanan hidrostatis pada titik P paling besar?

A. Bejana A
B. Bejana B
C. Dua-duanya sama besar

Alasan: ____ ________

5. Perhatikan gambar di bawah ini!

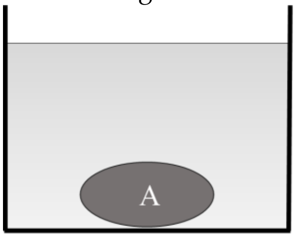


Jika bejana A dan bejana B diisi dengan air yang sama. Kemudian ke dalam setiap bejana di masukkan sebuah balok. Balok manakah yang mengalami gaya apung paling besar?

A. Balok yang berada di bejana A
B. Balok yang berada di bejana B
C. Keduanya mengalami gaya apung yang sama besar

Alasan: ____

6. Perhatikan gambar di bawah ini!

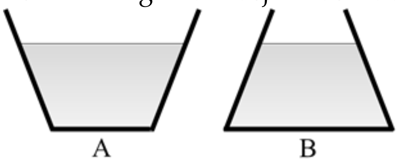


Seperti yang terlihat pada gambar di atas, benda A tenggelam di dalam air. Manakah cara yang tepat untuk membuat benda A mengapung?

A. Menambah massa benda A menjadi dua kali lipat
B. Mengganti air dengan zat cair lain yang memiliki massa jenis lebih besar
C. Memotong-motong benda A menjadi kecil-kecil agar lebih ringan

Alasan: ____

7. Perhatikan gambar bejana berhubungan di bawah ini

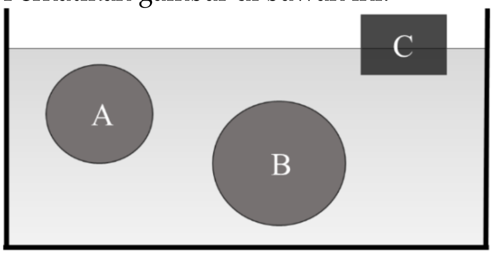


Bejana A dan bejana B diisi dengan zat cair yang sama dan dengan ketinggian yang sama. Bejana yang memiliki tekanan hidrostatis paling besar di bagian dasar bejana adalah?

A. Bejana A
B. Bejana B
C. Dua-duanya sama besar

Alasan:____

8. Perhatikan gambar di bawah ini!



Pada sebuah bejana berisi air rerdapat tiga buah benda yaitu: benda A, benda B, dan benda . Manakah pernyataan berikut yang benar tentang gaya apung yang dialami benda?

A. Gaya apung pada benda A > benda B > benda C
B. Gaya apung pada benda B > benda A > benda C
C. Gaya apung pada benda C > benda A > benda B

Alasan: ____

9. Sebuah benda X yang bermassa 10 kg tenggelam ketika dimasukkan ke dalam air. Benda X kemudian dikurangi massanya hingga menjadi 0,5 kg dan dimasukkan lagi ke dalam air. Bagaimana keadaan benda X?

A. Terapung
B. Melayang
C. Tenggelam

Alasan: ____