LEARNING THROUGH A MODULE BASED ON CONSTRUCTIVISM IN RECONSTRUCTION EFFORTS IN THE CONCEPT OF PLANT CELLS

Muhibbuddin[1*], Safrida[2], Cut Nurmaliah[3]

[1]Dr.,Universitas Syiah Kuala, Banda Aceh, Indonesia, muhib.bio@gmail.com
[2]Dr., Universitas Syiah Kuala, Banda Aceh, Indonesia, saf_rida@unsyiah.ac.id
[3]Dr., Universitas Syiah Kuala, Banda Aceh, Indonesia, cutnurmaliah@yahoo.co.id
*Corresponding author

Abstract

Misconceptions and alternative conceptions of the concept of plant cells are problems that always occur in students. Misconception is a mistake in understanding a concept, while an alternative conception is an understanding of an inappropriate concept. This case is experienced by many students caused by many factors. One of the contributing factors is the error in obtaining information about the concepts learned. Therefore, it is necessary to find the right learning strategy to solve these problems. This study aims to answer the question whether learning through constructivism-based modules is effective in reconstructing the concept of plant cells and improving learning outcomes. The method used in this study is Experimental one group pre-test post-test design. The research subjects were 80 students in one of the senior high schools in Aceh Besar District, Aceh, Indonesia. Research time for three months from February-April 2018. The parameters measured are the ability to reconstruct concepts and increase learning outcomes. Reconstruction of concepts that measure three aspects, namely reconstruction, understanding, and not understanding. Improved learning outcomes are measured by calculating the normalization of gain (n-gain). The instrument used is a constructivism-based module and an objective test with the CRI answer sheet. Data collection was conducted through pretest and post-test. Data analysis for concept reconstruction ability was carried out by percentage, while to compare improvements in learning outcomes were tested by two different test means using one sample t-test. The results showed that the ability to understand the concept increased 54.56%, did not understand 44.44% decreased, and misconceptions decreased 10.33%. The t-test results also show that there is a significant difference between pretest scores (initial ability) and n-gain score (final ability) at a significant level of 95% ($\alpha = 0.05$). The conclusion of this study is that learning through constructivism-based modules is effective in improving cell concept reconstruction capabilities and improving student learning outcomes.

Keywords: Module, Constructivism, Reconstruction, Cell Concepts,

1. INTRODUCTION

The misconception and alternative conception of the concept of plant cells is a problem that always occurs in students. The misconception is the misunderstanding of the concept, while the alternative conception is the lack of proper understanding of the concept (Xiaobao. 2006; Ibrahim, 2012). This case is experienced by many students caused by many factors. One of the causative factors is the error in obtaining information about concepts that students learn. One source of information about biological concepts that is used as a reference by students is a biology text book published by various types of publishers. The results of the analysis of textbooks from various publishers indicate that the presentation of biological concepts varies greatly (Adisendjaja, 2017). The presentation of diverse concepts will have an impact on the emergence of misconceptions and alternative conceptions. Many concepts experience misconceptions and alternative conceptions, namely concepts related to cell structure and function, diffusion, osmosis, and del chemical components (Mahardika, 2014).

Misconceptions and alternative conceptions certainly cannot be allowed to occur. If this is left unchecked, it will have an impact on understanding concepts that are not appropriate for students. Improving misconceptions and alternative conceptions of students is not an easy thing to do, it is necessary to find a solution to improve so that students are able to reconstruct the understanding of concepts that are wrong to understand the correct concepts. One alternative to correct misconceptions and alternative conceptions is through improving reliable learning strategies. Teachers as the main actors in the learning process are expected to be able to choose approaches, strategies, methods, and learning media accordingly to overcome the problem of misconceptions and alternative conceptions.

Another obstacle in overcoming misconceptions and alternative conceptions is the limited knowledge of science teachers in understanding biological concepts. More than 50% of 80 science teachers understand cell concepts as alternative conceptions (Muhibbuddin, 2015). In addition, limited books can be used as standard references in studying the concepts of plant cells. Efforts to identify and overcome alternative conception problems and misconceptions have been widely carried out (Adisendjaja, 2017; Arslan, et al., 2012; Antink-Meyer, & Meyer, 2017; Christianson & Fisher, 2010; Hasan et al., 1999; Haslam & Treagust, 2010; Kao, 2007; Karpudewan et al., 2014; Kumandas et al., 2018; Mahardika, 2014; Potgieter et al., 2010; Taber & Tan, 2010).

Studies in these studies only identify misconceptions and alternative conceptions that occur in students and teachers. While research related to the learning process to solve the problem of misconception and alternative conceptions is still very limited. However, several studies on the application of constructivist-based learning strategies to overcome the problem of misconceptions and alternative conceptions have been made (Al-Weher, 2010; Baviskar et al., 2009; Evergreen et al., 2016a; Evergreen et al., 2016b; Imamah, 2012; Kleickmann et al., 2013; Tang et al., 2012; Yustina & Kapsin, 2017).The results of these studies reveal that the application of constructivist-based learning can contribute well to the understanding of concepts by students. However, how the influence of the application of constructivist-based learning on concept reconstruction skills is still a question that needs to be answered. This study was conducted to answer the question of whether learning through constructivism-based modules is effective in reconstructing the concept of plant cells and improving learning outcomes.

2. RESEARCH METHOD

Method used in this research is experiment method with design one group pre-test post-test (Gall et al., 2003). Research design is as below.

Table-1: Experimental one group pre-test post-test design

Group	Pretest	Treatment	Post-test
Treatment Class	O_1	X	0_2

X = Learning with module based on constructivism
O_1 = Pre Test (before treatment)
O_2 = Post Test (after treatment)

The research subjects were 80 students in one of the senior high schools in Aceh Besar District, Aceh, Indonesia. Research time is three months from February-April 2018. The parameters measured are the ability to reconstruct concepts and increase learning outcomes. Reconstruction of concepts measured by three aspects, namely the reconstruction, understanding, and not understanding. Improved learning outcomes are measured by a normalized gain (n-gain) score. The instruments used are constructivist-based

modules and objective tests with the Certainty of Response Index (CRI) answer sheet. Data collection was carried out through pre-test and post-test.

3. DATA AND ANALYSIS

Data on pretest and post-test scores were tabulated, calculated on average and calculated the gain in a way look for the difference between the post-test score and the pretest score. The results obtained are then normalized using the formula from Meltezer (2002).

$$g = \frac{\text{post-test score} - \text{pretest score}}{\text{maximum possible score} - \text{pretest score}}$$

The concept comprehension data was analyzed through percentage calculations on the items that were answered correctly, which were answered incorrectly, the level of confidence chosen, and the accuracy of the reasons given. The results of the analysis are grouped into three categories, namely (1) understanding, (2) not understanding, and (3) misconception. The criteria used are as follows (Table-2). Data on learning outcomes improvement was analyzed through the average difference test between pretest score and n-gain score with t-test.

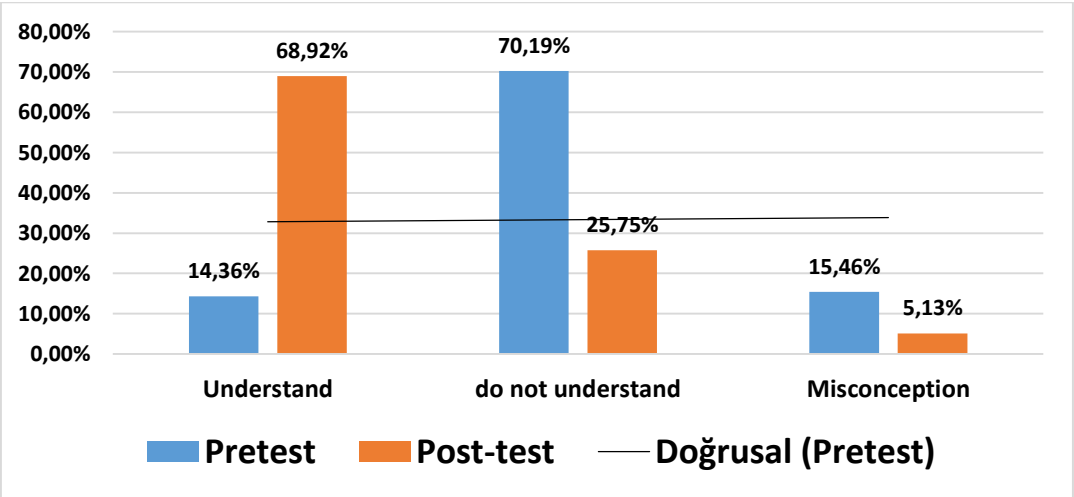
Table-2: Criteria Certainty of Response Index (CRI).

Answer	Reason	CRI	Category
True	Right	>2.5	Understand
True	Right	<2.5	Understand
True	Not right	>2.5	Misconception
True	Not right	<2.5	do not understand
False	Right	>2.5	Misconception
False	Right	<2.5	do not understand
False	Not right	>2.5	Misconception
False	Not right	<2.5	do not understand

(Hakim et al., 2012)

4. RESEARCH RESULT

4.1 Concept Understanding Analysis



The results of understanding concept analysis (Figure 1) show that understanding has increased, while not understanding and misconceptions are decreasing. Understanding criteria increased from 14.36% to 68.92% (increased 54.56%). Criteria for not understanding decreased from 70.19% to 25.75% (decreased by 44.44%), while misconceptions decreased from 15.46% to 5.13% (decreased by 10.33%).

Figure 1. The percentage level of understand, do not understand and misconceptions

The level of concept based understanding (Figure 2) shows that the students' initial knowledge (pretest) of all

cell concepts is very low (average 23.24%) compared to the final knowledge (post-test) on average reaching 93.60%. The lowest initial knowledge is the concept of cell transportation (9.05%) and the highest in the concept of cell chemistry (33.12%). The results of the measurement of final knowledge (post-test) show that concept understanding is increasing in all concepts (concepts of transportation, organelles, structure, and cell chemistry). The average increase in understanding reached 70.37%. The highest increase in understanding of the concept of cell organelles (57.98%) and the lowest in the concept of cell chemistry (42.10%).

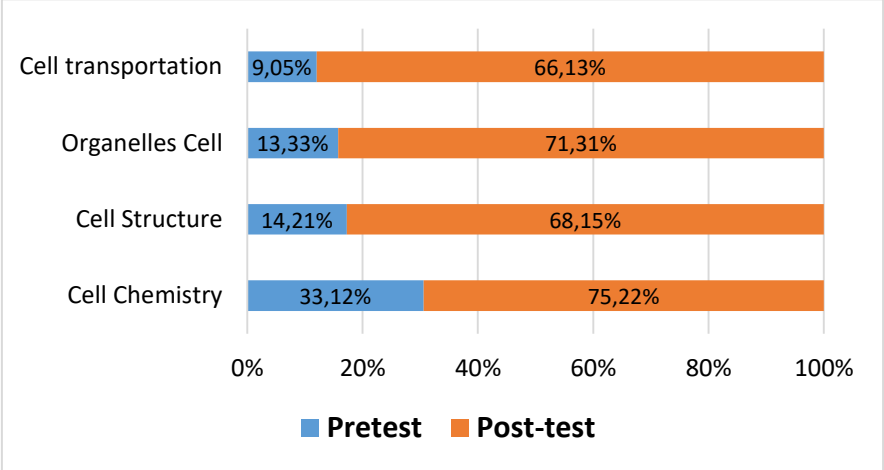


Figure 2. Percentage of understand category based on cell concepts

Students' prior knowledge (pretest) on concepts that are not understood very high (Figure 3). The average reached 66.55% compared to the final knowledge (post-test) an average of 24.80%. The highest concept that is not understood is cell transportation (50.08%) and the lowest cell structure concept (34.92%). The results of the measurement of final knowledge (post-test) showed that concepts that were not understood decreased in all concepts (concepts of transportation, organelle, structure, and cell chemistry), averaging 41.75%.

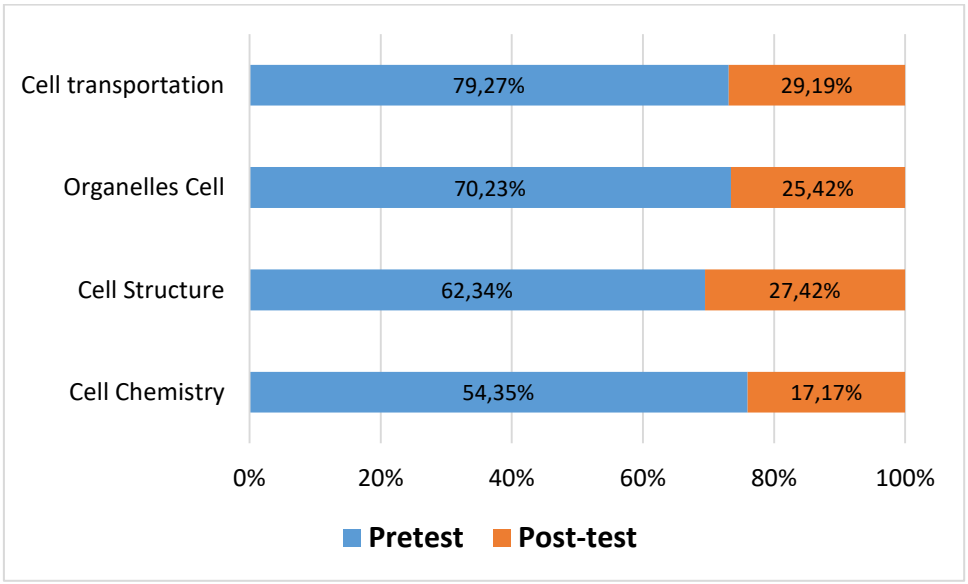


Figure 3. Percentage of do not understand category based on cell concepts

Early student knowledge (pretest) about misconceptions was also very high (Figure 3), reaching an average of 16.68% compared to final knowledge (post-test) an average of 5.75%. The highest misconception is the concept of cell structure (18.91%) and the lowest concept of cell chemistry (5.01%). The results of the measurement of final knowledge (post-test) showed misconceptions decreased in all concepts (concepts of

transportation, organelle, structure, and cell chemistry), the average decreased to 10.93%.

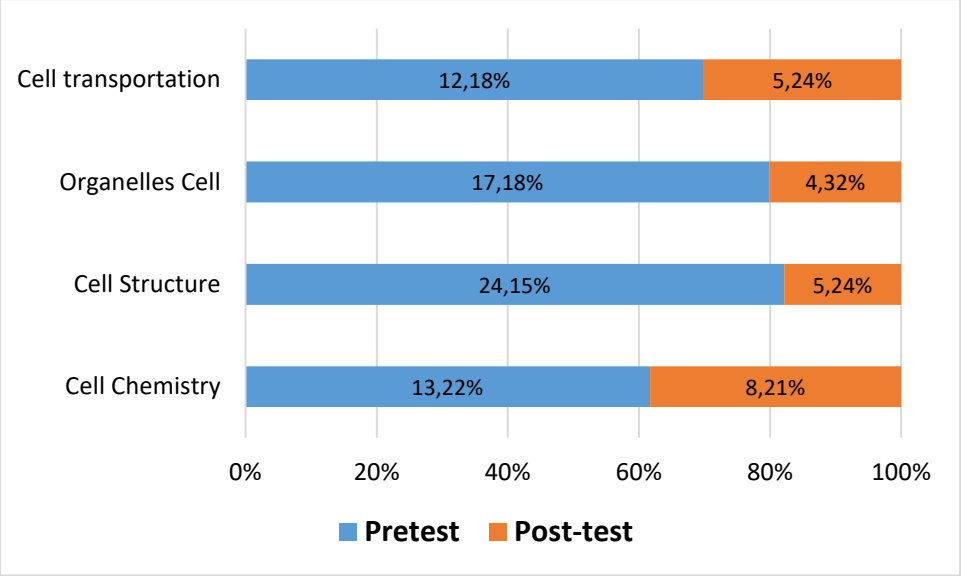


Figure 3. Percentage of misconception category based on cell concepts

4.2 Concept Comprehension Ability

The results of the measurement and analysis of concept comprehension ability (Figure 4) show that the students' initial knowledge in understanding the whole cell concept is very low, with an average score of 43.46 pretest results. The ability to understand cell concepts after the learning process is higher than the initial knowledge. The increase in (n-gain) ability to understand concepts averaged 68.77.

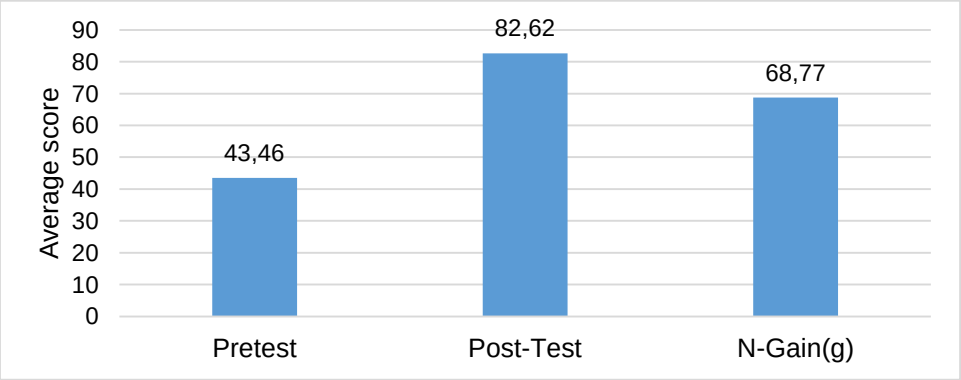


Figure 4. Concept comprehension ability

The results of different test mean pretest and n-gain scores showed significant differences (Table-2). Thus it can be believed that the application of learning with constructivist-based modules is very effective to improve the ability to comprehension concepts by students. In addition to the ability to comprehension, it is also very effective in helping students to reduce concepts that are not understood and misconceptions.

Table 2. The results of the average difference test between pretest score and n-gain score

Average Score		Normality*		Homogeneity**	Significant
Pretest	n-gain	Pretest	n-gain		
43,46	82,77	Normal X^2_{count} (13,93) < X^2_{table} (52,93)	Normal X^2_{count} (32,66) < X^2_{table} (124,1)	homogeneous F_{count} (1,94) < F_{table} (3,96)	significantly different $t\text{-}_{count}$(21,2) > $t\text{-}_{table}$ (1,65)

* Chi Square Test (Normal: $X^2_{count} < X^2_{table}$ (α=0,05)
** F-test (Homogeneous: $F_{cout} < F_{table}$ (α=0,05)

Increased ability in comprehension concepts, decreasing concepts that are not understood and declining misconceptions, indicate the occurrence of concept reconstruction in students. Concept reconstruction is a

change in students' conceptual understanding that occurs during the learning process. Changes in conceptual understanding occur from unpolluted concepts, alternative conceptions, and misconceptions become a true comprehension of concepts (Chi & Roscoe, 2002). Development with constructivist-based modules is feasible to be applied in learning to improve students' ability in concept reconstruction. Although in reality learning with constructivist-based modules has not been able to improve overall understanding of concepts. There are other factors that cause misconceptions. Tracing with modules automatically requires students to diligently read and understand the contents of the module. Students who are lazy to read will find it very difficult to understand the material only by using modules. This indirectly becomes one of the shortcomings in efforts to improve the reconstruction of the concept.

5. CONCLUSION

The results showed that the ability to understand the concept increased 54.56%, did not understand 44.44% decreased, and misconceptions decreased 10.33%. The t-test results also show that there is a significant difference between the pre-test score (initial ability) and n-gain score (final ability) at a significant level of 95% ($\alpha = 0.05$). The conclusion of this study is learning through effective constructivism-based modules in improving cell concept reconstruction capabilities and improving student learning outcomes.

REFERENCE LIST

Adisendjaja, Y. H. (2017). Identifikasi Kesalahan dan Miskonsepsi Buku Teks Biologi SMU. Laporan Penelitian. Bandung: Universitas Pendidikan Indonesia.

Al-Weher, M. (2010). The effect of a training course based on constructivism on student teachers' perceptions of the teaching/learning process. Asia-Pacific Journal of Teacher Education, 32(2), p.169-185.

Antink-Meyer, A. & Meyer, D.Z. (2017). Science Teachers' Misconceptions in Science and Engineering Distinctions: Reflections on Modern Research Examples. Journal of Science Teacher Education, 27(6), p.625-647.

Arslan, H. O., C. Cigdemoglu, and C. Moseley. 2012. "A Three-tier Diagnostic Test to Assess Pre-service Teachers' Misconceptions about Global Warming, Greenhouse Effect, Ozone Layer Depletion, and Acid Rain." International Journal of Science Education, 34 (11): 1–20

Baviskar, S.N.; Hartle, R.T. & Whitney, T. (2009) Essential Criteria to Characterize Constructivist Teaching: Derived from a review of the literature and applied to five constructivist-teaching method articles. International Journal of Science Education, 31(4), p. 541-550.

Christianson, R.G. & Fisher, K.M. (2010). Comparison of student learning about diffusion and osmosis in constructivist and traditional classrooms. International Journal of Science Education, 26(6), p.687-698.

Chi, M. T. H. & Roscoe, R. D. 2002. The process and challenges of conceptual change. In: M. Limon & L. Mason (Eds.) Reconsidering Conceptual Change: Issue Theory and Practice. Dordrecht: Kluwer. 3-27.

Evergreen, M.; Cooper, R. & Loughran, J. (2016a). The articulation of the development of teacher knowledge during the implementation of new teaching procedures to enhance student understanding of molecular biological concepts. Journal Teacher Development 22(3), p.355-374

Evergreen, M., Cooper, R. & Loughran, J. (2016b). "Investigating the Use of Term Recall and Recognition Tools in Learning Terminology and Concepts in a Senior Biology Classroom." Asia-Pacific Forum on Science Learning and Teaching,17(2), p1-26.

Gall, M.D.; Gall, J. P. & Borg, W. R. (2003). Educational Research an Introduction. Boston: Pearson Education Inc.

Hasan, S., D. Bagayoko, D., & Kelley, E. L. (1999). Misconceptions and the Certainty of Response Index (CRI). Journal of Phys. Educ., 34(5): 294-299

Hakim, A., Liliasari & Kadarohman (2012). Student Concept Understanding of Natural Product Chemistry in Primary and Secondary Metabolites Using the Data Collecting Technique of Modified CRI. International Online Journal of Educational Science, 4(3), p.544-553.

Haslam, F & Treagust, D.F. (2010). Diagnosing secondary students' misconceptions of photosynthesis and respiration in plants using a two-tier multiple choice instrument. Journal of Biological Education, 21(3), p.203-211.

Ibrahim, M. (2012). Konsep, Miskonsepsi dan Cara Pembelajarannya. Surabaya: Unesa University Press.

Imamah, N. (2012). Peningkatan Hasil Belajar IPA Melalui Pembelajaran Kooperatif Berbasis Konstruktivisme Dipadukan Dengan Video Animasi Materi Sistem Kehidupan Tumbuhan.

Jurnal Pendidikan IPA Indonesia, 1(1), p.32-36

Kao, H.L. (2007). A Study of Aboriginal and Urban Junior High School Students' Alternative Conceptions

on the Definition of Respiration. International Journal of Science Education, 29(4), p. 517-533.

Karpudewan, M.; Roth, W.M. & Chandrakesan, K. (2014). Remediating misconception on climate change among secondary school students in Malaysia. Journal Environmental Education Research, 21(4), p. 631-648.

Kleickmann, T., D. Richter, M. Kunter, J. Elsner, M. Besser, S. Krauss, and J. Baumert. 2013. "Teachers' Content Knowledge and Pedagogical Content Knowledge: The Role of Structural Differences in Teacher Education." Journal of Teacher Education, 64 (1): 90–106.

Kumandaş, B.; Ateskan, A. & Lane, J. (2018). Misconceptions in biology: a meta-synthesis study of research, 2000–2014. Journal of Biological Education, 52(3), p. p.235-341.

Li Xiaobao (2006). Cognitive Analysis of Student's Errors and Misconceptions in Variables, Equations, and Functions. Texas: A&M University.

Mahardika, R. (2014). Identifikasi Miskonsepsi Siswa Menggunakan Certainty of Response Index (CRI) dan Wawancara Diagnosis pada Konsep Sel. Tesis. Jakarta: UIN Syarif Hidayatullah.

Meltezer, D.E. (2002). The Relationship Between Mathematics Preparation and Conceptual Learning Gains in Physics: A Possible ''Hidden Variable'' In Diagnostic Pretest Scores. American Journal Physics.70(12), p.1259-1268.

Muhibbuddin (2015). Analisis Konsepsi Alternatif dan Miskonsepsi Konsep-Konsep Struktur Tumbuhan Terhadap Guru Sains dan Biologi. Serambi Akademika, 1(2), p.33-46.

Potgieter,M.; Malatje, E.; Gaigher, E. & Venter,E. (2010). Confidence versus Performance as an Indicator of the Presence of Alternative Conceptions and Inadequate Problem-Solving Skills in Mechanics. International Journal of Science Education, 32(11), p.1407-1429

Taber, K.S. & Tan, K.C.D. (2010). The Insidious Nature of 'Hard-Core' Alternative Conceptions: Implications for the constructivist research programed of patterns in high school students' and pre-service teachers' thinking about ionization energy. International Journal of Science Education, 33(2), p. 259-297.

Tang, S.Y.F.; Wong, A.K.Y. & Cheng, M.M.H. (2012). Professional learning in initial teacher education: vision in the constructivist conception of teaching and learning. Journal of Education for Teaching, 38(4), p. 435-451.

Yustina & Kapsin (2017). The Implementation of Constructivism-Based Student Worksheets Within the Theme 'The Prevention of Land and Forest Fire' In Science Education for Seventh Graders in Riau. Jurnal Pendidikan IPA Indonesia, 6(2), p.298-305