PREVENIRE (1) (2022), E-2961-8940, P-2961-8959
PREVENIRE
Journal of Multidiciplinary Science
https://jurnal.institutsunandoe.ac.id/index.php/prevenire

THE EFFECTIVENESS OF CONCEPT CHANGE ORIENTED LEARNING WITH DUAL SITUATED LEARNING MODEL (DSLM) ASSISTED BY MULTI REPRESENTATIONS (MRS) TO IMPROVE UNDERSTANDING OF ACID-BASE CONCEPTS FOR HIGH SCHOOL STUDENTS

Urwatil Wutsqo Amry*[1], Sri Rahayu[2], Yahmin[3], Taufiq Kurniawan[4]

[1,4]Departement of Chemistry Education, Institut Studi Islam Sunan Doe

[2,3]Departement of Chemistry Education, Universitas Negeri Malang

Accepted: 26 Agustus 2022. Approved: 27 Agustus 2022. Published: 31 Agustus 2022

ABSTRACT

Research on the Effectiveness of Concept Change Oriented Learning with Dual Situated Learning Model (DSLM) Assisted by Multi Representations (MRs) to Improve Acid-Base Concept Understanding of High School Students is a quantitative study which employs a quasi-experimental design with a non-equivalent control group design pretest-posttest. The research subjects were 70 students of class XI pattern 5 SMAN 4 Malang for the academic year 2020/2021 which comprised two classes taken by cluster random sampling, one class as the control class (34 students) and one class (36 students) as the experimental class. The research data was collected using the acid-base concept understanding test instrument (TPKAB) which comprised 25 items (17 items for two-tier questions and 8 items for multiple choice). The research hypothesis was examined through the ANCOVA test assisted by the SPSS 21.0 for windows program with a significance level of = 0.05. The results demonstrated the increase in the average value of the experimental class was higher than the increase in the average score of the control class after learning acid-base material. Meanwhile, the results of the delay-test demonstrated the PK-DSLM-MRs were effective in maintaining the retention of students' conceptual understanding on acid-base material. PK-DSLM-MRs gave the strongest influence on the group concept of acid-base strength. The number of misconceptions and students who experience misconceptions in the control class is more than the number of misconceptions and students who experience misconceptions in the experimental class.

Keywords: Acid Base, Dual Situated Learning Model, Multi Representations.

INTRODUCTION

Acid-base constitutes one of the topics in high school chemistry subjects which discusses several subtopics, including the concept of acid-base characteristics, development of acid-base theory, strength of acid-base and neutralization reactions. In studying acid-base material, students are required to master other concepts such as the concept of chemical equilibrium, chemical reactions, stoichiometry, the nature of matter and solutions (Artedj, et al, 2010; Sesen & Tarhan, 2011). Understanding the concept of acid and base also involves the ability to translate concepts at (1) the macroscopic level including observed properties, (2) the sub-microscopic level which includes an understanding of atoms, molecules and ions, and (3) concepts at the symbolic level which include understanding of the use of symbols, formulas, equations and graphs (Johnstone, 2006).

* **Correspondance Address**
E-mail: urwatilwutsqo@gmail.com

As an example of the concept of acid strength, students are required to be able to translate the difference in dissociation ability between strong and weak acids by observing the flame of a lamp when conducting an electrolyte test (macroscopic), then explaining the difference in the dissociation ability of the two compounds (sub-microscopic), and the equation for the reaction. dissociation with the use of appropriate (symbolic) arrows. The complexity of the scope of concepts in acid-base material can lead to misconceptions in students. The term misconception is frequently used in various studies (Roth, 1986; Nakhleh, 1992; Muchtar & Harizal, 2012; Demircioglu, et al, 2005).

Several previous studies reported that students experienced plenty of misconceptions on some basic concepts of acid-base material (Muchtar & Harizal, 2012, Demircioglu, 2009; Metin, 2011; Demircioglu, et al, 2005; Artdej, et al, 2010; Efendi, 2012). For example, students consider all compounds that contain H atoms in their chemical formulas to be acidic because they are able to release H+ ions (Metin, 2011; Demircioglu, et al, 2005; Muchtar & Harizal, 2012; Efendi, 2012). Another misconception is that students assume that the pH value indicates the strength of the acid (Sheppard, 2006; Demircioglu, 2009).

Due to the nature of misconceptions that are difficult to eliminate (Yuruk, 2007; Iskandar, 2011: 10), if not prevented, it will rpovide a bad impact on students. Students will establish a poor understanding of concepts and raise the possibility of other misconceptions (Nakhleh, 1992). Therefore, research related to preventing misconceptions becomes more important (Ozmen, 2007 & Demircioglu, 2009) and becomes a more reasonable option (Duit in Yang & Senocak, 2013).

To overcome misconceptions, experts develop a theory of concept change based on different perspectives (Treagust & Duit, 2009) those are epistemological perspective, ontology perspective and motivation. In its application in the classroom, all criteria for concept change must be reflected in the learning model implemented. There are strategies and learning models for concept change that have seriously been developed by experts, one of which is the Dual Situated Learning Model (DSLM) (She, 2002; Akpinar, 2007).

DSLM is a concept change learning model that can be used to encourage concept change and correct misconceptions experienced by students (She, 2002). DSLM has its own advantages, the so-called learning activities developed emphasizing on changing the concept of a combination of the three perspectives of changing the existing concept. The three perspectives referred to are ontology, epistemology and motivation perspectives (Treagust & Duit, 2009).

Several previous studies have also reported that DSLM is highly effective in overcoming misconceptions experienced by students, including on the material of air pressure and buoyancy (She, 2002), thermal expansions (She, 2003) and solubility equilibrium (Sabekti, 2014). Research conducted by Sabekti (2014) demonstrates that DSLM has a positive potential to be applied to prevent misconceptions of chemical topics that students have the potential to experience misconceptions such as acid-base material.

Based on the above background, several problem formulations can be formulated as follows: 1) Is there a difference in understanding the concepts of students who are taught with the PK-DSLM-MRs approach and students who are taught with a conventional approach on acid-base material? 2) Is the PK-DSLM-MRs approach effective in maintaining the retention of students' conceptual understanding on acid-base material?

LITERATURE RIVIEW

Acid-base material constitutes one of the materials in the high school chemistry curriculum that is quite vital to be studied and understood by students. Understanding the concept of acid and base involves the ability to translate concepts at (1) the macroscopic level including observed properties, (2) the sub-microscopic level which includes understanding atoms, molecules and ions, and (3) concepts at the symbolic level which includes understanding about the use of symbols, formulas, equations and graphs (Johnstone, 2006).

Several previous studies reported that students experienced many misconceptions on some basic concepts of acid-base material (Muchtar & Harizal, 2012, Demircioglu, 2009; Metin, 2011; Demircioglu, et al, 2005; Artdej, et al, 2010; Efendi, 2012). The tendency of students to explain the acid-base properties of a species with an acid-base theory is often found in several previous studies (Demircioglu, et al, 2005; Metin, 2011; Muchtar & Harizal, 2012; Efendy 2012). Students assume that compounds containing H atoms are acids while those containing OH groups are bases. In fact, not all compounds containing H atoms are always acidic, for example NH3. The emergence of this misconception indicates that students are still confused in determining the acid-base theory that should be used to determine the acid-base properties of a compound (Kousathana, 2005). This fact gives rise to an indication that although acid-base theory is taught in chronological order, the differences between the three models and their advantages and disadvantages are not explained in detail (Artdej et al., 2010). According to Iskandar (2011:10) in order to change the concept, in the learning process students must be faced with new concepts that are inconsistent with their mental model to cause cognitive conflicts that will make students replace old concepts with new concepts.

Dual Situated Learning Model (DSLM) constitutes one of the learning models that is usable to encourage conceptual change and improve students' misconceptions (She, 2002). This learning model is based on science education learning theory and cognitive psychology theory, the so-called Posner's theory and Piaget's theory. This learning emphasizes that learning starts from two things, the so-called the ontology perspective of students about a concept and scientific concepts (She, 2002). The stages in the DSLM are as follows: 1) Examining concept attributes and a list of mental sets needed to build the correct concept, 2) Investigating misconceptions in the material studied, 3) Analyzing basic concepts that are still poorly understood by students, 4) Composing Dual Situated Learning event (DSLE), 5) Learning using DSL event, 6) Challenges with Challenging Situated Learning Event (CSLE).

The concepts discussed in the acid-base material are not only limited to visible concepts (concrete concepts) but also discuss invisible concepts, concepts that involve symbolic representation. Characteristics of the abstract and complex concept of acid-base causes acid-base material to be potentially difficult to understand. The use of multi-representation-assisted DSLM can facilitate conceptual change in students. The DSLM stages are in accordance with the four conditions of concept change proposed by Posner et al (1982), the so-called the existence of dissatisfied with students' old concepts occurring in the first, second, and third DSLE stages of DSLE, students' new concepts meeting the criteria of intelligible, plausible and fruitful occurring in DSLE the fourth stage is the formation of a new mental set (She, 2002). The sixth stage of the DSLM, the so-called the provision of CLSE, will further strengthen that the new concept obtained meets the fruitful criteria.

Based on the description above, it can be shown that the concept change approach using a learning model that is able to facilitate the occurrence of conceptual concept changes in students such as multi-representation assisted DSLM will be able to increase concept understanding and maintain retention of students' conceptual understanding on acid-base material.

METHODS

This study employs a quasi-experimental research design (Quasy Experimental Design) to determine whether or not there are differences in concept understanding between students who are taught a concept change approach with multi-representation-assisted DSLM (PK-DSLM-MRs) and students who are taught using a conventional approach to the material of acid base. This research was carried out in a class XI MIA Senior High School (SMA). The population of this research is the students of class XI MIA semester 3 SMAN 4 Malang, the academic year 2020/2021. Two samples were taken by means of cluster random sampling, so that two classes were selected as samples, one class as the experimental class and the other as the control class.

RESULTS AND DISCUSSION

Students' score data is used as concept understanding data and understanding retention data with a value range of 1-100 are presented in table 1. Understanding data obtained through posttest with pretest as a reference to see the gain score that shows the level of student understanding. Retention data was obtained through a delay test with posttest scores as a reference to determine the retention level of students' understanding of acid-base material.

Table 1. Description of students' pretest, posttest and delay-test results

Activity	Pretest		Posttest Score		*Delay test* Score	
Class	KE	KK	KE	KK	KE	KK
Average	20,22	36,24	80,67	71,82	78.41	66.71
Standard of Deviation	6,76	7,99	9,89	16,02	9,41	14,06

Description: KE is Experiment class; KK is a conventional class

Table 1 depicts that both classes experienced an increase in average test scores from pretest to posttest. The increase in the average value of the experimental class and the control class, respectively, was 60.45 and 35.58. Based on the increase in the average test scores of the two classes, the increase in the average score of the experimental class was higher than the increase in the average score of the control class after learning.

Meanwhile, the results of the delay test showed that both classes experienced a decrease, the so-called the experimental class decreased by 2.26 while the control class decreased by 5.11. Both classes experienced a decrease, but the decrease in the experimental class was smaller than the control class, so it can be said that PK-DSLM-MRs managed to maintain retention of students' understanding.

Meanwhile, the normality test and homogeneity test were carried out on the three data, which were pre-test, post-test and delay-test data. The results of the normality and homogeneity test of the pretest data showed that the distribution of the data was normally distributed and had the same or homogeneous variance. The results of the normality and homogeneity test of the posttest data and the delay test data show that the distribution of the data is normally distributed but has unequal or inhomogeneous variants.

Hypothesis test results

The results of statistical analysis using the ANCOVA test depicted that there was a significant difference between the average post-test scores of the experimental class and the control class (F=150.546; 0.00 <0.05). Based on the data from the ANCOVA test, it can be concluded that there are differences in students' understanding of concepts taught by PK-DSLM-MRs with those taught by conventional approaches. Concept understanding of students taught by PK-DSLM-MRs is higher than students' understanding of concepts taught by conventional approach. Meanwhile, the results of the analysis using the ANCOVA test showed that there was a significant difference between the average value of the delay test in the experimental class and the control class (F=8,496, 0.005<0.05). This shows that there are differences in understanding retention between classes taught with PK-DSLM-MRs and conventional approaches. The retention of understanding of the experimental class is higher than the retention of understanding of the control class.

Further analysis was carried out on the posttest scores of each class, the ANCOVA test was used to determine which group of acid-base concepts PK-DSLM-MRs had the strongest influence on students' conceptual understanding based on the category of concepts described in chapter III. A summary of the comparison of the posttest scores of ANCOVA results and the effect size of each concept group with a range of 1-100 is presented in table 2 below.

Table 2. Summary Table of ANCOVA Test and Effect Size of Concept Group

Nu	Concept Group	Posttest Score				F_{count}	Average of SD	Effect Size	Category
		KE (n=36)		KK (n=34)					
		M	SD	M	SD				
1	Characteristics of acidic and basic solutions	77,47	18,68	69,28	21,37	1,36	20,03	0,41	Medium
2	Development of acid base theory	65,50	17,08	56,37	19,68	0,63	18,38	0,49	Medium
3	Acid base strength	93,06	12,83	79,04	27,48	5,86	20,16	0,70	Large*
4	Neutralization	100	0,0	97,06	17,15	1,17	8,58	0,34	Medium

Description: KE is Experiment class; KK is a conventional class

Based on the results of the ANCOVA test for each group of acid-base concepts, only the acid-base concept group showed ($F(0.05) = 20.16$, $0.018<0.05$). The results of the statistical analysis showed that there was a significant effect of PK-DSLM-MRs on students' conceptual understanding in the acid-base concept group. The calculation of the effect size value in the concept group is 0.70, indicating that quantitatively the difference in the average post-test value of the experimental class and the control class is included in the large category (Becker, 2000). The results of the ANCOVA test for the other three concept groups showed a significance level > 0.05 so it can be said that statistically PK-DSLM-MRs did not have a significant effect on students' conceptual understanding in the acid-base characteristic concept group, the acid-base theory development concept group, the acid-base theory group dan neutralization concept. Although statistically the three concept groups were not influenced by the PK-DSLM-MRs, quantitatively the difference in the average posttest scores of the two classes in the three concept groups was in the medium category (Becker, 2000). The results of the calculation of the effect size values are 0.41, 0.49 and 0.34 respectively. From the description of the calculation of effect size in each group of concepts in the acid-base material, it can be determined the order of strength of the influence of PK-DSLM-MRs on students' understanding of concepts. Sequentially from the strongest are (1) the concept of acid-base strength concept group, (2) the concept group for the development of acid-base theory, (3) the concept group for acid-base characteristics, and (4) the neutralization concept group.

Based on the pattern of students' answers at the time of the posttest as described in Chapter III, identification of some conceptual errors must be made to see the possibility that there are still misconceptions in students after learning takes place. Based on the pattern of answers, it was found that in this study there were still errors in the concept of acid-base both in the experimental and control classes as presented in table 3.

Table 3. Percentage of Students' Misconceptions on Acid-Base Materials

Nu	Misconception	Average (%)	
		KE	KK
1	Acid Base Theory		
	These compounds contain H atoms so they are acidic because they will be able to produce H+ ions when dissolved in water	0,00	3,00
	One acid-base theory can explain all acid-base reactions	0,00	0,00
2	Neutralization reaction		
	The reaction between a strong acid and a strong base will always produce a neutral solution even if the moles of acid and base are not equivalent	0,00	0,00
3	Acid Strength		
	The lower the pH value, the more acidic it is because pH affects the strength of the acid	3,00	3,00
	The lower the pH value, the stronger the acid because pH indicates the concentration of H+ ions in the solution	0,00	6,00
4	The Power of Language		
	The strength of the base is directly proportional to the magnitude of the pH value. The higher the pH value, the more alkaline the solution is	0,00	3,00
5.	Polyprotic acid base strength		
	The more H atoms in the formula of an acid, the stronger the acid will be	0,00	0,00
6	Characteristics of acidic solutions and basic solutions		
	Only acids are dangerous because they contain H+ which are destructive, while bases are harmless	0,00	6,00
	Acids contain H atoms and can release H+ ions which are destructive	0,00	0,00
7.	Acid solution and alkaline solution as electrolyte solution		
	Strong bases conduct electricity because they have stronger covalent bonds than weak bases	14,00	26,00
	Average	2,00	5,00

Description: KE is Experiment class; KK is a conventional class

Referring to the formulation of the problem that has been described previously, the main purpose of this study is to test whether there are differences in understanding the concepts of students who are taught by PK-DSLM-MRs and students who are taught by conventional approaches to acid-base material. The comparison of the posttest mean scores showed that the experimental class students scored higher than the control class students.

There are differences in understanding of the concepts of students who are taught by PK-DSLM-MRs and students who are taught by conventional approaches to acid-base material which is caused by several things. First, PK-DSLM-MRs are specifically designed by considering the possibility of students' misconceptions on acid-base material while the conventional approach does not consider this. Second, the PK-DSLM-MRs used in the experimental class provide opportunities for students to be more actively involved during the learning process with the aid of worksheets designed by researchers to facilitate concept changes to the formation of new concepts.

This is another advantage of the PK-DSLM-MRs learning, at the end of the meeting on the strength of acid-base material in understanding students' understanding of challenges at the CSLE stage to follow up the understanding of the concepts that have been obtained. If in CSLE activities there are still students who have not changed their concepts, the teacher can provide reinforcement again at the next meeting. In conventional classes, students are not taught by learning that causes cognitive conflict. If there are practical activities in the experimental class, the control class also carries out practical activities. The practicum in the control class is verification and does not cause cognitive conflicts.

The results of this study strengthen the results of previous studies which reported that DSLM as a learning model that can support concept change so as to improve students' conceptual understanding (Akpinar, 2007, Sabekti, 2014, She, 2002; 2003; 2004; She & Liao, 2009). Furthermore, the results of this study show the same results as the results of studies that have been reported in the literature that the use of multi-representation integrated in DSLM in concept change can improve students' understanding (Sabekti, 2014). This study shows that the concept change approach is effective in improving students' understanding. This is in line with the results of research conducted by Ozmen (2007) that the concept change approach is effective in increasing students' understanding of concepts.

CONCLUSION

Based on the results of data analysis, the findings and discussions that have been carried out, it can be concluded that; 1) There are differences in students' understanding of concepts taught by the PK-DSLM-MRs approach and students who are taught by conventional approaches to acid-base material. 2) PK-DSLM-MRs are effective in increasing students' understanding of concepts on acid-base material. 3) PK-DSLM-MRs are effective in maintaining the retention of students' conceptual understanding on acid-base material. 4) The quantity of students' misconceptions after learning with PK-DSLM-MRs on acid-base material is lower than students taught by conventional learning. 5) PK-DSLM-MRs gave the strongest influence on the group concept of acid-base strength. Then the concept group for the development of acid-base theory, the concept group for acid-base characteristics and the last sequence is the neutralization reaction concept group.

REFERENCES

Agustina Atinia, H., Inelda, Y., & Nina, A. (2021). pengembangan media pembelajaran komik kimia elektronik asam basa untuk peserta didik SMA (Doctoral dissertation, Universitas Maritim Raja Ali Haji).

Ainsworth, S. 1999. The Function of Multi-representation.*Computer & Education 33 (1999) 131-152.*

Ainsworth, S. 2008. The Educational Value of Multi-representation when Learning Complex Scientific Concept. *Visualization: Theory and Practice in Science Education, 191-208. Springer.*

Akbarpoorganjeh, A., & Amani, V. (2022). Investigating the misunderstandings of 12th grade students in acid-base concepts through a three-tier diagnostic test.

Akpinar, E. 2007. The Effect Of Dual Situated Learning Model On Students’Understanding Of Photosynthesis ans Respiration Concepts **.** *Journal of Baltic Science Education, Vol. 6, No.3, 2007***.**

Arifani, D. Y. M., Savalas, L. R. T., Ananto, A. D., Junaidi, E., & Hadisaputra, S. (2021). Pengembangan Modul Praktikum Kimia Berbasis Kimia Komputasi Pada Materi Asam Basa. *Prosiding SAINTEK*, *3*, 660-666.

Artdej, R., Ratanaroutaia, T., Coll, R. K. & Thongpanchang, T. 2010. Thai Grade 11

Students' Alternative Conceptions For Acid-Base Chemistry. *Research in Science & Technological Education, Vol. 28, No. 2, July 2010, 167-183.*

Aziza, A. N. *Pengaruh Media Simulasi Phet (Physics Education Technology) Terhadap Hasil Belajar Kimia Pada Materi Bentuk Molekul* (Bachelor's thesis, Jakarta: FITK UIN SYARIF HIDAYATULLAH JAKARTA).

Barke, H.D., Hazari, A. & Yitbarek, S. 2009. *Misconception in Chemistry: Addresing Perception in Chemical Education*. German : Springer.

Becker, L.A. 2000. (Online) (http://web.uccs.edu/lbecker/Psy590/es.htm) diakses tanggal 02 Februari 2016.

Cetingul, P.I. & Geban, O. 2005.Understanding of Acid-Base Concept By UsingConceptual Change Approach. *Hacettepe Ûniversitesi Eĝitim Fakûltesi Dergesi (H.U. Journal of Education) 29: 69-74.*

Chandrasegaran. A.L., Treagust D. F., & Mocerino, M. 2007. The Development of a two-tier multiple-choice diagnostic instruments for evaluating secondary school students' ability to describe and explain chemical reactions using multiple level of representation. *Journal of Chemistry Education Research and Practice, 8 (3),293-307.*

Cresswell, J.W. 2009. *Research design: Qualitative, Quantitative, and Mixed Methods Approaches Thirth Edition.*USA: SAGE Publications, Inc.

Cresswell, J.W. 2015.*Riset Pendidikan Perencanaan, Pelaksanaan, dan Evaluasi Riset Kualitatif dan Kuantitatif Edisi Kelima*. Terjemahan Soetjipto, H. P. & Soetjipto, S.M. 2015. Yogyakarta : Pustaka Belajar.

Demircioglu, G. 2009. Compaison of the effects of conceptual change texts implementated after and before instruction on secondary school students' understanding of acid base concepts . *Journal of Asia-Pasific Forum on Science Learning and Teaching, Volume 10 issue 2, Article 5, p.1, Desember.*

Demircioglu, G., Ayas, A., & Demircioglu, H. 2005. Conceptual Change Achieved Through A New Teaching Program on Acid and Base. *Journal of Chemistry Education Research and Practice, 6 (1),36-51.*

Efendi, A. 2012. *Pengembangan dan Penggunaan Instrumen Diagnostik Two Tier Untuk Mengidentifikasi Miskonsepsi Siswa Tentang Asam Basa di SMA N 7 Malang*. Malang: Skripsi Tidak diterbitkan.

Effendy. 2011. *A-Level Chemistry For Senior High School Students Volume 2B*. Malang: Bayumedia Publishing.

Effendy. 2012. *A-Level Chemistry For Senior High School Students Volume 2A*. Malang: Bayumedia Publishing.

Effendy. 2016. *Ilmu Kimia Untuk Siswa SMA dan MA Kelas X Jilid IB*. Malang: Indonesian Academic Publishing.

Elvinawati, E., Rohiat, S., & Solikhin, F. (2022). IDENTIFIKASI MISKONSEPSI MAHASISWA DALAM MATA KULIAH KIMIA SEKOLAH II PADA MATERI ASAM BASA. *ALOTROP*, *6*(1), 10-14.

Franco, A.G., 2005. Secondary Students' Multiple Representations Relating to The Structure of Matter. *Seminar Sponsored by The Chemical Education Research Group of The Royal Society of Chemistry : University of Cambridge.*

Hitipeuw, I. 2009. *Belajar dan Pembelajaran*. Malang: Universitas Negeri Malang.

Iskandar, S. M. 2011. *Pendekatan Pembelajaran Sains Berbasis Konstruktivistik* (Ibnu, S., dkk, Ed). Malang: Bayumedia Publishing.

Johnstone, A.H. 2006. Chemical education research in Glasgow in perspective. *Chemistry Education Research and Practice*, 2006, 7 (2), 49-63

Kala, N., Yaman, F. & Ayas, A. 2012. The Effectiveness Of Predict–Observe–Explain Technique In Probing Students' Understanding About Acid–Base Chemistry: A Case For The Concepts of pH, pOH, And Strength. *International Journal of Science and Mathematics Education (2013) 11: 555-574.*

Karyadi, B. 1997. *Kimia 2 Untuk Sekolah Menengah Umum Kelas 2*. Jakarta: Balai Pustaka.

Kim, J. S. 2005.The Effects of Constructivist Teaching Approach on Student Academic Achievement, Sel-Concept and Learning Strategies. *Asia-Pasific Education Review*. 6(1): 7-19.

Kousathana, M., dkk. 2005. Instructional Misconceptions in Acid-Base Equilibria: An Analysis from a History and Philosophy of Science Perspective. *Science & Education (2005) 14: 173–193.*

Landis, J. R. & Koch, G. G. 1977. The Measurement of Observer Agreement for Categorical Data. *Biometrics 33, 159-174.*

Majoul, A. A., & Arheef, S. L. (2022). The effect of dual situated learning model (DSLM) on the achievement of fourth grade students in biology. *Journal of Positive School Psychology*, 5223-5233.

Metin, M. 2011. Effects of Teaching Material Based on 5E Model Removed Preservice Teachers' Misconceptions About Acid-Bases. *Bulgarian Journal of Science and Education Policy (BJSEP), Volume 5, Number 2, 2011.*

Muchtar, Z. & Harizal. 2012. Analyzing Of Students' Misconceptions On Acid-Base Chemistry At Senior High Schools In Medan. *Journal Education and Practice, Vol 3, No. 12.*

Nakhleh, M.B. 1992. Why Some Students Don't Learn Chemistry Chemical Misconceptions. *Journal of Chemical Education Volume 69 Number 3 March 1992.*

Özkan, G. 2012. How Effective Is "Conceptual Change Approach" In Teaching Physics?. *Journal of Education and Instructional Studies In The World, May 2012, Volume: 2 Issue:2 Article: 24 ISSN: 2146-7463.*

Ozmen, H. 2004. Some Student Misconceptions in Chemistry: A Literature Review of Chemical Bonding. *Journal of Science Education and Technology, Vol. 13, No. 2, June 2004.*

Ozmen, H. 2007. The Effectiveness of Conceptual Change Texts in Remediating High School Students' Alternative Conceptions Concerning Chemical Equilibrium. *Journal of Asia Pacific Education Review, Vol. 8, No.3, 413-425.*

Palmer. 2005. A motivational view of contructivist-informed teaching. *International Journal of Science Education, 27 (15):413-425.*

Pinarbasi, T. 2007. Turkish Undergraduate Students' Misconceptions on Acids and Bases. *Journal of Baltic Science Education, Vol. 6 No. 1. 23-34.*

Pinarbasi, T., Sozbilir, M., & Canpolat, N. 2009. Perspective Chemistry Teachers' Misconceptions about Colligative Properties: Boiling Point Elevation and Freezing Point Depression. *Chemistry Education Research and Practice, 10(4): 273-280.*

Posner, G.J., dkk. 1982. Accommodation of Scientific Conception: Toward a Theory of Conceptual Change. *Science Education 66(2): 211-227(1982).*

Rizkiana, F. 2016. *Pengaruh Praktikum dan Demonstrasi Dalam Pembelajaran Inkuiri Terbimbing Terhadap Motivasi dan Hasil Belajar Siswa Pada Materi Asam Basa Ditinjau Dari Kemampuan Awal*. Malang: Tesis Tidak diterbitkan.

Roth, J. K. 1986. Conceptual-Change Learning and Student Processing of Science Texts. *Research Series No. 167: The Institute for Research on Teaching 252 Hall.*

Sabekti, A. W. 2014. *Kajian kualitatif miskonsepsi peserta didik pada topik kesetimbangan kelarutan dan perbaikannya menggunakan Dual Situated Learning Model (DSLM) berbasis MRs*. Malang: Tesis Tidak diterbitkan.

Sahin, C. & Cepni, S. 2011. Developing Of The Concept Cartoon, Animation and Diagnostic Branched tree Supported Conceptual Change Text: " Gas Pressure". *Eurasian J. Phys. Chem. Educ., Jan (Special Issue):25-33, 2011.*

Saputri, E. N., Wigati, I., & Laksono, P. J. (2022, August). KEMAMPUAN LITERASI KIMIA PADA ASPEK KOMPETENSI SAINS PADA MATERI ASAM BASA. In *Prosiding Seminar Nasional Pendidikan Kimia* (Vol. 1, No. 1, pp. 223-231).

Sesen, B.A. & Tarhan, L. 2011. Active-Learning Versus Teacher-Centered Instruction For Learning Acid and Base. *Research in Science & Technological Education, Vol. 29, No. 2, July 2011, 205-226.*

Seufert, T. 2003. Supporting Coherence Formation in Learning from Multiple representation. *Learning and Instruction 13 (2003) 227-237.Pergamon.*

She, H.C. & Liao, Y.W. 2009. Enhancing Eight Grade Students's Scientific Conceptual Change and Scientific Reasoning through a Web-based Learning Program. *Educational Technology & Society, 12 (4), 228-240.*

She, H.C. 2002. Concept of A Higher Hierarchical Level Require More Dual Situated Learning Event For Conceptual Change: A Study Of Air Pressure and Buoyancy. *International Journal of Science Education, Vol. 24, No. 9, 981-996.*

She, H.C. 2003. DSLM Instructional Approach to Conceptual Change Involving Thermal Expansion. *Research in Science and Technological Education, Vol. 21, No. 1, 2003.*

She, H.C. 2004. Facilitating Changes in Ninth Grade Students' Understanding of Dissolution and Diffusion through DSLM Instruction. *Research in Science Education 34: 503-525, 2004.*

She, H.C. 2004. Fostering Radical Conceptual Change Throught Dual Situated Learning Model. *Journal of Research in Science Teaching, Vol. 41, No. 9. PP. 142-164 (2004).*

Sheppard, K. 2006. High school students' understanding of titrations and related acid-base phenomena. *Journal of Chemistry Education Research and Practice,* **7** *(1), 32-45.*

Silberberg & Amateis. 2012. *Chemistry: The Molecular Nature of Matter and Change, Seventh Edition*. New York: McGraw-Hill Education.

Siswaningsih, W., Nahadi, V. C., & Chandratika, V. (2020, July). Profile of Misconception in Senior High School Students on the Concept of Acid-Base Strength. In *MSCEIS 2019: Proceedings of the 7th Mathematics, Science, and Computer Science Education International Seminar, MSCEIS 2019, 12 October 2019, Bandung, West Java, Indonesia* (p. 409). European Alliance for Innovation.

Talib, O., Matthews, R. & Secombe, M. 2005. Computer-animated instruction and students' conceptual change in electrochemistry: Preliminary qualitative analysis: *International Education Journal, ERC2004 Special Issue, 2005, 5(5), 29-42.*

Treagust, D. F. & Duit, R. 2009. Multiple perspective of conceptual change in science and the chalangges ahead. *Journal of Science and Mathematic education in Shoutest Asia, 32 (2) 89-104.*

Ulfarina, L. 2010.*Penggunaan Pendekatan Multi Representasi Pada Pembelajaran Konsep Gerak Untuk Meningkatkan Pemahaman Konsep dan Memperkecil kuantitas Miskonsepsi Siswa SMP***.** Tesis Online.

Wahyuningtyas, R. A. R. (2022). *Pengaruh pembelajaran dual situated learning model untuk mencegah miskonsepsi peserta didik pada materi asam basa larutan garam* (Doctoral dissertation, Universitas Negeri Malang).

Wicaksono, A.T. 2013. *Keefektifan Pembelajaran Larutan Penyangga Menggunakan Ceramah Demonstrasi dan Praktikum Berbantuan Diagram Vee Ditinjau dari Motivasi dan Hasil Belajar Siswa*. Malang: Tesis Tidak diterbitkan.

Winarko, S. H. (2022). Proses perubahan konsep pada mahasiswa dengan menggunakan konflik kognitif Dual Situated Learning Model (DSLM) pada materi elektrokimia. *SKRIPSI Mahasiswa UM*.

Yang, D. & Senocak, I. 2013. The Search for Strategies to Prevent Persistent Misconception. *American Society for Engineering Education, 2013.*

Yuruk, N. 2007. The Effect of Supplementing Instruction with Conceptual Change Texts on Students' Conceptions of Electrochemical Cells. *Journal of Science Education and Technology, 16:515–523.*