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Reduction of Cognitive Conflict and Learning Style Impact towards Student-Teacher’s Misconception Load

Kurroti A’yun1, a) Suyono2; Sri Poedjiastoeti3; Saidna Zulfiqar Bin-Tahir4

1Department of Science Education, Surabaya State University, Surabaya 60231 – Indonesia
2Department of Mathematic and Science, Surabaya State University, Surabaya 60231 – Indonesia
3Department of Mathematic and Science, Surabaya State University, Surabaya 60231 – Indonesia
4Education Department, University of Iqra Buru, Maluku 97236 – Indonesia

a) Corresponding author, Email: ayun_tlits99@yahoo.com

Abstract. The most crucial issue in education is a misconception that is caused by the misconception of the students themselves. Therefore, this study provided the solution to improve the quality of teaching chemistry in the schools through the remediation of misconceptions to the chemistry teacher candidates. This study employed a mixed method approach using concurrent embedded designs where it tended more to the qualitative research, but it still relied on the quantitative research in the assessment of the learning impact. The results of this study were the students with higher levels of cognitive conflict still have high loads of misconceptions (MC), it possibly due to the type of students’ learning styles that is the sequential-global balanced. To facilitate the cognitive conflict character and the learning style of sequential-global balanced, the researchers created an integrated worksheet conceptual change with peer learning (WCCPL). The peer learning undertaken in the last stages of conceptual change of WCCPL can increase the resistance of students’ concept in a category of knowing the concept significantly, but it should be examined in an in-depth study related to the long-term memory.

INTRODUCTION

It is urging to understand the meaning of the concept in studying a science. The concept is ‘given’ and ‘objective’, whereas the conception is the transformation of the given and the objective becomes the individual property so that it is subjective [1], [2]. Because the concepts are subjective, the same concept can be understood differently by different people [3]. Based on the statement of Arslan, Cigdemoglu, and Moseley [4], the conception of different learners can be divided into three categories, namely known the concept (NC), misconception (MC), and unknown the concept (UNC).

From the three categories, the most difficult conception to overcome is the misconception which as an immortal scourge in the field of education. Therefore, the learners with misconception conditions have discomfort in accepting a new concept and the resistance that occurred in the cognition, especially the resistance to the wrong concept they have and the new correct concept that they will obtain. According to Queloz, Schar, Wallny, Bonaccorso, and Schmidt [5] statement that the condition of the misconceptions are more resistant to conceptual change in conditions of unknown the concept or just known some concepts.

Taber [6] states that misconceptions have been reported in most educational research topics at various levels of education, both schools level, and university students. The misconceptions have the other terms used by some researchers, namely: (1) preconceptions [7], (2) Alternative frameworks [8], (3) Children's science [9], (4) Naive conceptions [10], and (5) Alternative conceptions [11]. Misconceptions can be defined as a mismatch of understanding the concept with scientific sense formulated by scientists in one field of study [12]. According to Ibrahim [13], the misconception is the condition when the preconception is not easily changed, and it always occurs repeatedly despite it has been given the correct concept.
The misconception is caused by several factors and can be broadly divided into two causes, namely the external and internal factors. The external factor is defined as a factor that comes from outside the self-learners. Some causes of misconceptions presented by Kemp et al. [14] were the environmental background, race, gender, learning style, and level of learners’ cognitive conflict. In addition, the external factors can be: (1) the existence of inconsistencies of the benchmark scientific use, (2) the existence of inequalities use in everyday language with scientific language related to the concepts learned, (3) the failure of the preparation of teaching environment in accordance with materials and concepts learned, (4) the presentation of the concepts in learning is not sought to establish the links between concepts learned with the knowledge to understand in general and do not associate with the concepts taught by everyday phenomena.

The internal factors of learners’ misconceptions are defined as factors sourced from within the students themselves in which typical and distinctive characteristics of each learner [15]. Internal factors cause of misconceptions included: (1) the learning style, (2) the level of cognitive conflict (LCC), (3) the mental models, (4) the social tradition, (5) the level of maturity, and (6) gender. This research focuses the discussion on internal causes of misconceptions in learning styles and levels of cognitive conflict. While the external causes are focused on educators, particularly chemistry teacher candidates. According to Lemma [16], the teacher factor is still the main causing of the misconceptions; with the value of the effect is 90%. By correcting the internal factors of misconceptions influence the chemistry teacher candidates then the external factors that lead to student’s misconceptions can be minimized earlier.

Based on the problems identification above, this study aimed to investigate 1) how do the individual characteristics influence the students’ conception? 2) how to facilitate the individual characteristics of students in order to improve the quality of their conceptions? And 3) how to analyze the success of the remedial learning through the WCCPL?

**METHOD**

**Research Design**

This study employed a mixed method design. According to Creswell [17], mixed method is an approach to research that combine or associate the form of qualitative and quantitative, while according to Mertens [18], mixed method is a research whereby researchers collect and analyze data integrating the findings and drawing conclusions inferentially by using two approaches or methods of qualitative and quantitative in one study. Types of mixed method research applied in this research are embedded concurrent strategy. This strategy was chosen because it implements a strategy of primary techniques (e.g., surveys) and secondary techniques (such as an interviewed several participants who have already filled out the survey instrument) in data collection. In addition, concurrent embedded strategy gives unequal weights on two forms of data that have a different magnitude and complexity allowing researchers to limit the scope of the study and set the time and available resources [18].

The researchers assumed that the use of the mixed method in accordance with the problems statement indicated to the positivism paradigm, that there is a causal correlation between the successes of the remedial learning process with the success of the conceptual change process using conceptual change strategies that are integrated with peer learning. In addition, the problems in this study also show phenomenological paradigms, such as the phenomenon that occurs when the process of conceptual changed by the student's learning style was sequential-global balanced and the level of cognitive conflict moderate to high range. The study conducted at FMIPA of Surabaya State University, Indonesia.

**Research Instrument**

The instrument used in this study were arranged and adapted to the research needs. Here are a variety of instruments in this study: 1) Instrument of misconceptions detection provided in Indonesian language: the detection of misconceptions about the concept of a chemical solution that can be seen in appendix 1; 2) The remedial learning strategy consists of: a) WCCPL (an example can be seen in appendix 2); b) The observation sheet activity and student’s response (not presented in this paper); c) The evaluation of the implementation of remedial learning strategies (not presented in this paper).
Technique of Data Collecting

The data collection technique used to obtain materials that are relevant, accurate and can be used to exactly fit the purpose of research. Data collection techniques used in this study were: 1. The documentation to collect relevant data: a) the name of the student as a research subject, b) student test scores before and after remedial learning, c) photograph of students during the learning remedial and d) any other necessary supporting data. 2. The observation to assess the adherence of WCCPL, student activities, social and spiritual attitudes of students during the learning process (as supporting data) on remedial teaching for student-teachers integrated chemical change used conceptual peer learning strategy. 3. The test which included pretest and posttest form identification tests on the concept and misconceptions about the chemical solution-based on the analysis of the concept designed by Herron et al. [19]. This test aimed to measure or determine a load of student’s misconceptions before and after the implementation of remedial teaching for the candidate of chemistry teachers using conceptual change strategies that are integrated with peer learning as a strategy to meet the demands of supporting data in UNESA as LPTK based on KKNI 2015 and NSTA 2012. 4. The interviews to obtain information about the student’s response to the application of WCCPL, the burden of misconceptions held, conformity with learning styles and levels of cognitive conflict of the students, the students’ ability to understand and get the hang of his friend after understanding the concept, as well as the constraints felt when the concept has been understood in peer learning strategy.

Technique of Data Analysis

There were four important aspects been analyzed in this study including body language and gesture, written answer, retention analysis test, and the student's response. Those aspects can be described as follows: Body language and gesture were analyzed using the reference exposure by Müller, Cienki, Fricke, H.Ladewig, McNeill, and Bressem [20] and Pease and Pease [21]. Body language and gesture picture obtained from the video tape which is hidden in front of students in order to not disturb the remedial learning process. Body language and gesture video recordings and then cut into pieces in the form of JPEG files, making it easier to be analyzed and reported in research reports.

The students who are analyzed in this article are students who are given teaching and learning outcomes through WCCPL with their peers so that the main subject of research are discussed in this paper were 2 students. The details of the main subject of research here are one of pure research subjects who get remedial learning to use WCCPL by peer learning at the end of the lesson. Between the two students, one of them who did not receive direct WCCPL from lecturers but he received the instructional using WCCPL from his friend who had received direct instruction by WCCPL from lecturers.

The written test analysis aimed to make sure the students have understood the concept or still have misconceptions load. Moreover, from the written answer presented in WCCPL can be seen to what extent the UNC student during the phase of the conceptual change process and during the setup process using WCCPL schemata. Students who have high CCPs should have been more rapid than the process of conceptual change with UNC students [22]. The illustration of written answer can be seen in Figure 4.

The retention test analysis carried out about 56-63 days after remedial learning by using WCCPL. This is in accordance with the exposure of Cetin [23], that the retention test can be done after 2 months of research. In addition, according to Roediger and Karpicke [24], to find out some information came to the students, it is necessary to carry out the long-term memory retention test about 56-63 days after the learning done. The retention test in this research has done specifically for four students who received WCCPL learning as a whole, which ended with peer teaching on peer learning session.

The student's response analysis aimed to determine his response to learning by providing open questions related to remedial learning through WCCPL. The student’s answers to the questions regarding this response are only a student voice that is documented in the form of a brief written description created by the researchers (such as notes). Questions pertaining to the response submitted by the student after each student completed a change in the conceptual stage of WCCPL.
RESULTS AND DISCUSSION

The Effects of Student’s Conflict Cognitive Level and Learning Style to the Student’s Conception

The result found that the level of cognitive conflict (LCC) affected the student’s acceptance to the new concept in the learning process. It can be described in Table 1 below.

<p>| Table 1: The student’s conception in the process of remedial learning through WCCPL |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|</p>
<table>
<thead>
<tr>
<th>Students and WCCPL type</th>
<th>Phase of Conception</th>
<th>MC Validation</th>
<th>Conflict Condition Creation</th>
<th>Equilibration Aid</th>
<th>Reconstructing the comprehension</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (01)</td>
<td>MC</td>
<td>NC partial</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>1 (02)</td>
<td>NC partial</td>
<td>NC partial</td>
<td>NC</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>2 (01)</td>
<td>NC partial</td>
<td>NC partial</td>
<td>NC partial</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>3 (01)</td>
<td>MC</td>
<td>NC partial</td>
<td>NC partial</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>4 (02)</td>
<td>MC</td>
<td>NC partial</td>
<td>NC partial</td>
<td>NC</td>
<td>NC</td>
</tr>
<tr>
<td>6 (02)</td>
<td>NC partial</td>
<td>NC partial</td>
<td>NC partial</td>
<td>NC</td>
<td>NC</td>
</tr>
</tbody>
</table>

The Table 1 shows that all the subjects of the study subjected to conceptual change with slight differences in patterns. The conceptual change pattern for student 1 in the concept of the solution conductivity is MC → NC partial → NC → NC through adaptation phases according to Piaget in Woolfolk [25], in the form of assimilation, accommodation, and equilibrium. The assimilation phase is passed by student 1 when the conception component of the solution conductivity is in accordance with its conception. The result of student’s conception obtained from the correct answer to the questions while remedial learning through WCCPL as can be seen in Figure 1.

![FIGURE 1: The student’s answer](image)
At the beginning of learning, students with high of LCC have a high level of anxiety when the conception is not the same or inappropriate to the true conception proposed by the experts. While students with low of LCC, which in this article is who received WCCPL from his friends had lower levels of anxiety and knowing the different conceptions offered by the experts in WCCPL conception. These results are in accordance with the statement of Kang et al. [25] that students with low level of LCC will have low anxiety when the conception is owned contrary to the experts’ conception because the students have a high confidence when they have the correct conception. The students’ anxiety detected from the questions related to the CCP in WCCPL containing levels of anxiety, the level of doubt, the level of students’ interest in obtaining further information, the level of curiosity about the new information, the level of confusion in the information that is different from their understanding, and the level of sadness when they have different understandings and misunderstanding. It can be seen in the Figure 2.

![FIGURE 2: The student’s body language and gesture while answering WCCPL](image)

LCC is not only measured through the students’ response to the test of CCP in WCCPL but also examined his body language and gesture that is displayed from the video recorded. According to Pease and Pease [26], when someone moves his legs crossed, then the person is likely to defend his opinion. In addition, when a person communicates with others and scratching his head or put his hand on the head, it means the person is doubt to the statements made by the interlocutor or communications partner. However, according to Müller, Cienki, Fricke, H.Ladewig, McNeill, and Bressem [27], a person’s body language and gesture can have different meanings, when it is in a different community, such as those of India approved someone statement with a shaking of the head, while the Indonesia or the Americans, and Chinas, agreed to the statement by nodding the head. Therefore, the meanings of body language and gesture of students in this study referred to the Pease and Pease meaning and synchronized with the meaning of the tradition of the Indonesian culture.

The student who taught his/her friend through the peer learning session on the study in the early stages of conceptual change, the validation phase of misconceptions, they have a fairly high anxiety. However, after being in the relief phase to the equilibration, the students become more calm and confident. In addition, through peer learning, the students who have lower of LCC which is taught in sessions of peer learning can receive a message from a concept correctly and more quickly, because it takes no more than 1 hour, the students had received and would change their misconception with the correct conception according to the experts’ concept.

Based on the study of the student’s condition at remedial learning, the researchers made the schemata pattern of student’s verbal and nonverbal by comparing Piaget's pattern written by McLeod (2015) in the following illustration in Figure 3.
The Effects of WCCPL in Reducing Pre-Service Teachers’ Misconceptions in Solution Conductivity

Based on data analysis in Table 1, the students’ misconception decreased drastically due to what they received and responded correctly to questions of WCCPL in a stage of the assistance of the equilibration and strengthened by peer learning sessions. Peer learning is proven to strengthen the student's conception. According to Silberman [28], peer learning used to support the peer learning in with high responsibility. In addition, Philipp, Tretter, and Rich [29] stated, by applying peer learning in teaching can improve the student’s conception or understanding. Through peer learning, they have permanence or stability themselves with a chemical concept achieved and learners can communicate a concept that has been conceived and solve the problems independently in accordance to the Zone of Proximal Development (ZPD).

The Student’s Conception in Long-term Memory after Participating in Remedial Learning through WCCPL by Retention Test

After approximately two months, the students’ conception redetected or carried out the tests again to determine the strength of students’ retention in remedial learning by using WCCPL. The results found that the students still recalled the content of the conductivity concept which 95% students answered the questions correctly in WCCPL. Figure 4 is the sample of the student’s test result.
FIGURE 4: The result of student’s retention test

In accordance with Figure 4 above, the student still seems to remember the information related to the concept of conductivity based on the expert conception as it has been received in WCCPL. The student's answer shows that they felt confidence in answering the questions because there is no scribbling of writing errors in the text. In fact, at the point e, students seem to correct the question by replacing the wrong word of the question which indicated that they have accuracy in reading the question.

CONCLUSION

A load of students’ misconception can be derived exclusively by using WCCPL and remedial learning, whereby the learning is applied individualized and tailored to the individual character of the students. The students’ misconceptions character with high load, high and low of LCC, as well as sequential-global balanced learning styles can be facilitated through the provision of the WCCPL in remedial learning with conceptual change strategy. The WCCPL can be applied exclusively to students with high character of misconceptions load, high and low of LCC, as well as sequential-global balanced learning styles. The researchers suggested that the WCCPL can also be applied to the young learners before they join the university so that the students can have a good conception and readiness towards adulthood or andragogic learning.

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REFERENCES

Appendixes

Appendix 1: The example of the misconception detection test

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tier 1</strong></td>
<td>Larutan dibawah ini yang dapat menghantarkan listrik paling baik adalah</td>
</tr>
<tr>
<td></td>
<td>a. HCl</td>
</tr>
<tr>
<td></td>
<td>b. H₂SO₄</td>
</tr>
<tr>
<td></td>
<td>c. CH₃COOH</td>
</tr>
<tr>
<td></td>
<td>d. CsH₂O₆</td>
</tr>
<tr>
<td></td>
<td>e. CO(NH₂)₂</td>
</tr>
<tr>
<td><strong>Tier 2</strong></td>
<td>Manakah salah satu alasan yang paling sesuai dengan jawaban anda?</td>
</tr>
<tr>
<td></td>
<td>a. Bersifat asam kuat</td>
</tr>
<tr>
<td></td>
<td>b. Zat elektrolit dalam larutannya terurai menjadi ion-ion yang terbentuk listrik dan ion-ion tersebut saling bersarang</td>
</tr>
<tr>
<td></td>
<td>c. Zat elektrolit dalam larutannya terurai menjadi ion-ion yang terbentuk listrik dan ion-ion tersebut saling bersarang dan memiliki jumlah kation dan anion yang lebih banyak</td>
</tr>
<tr>
<td></td>
<td>d. Memiliki jumlah atom yang lebih banyak</td>
</tr>
<tr>
<td><strong>Tier 3</strong></td>
<td>Apakah anda yakin dengan jawaban anda?</td>
</tr>
<tr>
<td></td>
<td>a. Yakin</td>
</tr>
<tr>
<td></td>
<td>b. Tidak yakin</td>
</tr>
</tbody>
</table>
| **Tier 1** | Suatu larutan merupakan penghantar listrik yang baik, jika larutan tersebut meganggung ...
|   | a. Ion-ion yang dapat bergerak bebas |
|   | b. Logam yang bersifat konduktif |
|   | c. Molekul-molekul zat tekanan |
|   | d. Pelarut yang bersifat polar |
|   | e. Elektron yang bebas bergerak |
| **Tier 2** | Manakah salah satu alasan yang paling sesuai dengan jawaban anda? |
|   | a. Larut dalam air |
|   | b. Memiliki kepekaan yang tinggi terhadap kutub positif dan negatif |
Appendix 2: The form of WCCPL and students’ answer