

# Tracing Individual Conception in Conceptual Change Stages Using Module Assistance

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**Abstract**— Misconceptions have been the problem in the educational field until nowadays. Tracing them will be an important part to solve the problems. The study aims to trace the individual conception using module assistance. The method was implementing a module of M3CGK containing conceptual change strategic to 16 students of Chemistry Department, Universitas Negeri Surabaya, as research participants. The finding showed that the traces of individual conception for each participant were different, although they got the same treatment. In addition, conceptual change strategic administered in the module of M3CGK succeeded in reconstructing the understanding of the majority of individuals with 81.25% of individuals shifting conceptions status from MC to KC. Also, 18.75% remained misconceptions.

**Keywords**— trace; individual conception; conceptual change; module assistance

## I. INTRODUCTION

The facts on the educational institutions have been showing that chemical misconceptions can be experienced by various groups involving high school students, higher school students and the teachers. According to some researchers, misconception is defined as the incompatibility of students' conceptual understanding with the scientific understanding formulated by scientists in their fields [1]. According to Chiu as cited in [2] explained when teachers experience misconceptions, students will experience misconceptions more easily, because the teachers are considered as one of the references of knowledge for students. Reference [2] Taber (2009) asserts that chemical misconceptions in students can be caused due to chemical learning processes designed and implemented by teachers who misconceptions. Lemma [3] has proven a significant correlation between the intensity of chemical misconceptions in students and their teachers with a determination index of 90%. This means that the misconception that occurs in students is 90% caused by misconceptions that occur in the teacher, while 10% is due to other factors.

One way to substitute existing misconceptions in the field is the preparation of chemical teacher candidates who are free from misconceptions or at least poor misconceptions of chemical content that will be taught to their students. If this preparation is not carried out, the chemistry teacher candidates who in this case are graduates of the Bachelor of Chemical

Education will enter the education system in school with the burden of misconception. Research [4] mentioned that 36% of the students of chemistry education program (semester 7<sup>th</sup>) of FMIPA Unesa had high misconceptions on the concept about a solution which includes the concept of solution conductivity. Students are stated to have a high burden of misconception if they get more than 50% misconceptions of all test items.

One way to reduce the burden of student misconceptions on the concept of chemistry is conceptual change. According to Liljedahl [5], conceptual change is a process of denial of conception held by students and then adopted a new conception. Reference [6] complements the conceptual change description proposed by Liljedahl, that is, a complete process starting from the condition of misconception to the experience of conflict until it turns into a correct conception. The process of conceptual change occurred between the students are not necessarily the same, despite being involved in the same treatment of conceptual change strategic. It is because each individual has different achievement in terms of conception [7]. Concepts are given and objective, while conceptions are transformations from those given and objective that belong to people, so that they are subjective [8]. This subjective nature causes the same concept to be understood differently by different people [7].

Suyono, Masriyah and Muchlis [4] have succeeded in developing five variants of conceptual change strategic. The simplest conceptual change strategic consists of four stages, namely: (1) validation or clarification of misconceptions, (2) the creation of conflicts on the individual condition, (3) the provision of assistance to the equilibration, and (4) the reconstruction of individual understanding. Validation is done to ensure that the individual is truly a misconception on certain chemical concepts because the identification phase of certain chemical misconceptions has been done before. The creation of conflict conditions in the individual self is intended to occur cognitive dissonance or cognitive conflict, carried out by: (a) displaying the correct conception (conception of scientists, scientific conception) then the student is invited to confront the conception already possessed with the correct conception, or (b) presenting anomalies, provides facts or facilitates students to obtain facts derived from the results of other people's research, facts obtained through experiments, and the like that contradict the concept of students. A number, data/facts provided, facts obtained from the results of the conditioned

experiment can lead students to be more in favor of a new conception in accordance with the conception of the scientist. According to Reference [9], individuals with conditions of misconception have an uncomfortable feeling in accepting new concepts, and there is resistance in their cognition, especially the resistance between the wrong conception that it holds and the new, correct conception. Individuals like this will experience cognitive conflict when receiving new information that is different from the old conception. Providing assistance for the equilibration is done through asking questions or providing information. The question or additional information provided leads to evidence that the new conception makes more sense than the old concept (plausible) and more fruitful. Reconstruction of individual understanding is carried out by encouraging or encouraging students to be willing to give up the old conception and accept a new conception. Students are involved in deepening the concept of training by answering questions and/or explaining to others, or applying new concepts that are already owned to explain phenomena in everyday life.

A research conducted by [10] has managed to embody the conceptual change strategies as described above into the module called module of conceptual change for pre-service chemistry teachers (M3CGK), one of which functions is that M3CGK to change misconceptions of pre-service chemistry teachers for concepts in Topic of conductivity of solution. Through individual involvement in the stage of conceptual change strategy that is administered in the form of modules it is hoped that individuals experience cognitive conflict which results in the disequilibrium of the old scheme which is not in accordance with the scientific conception. The relief phase to the reconstruction of individual understanding equilibration and is expected to change the status of individual conception of misconceptions come to know the concept, a change in conceptions (conceptual change). Previous researchers found that not all individuals successfully changed their misconceptions even though they were treated with the conceptual change module. There were six articles referred to be those written in [11], [12], [13], [14], [15], and [16].

Based on the findings above, it is necessary to find the causative factor for the failure in terms of the conceptual change process as defined by Reference [6] starting from the condition of misconception to the experience of conflict until it changes to the correct conception. To reach the correct conception, it can be prefixed with shortly describe individual cognition trail on the stage of conceptual change strategy that is administered in a module that is used for treatment. How is the current individual cognition in conflict with the creation of conditions of different ways? Does the individual experience cognitive dissonance when it is an important data to discuss the success and/or failure of the conceptual change strategy that is administered into module form? Are experimental data (authentic facts) presented to individuals able to direct cognition or reverse the direction of individual cognition to then be more in favor of a new conception in accordance with the conception of scientists? Whether submitting questions or providing information leading to the evidence that a new conception more sense than the old conception (plausible) and more fruitful makes individuals experiencing equilibration,

characterized started rejecting the old conception? Is the individual engagement in deepening the concept exercise by answering questions and/or explain to others, or to apply a new concept that has been held to explain the phenomenon in everyday life triggered reconstruction individual understanding? The success of reconstruction is indicated by removing the old conceptions and receiving a new conception, moving from misconceptions to knowing concepts.

The discovery of symptom that represents that individual experience cognitive conflict is an important data to discuss the success and/or failure of conceptual change strategies. According to Reference [17], individuals with high levels of cognitive conflict will have high logical thinking abilities. That is, individuals with high levels of cognitive conflict have a constructive impact on understanding the concept so that tendencies have a low burden of misconception. Furthermore, Reference [17] explained the constructive nature of individuals with high levels of cognitive conflict, namely: 1) having a high level of recognition of anomalous situations or when given new information, 2) having a high interest in understanding information new, 3) having high anxiety when not recognizing new information, and 4) reassessing conflict situations or repeat information searches that are not yet understood. The question is whether individuals who are found to experience high levels of cognitive conflict when entering the second stage of conceptual change strategies prove to be individuals who know the concept.

The purpose of this study was to trace the individual conception using module assistance. By considering the statement of Reference [7], the research pointed that conceptual change process occurred by each student is different, even they got the same treatment.

## II. METHODS

The participant was 16 students who had two chemical conception statuses that were less even unfavorable. First, these 16 students have a high burden of misconception on concepts in solution chemistry. Second, the 16 students experienced misconceptions on the concept of solution conductivity. Conception status of students is divided into three categories, namely "knowing concept" (KC), "not knowing concept" (NKC), and misconception (MC). The conception data of each individual before and after being involved in the conceptual change strategic, the data of each individual's conception in each stage of the conceptual change strategic is identified from the mind representation of each individual written in the module composing modules developed based on conceptual change strategic.

The module used in the study have been declared feasible to use, meaning that they meet the criteria for content and construct validity, practicality and effectiveness. The module was declared valid content and construct the percentage of agreement between the validator majority in the 100% with the lowest value of 88.9%. The module had high practicality because in a large proportion of the content can be understood by all participants. Furthermore, the effectiveness of the module reached 71%, in which the participants experienced changes in terms of their conceptual status, from MC to KC

[10]. The data of individual conception have been analyzed descriptively to describe the traces of individual conception at each stage of the conceptual change strategic assisted by the module.

### III. RESULTS AND DISCUSSION

The results and discussion is divided into two parts. The first one is Individual Conception Status. The second one is Individual Conception Traces in Conceptual Change Stages. Each will be elaborated in more detail below.

#### A. Individual Conception Status

Changes in students' conceptions are seen from the status of the initial conception (before treatment) and the status of the final conception (after undergoing a conceptual change-based module strategic). A total of 16 pre-service chemistry teachers as participants was initially having (1) a high burden of misconception on the concept of solution and (2) misconception on the concept of solution conductivity. The data of conceptions status changes are presented in Table 1.

module, namely, individuals with ID.1, ID.2, and ID.14. The individual was occurring misconceptions resistant. In other words, the treatment with the conceptual change strategic assisted by the module did not succeed in changing (disrupting) the scheme that had been built in his brain.

The above facts can be discussed, one of which is based on the statements of Reference [18] which explains that the condition of misconceptions on an individual's cognitive structure is more difficult to change than the condition of not knowing the concept or understanding partially. Changing the majority of individuals from misconception status to know the concept may be passed through the status of not knowing the concept first or the shock of conception. This prediction will be proven in the trace data of each individual's conception (see Table 2).

TABLE I. CHANGES OF INDIVIDUAL CONCEPTION ON CONCEPTS OF SOLUTION CONDUCTIVITY

ID. Code	Conception Status		Impact
	Before Treatment	After Treatment	
ID.1	MC	MC	0
ID.2	MC	MC	0
ID.3	MC	KC	+
ID.4	MC	KC	+
ID.5	MC	KC	+
ID.6	MC	KC	+
ID.7	MC	KC	+
ID.8	MC	KC	+
ID.9	MC	KC	+
ID.10	MC	KC	+
ID.11	MC	KC	+
ID.12	MC	KC	+
ID.13	MC	KC	+
ID.14	MC	MC	0
ID.15	MC	KC	+
ID.16	MC	KC	+

Based on the Table 1, there were 13 individuals from 16 treatment targets (81.25%) who had changed their conceptual status from MC status to KC status after being treated with a conceptual change strategic assisted by the module. The majority (81.25 %) of individuals have successfully changed their conceptions incorrectly through the conceptual change strategy stages which are administered into modules. There were three individuals (18.75%) who did not experience a change in their conceptual status even though they have been treated with a conceptual change strategic assisted by the

**B. Individual Conception Traces in Conceptual Change Stages**

The changes of individual conception status are presented in Table 2. The Table 2 presented the data of conception status in each stage of the conceptual change strategic.

**TABLE II. STUDENTS' ACHIEVEMENTS FOR EACH CONCEPTUAL CHANGE MODULE STAGE**

ID. Code	MC Validation (Stage I)	MC Validation (Stage II)							Conflict Cognitive Stages	Providing Assistance for Equilibration	Reconstruction	Evaluation
		1	2	3	4	5	6	7				
ID.1	KC	NKC	MC	MC	MC	MC	NKC	KC	In conflict	already understand the relationship between the variables of conductivity, type of ion and number of ions	50	60
ID.2	KC	MC	KC	KC	KC	MC	KC	KC	Not in conflict	do not understand the relationship between the variables of conductivity, type of ion and number of ions	50	80
ID.3	KC	MC	KC	KC	MC	KC	KC	KC	Not in conflict	do not understand the relationship between the variables of conductivity, type of ion and number of ions	83	100
ID.4	KC	MC	KC	KC	KC	MC	KC	KC	In conflict	already understand the relationship between the variables of conductivity, type of ion and number of ions	67	100
ID.5	KC	KC	KC	KC	KC	MC	KC	KC	In conflict	already understand the relationship between the variables of conductivity, type of ion and number of ions	100	100
ID.6	KC	MC	MC	KC	KC	MC	KC	KC	In conflict	already understand the relationship between the variables of conductivity, type of ion and number of ions	67	40
ID.7	KC	KC	KC	MC	KC	KC	KC	KC	In conflict	already understand the relationship between the variables of conductivity, type of ion and number of ions	83	100
ID.8	MC	NKC	KC	KC	KC	KC	KC	KC	In conflict	already understand the relationship between the variables of conductivity, type of ion and number of ions	83	100
ID.9	NKC	NKC	NKC	NKC	NKC	NKC	NKC	NKC	In conflict	already understand the relationship between the variables of conductivity, type of	83	100

ID. Code	MC Validation (Stage I)	MC Validation (Stage II)							Conflict Cognitive Stages	Providing Assistance for Equilibration	Reconstruction	Evaluation
		1	2	3	4	5	6	7				
										ion and number of ions		
ID.10	KC	NKC	KC	KC	KC	KC	KC	KC	In conflict	already understand the relationship between the variables of conductivity, type of ion and number of ions	83	100
ID.11	KC	MC	KC	KC	KC	KC	KC	KC	In conflict	already understand the relationship between the variables of conductivity, type of ion and number of ions	83	100
ID.12	KC	NKC	KC	KC	KC	KC	KC	KC	In conflict	already understand the relationship between the variables of conductivity, type of ion and number of ions	83	100
ID.13	KC	MC	MC	KC	KC	MC	KC	KC	In conflict	already understand the relationship between the variables of conductivity, type of ion and number of ions	67	40
ID.14	MC	KC	KC	MC	MC	MC	KC	MC	In conflict	already understand the relationship between the variables of conductivity, type of ion and number of ions	67	80
ID.15	KC	MC	KC	MC	KC	MC	KC	KC	In conflict	already understand the relationship between the variables of conductivity, type of ion and number of ions	83	80
ID.16	NKC	NKC	MC	NKC	NKC	MC	KC	NKC	In conflict	already understand the relationship between the variables of conductivity, type of ion and number of ions	50	100



Additional information for the substance in Table 2 is given as follows. The validation stages was divided into validation stage I and stage II. It was in order to confirm the conception of students. In the stage I, the students assessed the truth of one main statement and in the stage II the students assessed the truth of 7 statements related to the concept of conductivity. The cognitive conflict stage is carried out by asking individuals to observe and assess data related to the concept of solution conductivity and accompanied by questions for observing the opportunities of students' confusion individually. The stage of providing assistance for equilibration is done by exposing individuals to data or facts that support the process of justification of the concept of conductivity. At this stage the assessment is carried out on the individual's response to the concept statement and written evidence made by the individual to justify the response given. The reconstruction stage was conducted by giving a scientific text and application of concepts in everyday life to force individuals for holding the new constructed concepts in their cognitive structures and building the old conceptions. The evaluation stage in the module is designed to capture the final status of each individual.

Based on the Table 2, It has been successfully described the traces of individual conception at the conceptual change strategy stage administered in the module (M3CGK). The traces of individual conception differ from one another. Individuals who were originally misconceptions due to the passage of time most experienced a change in conception status to know the concept, but not yet strong (stable) sometimes still returning to misconception status when validated (clarification). Some others have a tendency to change status to NKC. Two of the 16 individuals do not conflict at the cognitive conflict stage. Individuals who did not experience this cognitive dissonance turned out to be misconceptions at the end of the treatment. This is an important data to discuss the success and/or failure of the conceptual change strategic that is administered into the module form. The cognition of most individuals is successfully directed and reversed by presenting experimental data (authentic facts) that are contrary to the initial conception of the individual. The asking questions or providing information leading to the evidence makes individuals to experience equilibration indicated rejecting the old conception. The involvement of individuals in the deepening of concept exercise by answering questions and/or explain to others, or to apply a new concept that has been held to explain the phenomenon in everyday life triggered the reconstruction of individual understanding. The majority of individuals reach KC status at the end of treatment.

ID.01 and ID.2 did not conflict when they were in cognitive conflict stage. These two individuals remained misconceptions at the end of the treatment. If it is discussed based on the opinions of Reference [17], the individuals did not have sufficient logical reasoning, so that the lack of a high level of recognition of anomalous situations or when given new information occurred. In addition, they could not have high interest in understanding new information and anxiety when not recognizing new information. Moreover, they were unable to reassess conflict situations or repeat information searches that were not yet understood.

#### IV. CONCLUSION

There were three points to sum up the results and discussion. They are presented below:

1. Conceptual change strategic administered in the module of M3CGK succeeded in reconstructing the understanding of the majority of individuals with 81.25% of individuals shifting conceptions status from MC to KC. Also, 18.75% remained misconceptions.
2. The traces of individual conception for each participant are different.
3. For the further implementation of conceptual change strategic and development of conceptual change module, the educators or researchers have to consider the construction of cognitive conflicts.

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