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Effect of Cognitive Conflict Strategy and Motivation on Conceptual Change in Algebra

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Abstract

This paper aims to determine the effects of cognitive conflict instructional strategy and motivation on conceptual change in algebra among Tenth Graders in UAE. To collect data, the author adapted a Motivation to Engage in Conceptual Change Questionnaire (MECCQ) to measure level of student's motivation to engage in conceptual change. Pre and post of Conceptual Change in Algebra Test were analyzed. Four classes of Tenth Graders from two schools (two classes for experimental group (n=60) and the other two classes for control group (n=57)) were choose randomly from 20 classes of 543 Grade Ten male students. Two-way ANOVA test was used to answer questions of this study. The results showed that there is significant main effect of cognitive conflict strategy and motivation on conceptual change in algebra among Tenth Graders in the United Arab Emirates. However, there is no significant interaction effect of instructional strategy and motivation on conceptual change in algebra.

Keyword: Algebra, Algebra Misconceptions, Cognitive Conflict Strategy.

Introduction

Learners acquire their mathematical concepts from a variety of sources including peers, teachers, parents and everyday experiences. If concepts are not accurately developed in learner's mind, he or she may have misconceptions (Karadeniz, et al., 2017). According to Mulungye, et al (2016), these misconceptions have direct negative effect on learners' achievement and performance. Mathematics misconceptions as a part of the learner's inaccurate mathematical structure drive him or her to provide incorrect answer (Holmes, et al., 2013).

As with other branches of mathematics, students have many conceptual errors in algebra. For example, some learners have misconception of adding non-like terms in algebraic expressions: they simplified $5x + 3$ as $8x$. They used an alternative concept that includes merging two non-like terms in one term. It is clear that this error is not computation error, but rather built a conceptual error in their cognitive structure. Also, some learners join algebraic 'objects' as a new one 'object' incorrectly like " $2x + 5y = 7xy$" (Campbell, 2009).

Learners use their misconceptions in algebra subjects and related lessons in other subjects. This indicates that students stick to these concepts because of their firm belief in their validity. Therefore, there is an urgent need to uncover these errors in school algebra. In addition to finding effective strategies to get rid of these harmful concepts.

Problem statement & Study rationale

Studies have indicated the presence of conceptual errors in various school algebra classes. Students move to higher grades bringing with them a variety of misconceptions that directly impact understanding of new algebra lessons (Öçal, 2017; Mulungye, et al., 2016; Akhtar & Steinle, 2013; Muzangaw & Chifamba, 2012; Küçük, 2011). In general, it seems that conceptual errors in algebra constitute one of the reasons for students' weakness in mathematics, due to the close connection of algebra with other branches of mathematics.

The researcher (who was a mathematics teacher in the United Arab Emirates) noticed that tenth graders had a number of conceptual errors in algebra. It was clear that these students carry these errors from previous classes. When students tried to use their preconcepts to learn new algebraic topics, they encountered incorrectness or did not reach a correct result in their solutions.

In search of ways to address these misconceptions, Irawati, et al (2018); Maharani and Subanji (2018); Assagaf (2013); Chow and Tregust (2013); Kabaca, et al (2011); Toka and Aşkar (2002), suggested cognitive conflict as an instructional strategy to redress conceptual errors that students have by presenting contradictory experiences that confront students' prior knowledge in order to reconstruct their concepts. This instructional strategy provides an opportunity for students to be dissatisfied with their exist knowledge which is inaccurate. It is predictable that cognitive conflict strategy can make students aware of their misconceptions (Irawati, et al., 2018).

Conceptual Change and Cognitive Conflict Strategy

Constructivist theory emphasizes the importance of students' prior knowledge. Accordingly, in order to encourage constructive learning, students need to connect the concepts to be learned to their prior concepts. In case of misconceptions, learning new concepts collides with prior inaccurate concepts, which requires promoting conceptual change to replace students preconceived inaccurate concepts with mathematically acceptable concepts. Teachers will not be able to add new valid concepts that conflict with existing ones simply by presenting these concepts as alternative concepts. It seems that teachers need to construct meaningful cognitive conflict as a strategy to change learners' perceptions by presenting contradictory information.

According to Vosniadou and Verschaffel (2004), conceptual change needs different techniques to be accomplished. They argued that the use of additional techniques in situations requiring conceptual change usually causes misunderstandings. Kang, et al (2010) argued that students sometimes refuse amendment even if they are aware of inconsistency. They constructed a model of conceptual change in which cognitive conflict and/or situational interest persuaded by a discrepant event. They suggested four conditions that are essential for conceptual change (dissatisfaction, intelligibility, plausibility and fretfulness). If these conditions are not met in the new concepts, students' preconcepts will keep on, and conceptual change doesn't proceed (Kural & Kocakualah, 2016).

In Piaget's theory of cognitive development, learners acquire new knowledge through three main principles: assimilation, accommodation and equilibration. Equilibration refers to the process in which learners explain phenomena through encountering new experiences and attempt to appropriate their current structure with conflict to reach equilibration. Lee et al. (2003) claimed that cognitive conflict refers to the equilibration principle in Piaget's model.

Some models support positive result of cognitive conflict to foster conceptual change (Chow & Treagust, 2013; Kabaca, et al., 2011; Toka & Aşkar, 2002; Kwon, et al., 2000; Hewson &

Hewson, 1984). Despite the positive results of cognitive conflict as an instructional strategy for conceptual change, some negative effects were found. These cases derive us to analyze the difficulties that make students unable to change their preconceptions even they realize the contradiction. Kang, et al (2010) claimed that cognitive conflict alone cannot be as effective as expected in stimulating conceptual change. They discussed the potential role of some non-cognitive factors such as motivational factors, attention to the situation, and effort. Limón (2001) believes that there are many difficulties facing the application of the cognitive conflict strategy, as there are many variables that affect students' learning such as motivation, cognitive beliefs, attitudes, etc. He indicated that it is necessary to take these factors into account. He justified that the cognitive conflict strategy requires that learners have a higher level of cognitive engagement compared to traditional instructional strategies. It was recommended that further studies be conducted to study the influence of all these aspects independently and the interaction between them.

Despite the criticisms directed at cognitive conflict as a strategy for conceptual change, it remains effective for achieving this purpose. But it is necessary to take into account the criticisms of this strategy. Some procedures may improve the use of cognitive contradiction in conceptual change. Teachers must know how to create cognitive conflict situations for their students and carefully prepare counterexamples that make learners dissatisfied with their preconceptions. The literature shows that motivation is likely to be an important factor in encouraging students to resolve dissatisfaction when faced with anomalous data.

The researcher of the current study considers the criticisms that faced the classical approach of conceptual change by taking in account motivation factor as a separate factor and integrating it with cognitive conflict. Some fruitful efforts have been made in this area, but more research is needed in this field especially in the United Arab Emirates. To the best of the author's knowledge (this research is the first of its kind in the United Arab Emirates). This research is an occasion to treat students' conceptual errors in algebra to help them get a deeper understanding of algebraic concepts, relationships, expressions, equations and functions as well as prepare them for advanced and more abstract mathematics knowledge. No doubt, students with accurate scientific concepts are much abler to solve real life problems.

The author adopted some models that support positive results of cognitive conflict to promote conceptual change. These models include four main common elements: make students aware of their preconcepts, comforting them by anomalous data, using cognitive conflict to change student's prior knowledge and finally evaluate the results of conceptual change. The author suggests a new part named "Achieve Scientific Concept" which is not included in other approaches of conceptual change.

This part aims to ensure that student-student and teacher-student discussions lead to understanding the scientific concept. For the motivation factor, the researcher takes the cales self-efficacy and goal orientation which are strongly related to the role of motivation as a non-cognitive factor in conceptual change process. Goal orientation refers to the reasons why a student engages in a learning task and self-efficacy includes judgments about one's ability to master a task in addition to one's confidence in one's skills to accomplish that task (Pintrich et al.,1991). The process of this approach is shown through the example: solve the equation $(x + 7)/4 = 8$ under these headings:

(a) Detect Students Preconceptions

In this part, teachers can elicit students' preconceptions using 'exposing situation' which urges students to use their existing conceptions to interpret the situation. Once students' preconceptions are detected, teachers can use them as a basis for the next instruction. The expected misconception for solving the equation $(x + 7)/4 = 8$ is that students subtract "7" from the both sides instead of multiplying by "4" to get $\frac{x}{4} = 1$ and then $x = 4$.

(b) Evaluate Students Preconceptions

After detecting students' existing knowledge, teachers start to facilitate discussion between students in pairs or groups to evaluate these preconceptions for its intelligibility, plausibility and fruitfulness. Teachers in this part ask students 'critical questions' that can make students aware of their preconceptions and prepare them for cognitive conflict (Merenluoto & Lehtinen, 2002). Teachers try to make students dissatisfy of their incorrect choosing of the inverse operation by asking them: can we write $\frac{x+7}{4}$ as $\frac{x}{4} + 7$?

(c) Create Cognitive Conflict

Cognitive conflict can be created when learners become dissatisfied with their prior ideas and more open to replace them. Teachers should give students a counter example or more that contradicts their theory to destabilize student's confidence in their existing knowledge (Chow & Treagust, 2013). In all parts of conceptual change process, especially in cognitive conflict state, students need to be motivated by teachers to engage in conceptual change learning. Motivation beliefs may influence students' readiness to accept new conceptions that contradict their exist knowledge. Teachers ask students: how to check if $x = 4$ is the solution of the equation $\frac{x+7}{4} = 8$ or not? Substitute your solution " $x = 4$" in the equation " $\frac{x+7}{4} = 8$".

(d) Achieve Scientific Concept

The author suggests this new to ensure that student-student and teacher-student discussions derive to understanding the scientific concept. To which degree do students reach to a meaningful cognitive conflict process that support the accurate mathematical concept? Teachers ask students to explain the accurate concept to whole class. Teachers ask students in groups to do exercises like $\frac{5-x}{3} = 7$ as new problem is related to the new concept.

(e) Explore New Problems

The author agrees with Kural & Kocakualah's (2016) approach which stated students should compare their preconcepts and new concepts, how they are different, and to what extent these new concepts are useful in resolving new problems. Teachers use exercises like $\frac{3y-2}{5} = 4$ to assess the new concept. Teachers should motivate students to make conclusions using their own words about the new concepts.

Literature Review

Algebra Misconceptions

Based on literature, the author classified expected misconceptions in algebra for Tenth Graders into four categories: algebraic expressions, linear equations, polynomials, exponents and radical expressions, and finally functions and graphs. In this subsection, some literature will be reviewed for these categories.

For algebraic expressions misconceptions, Campbell (2009) observed a conceptual error when they try to simplify a fraction like: $\frac{x+y}{x}$ in which they wrote y as a simplest form. Mulungye (2016) found the learners simplified $\frac{1}{3x}+\frac{2}{x}$ as $\frac{3}{4x}$. He observed that students treated the sum of denominators as a common denominator. Students see the (+) symbol as invitations to do something (Chow, 2011). Irawati and Ali (2018) described this misconception as merging the algebraic addition (conjoining) mistakenly. Dodzo (2016) revealed the misconception of merging the algebraic addition inaccurately. The researcher observed that students simplify $2a+5$ as 7 . It was found that many students ignore the order of operations rules (Chow, 2011). He also noted that some learners simplified $3+x\times 2$ as $6x$. They worked the problem from left to right.
Naturally, if students have misconceptions in algebraic expressions, they will face difficulties in solving linear equations. Toka and Askar (2002) noted that some students rewrote the equation $12-3\,(4-y)=-15$ as $12-12-3y=-15$. They used distributive property incorrectly. Steinle, et al. (2009) found that some students treat the letter x in the equation $x+x+x=12$ as they do with empty boxes ($\square+\square+\square=12$), choosing 2, 5, 5 or 10,1,1 as the values of x, x, x respectively. Chow (2011) observed that some students removed a term from both sides of the equation using subtraction regardless of the adjoining operator symbol (+ or -). They wrote $x-12=4$ as $x-12-12=4-12$ and then, $x=-8$. Some students they solved $5=9a$ by selecting the option $9\div 5$ instead of $5\div 9$. Here, it is clear that students perceived the need to isolate the variable, but they unsure which operation was needed to inverse the one given.
For polynomials and exponents misconceptions, Mulungye, et al. (2016) found a common error in this category that students expanded $(x+y)^2$ as x^2+y^2. Campbell (2009) named this misconception as over-generalising, including false-linearity. Booth, Barbieri, Eyer, and Blagoev (2014) found that students start correctly when they expanded $(a+4)^2$.They wrote $(a+4)(a+4)$. In the second step, did not distribute entire binomial to entire binomial, they wrote a^2+ 16 as a final answer. Luka (2013) described this misconception as a misunderstanding of distributive law in which $a(b+c)=ab+ac$. Students intuitively misapplication the rule in similar situations because the formal distributive property of multiplication over addition was deeply precipitated in their mind. Students simplified $3(x-y)$ as $3x-y$ and $4\,(a+2)$ as $4a+2$.
Another misconception in this category was observed by (Ojose, 2015). He observed that some students add powers in case of adding exponents. They added the powers: y^4+y^4 as y^8 because both terms have the same base and simplified. Campbell (2009) observed that some students operated on one part of a compound term, for example: $(2x)^2=2x^2$. A'yun and Lukito (2018) found a misconception about second degree radicals' addition, for example: student wrote $\sqrt{x^2+y^2}$ as $x+y$ which was observed by (Mulungye, 2016) when learners asked to write $\sqrt{a^2+b^2}$ in a simplest form.
Students use their prior knowledge about algebraic expressions, exponents, polynomials and equations to perform skills related to functions and their graphs. Casnsiz, et al. (2011) observed some students can't determine whether a given graph is function. They misunderstood the definition of the function. For example, students combined the lines that was given in the graph and then decided that graph was a function. Students stated that the graph cannot be a function if it is not continuous. Some students also cannot distinguish between independent variable and dependent variable. Xiaobao (2006) observed that students consider only one variable of a function. They tend to ignore the independent

variable. For example, they only considered the differences between values of the dependent variable (car value) in order to determine whether given values of independent and dependent variables represent linear function. They ignored the value of independent variable (the age).

Cognitive Conflict for Conceptual Change in Algebra

Effective cognitive conflict interventions require that students be in a situation that can lead to conflict, and that alternative concepts are available and understandable. (Fraser, 1983). In his imperial study, the researcher found that cognitive conflict interventions were effective in structural understanding in algebra for the majority of students but were not effective in the case of weak students. Toka and Askar (2002) designed conceptual change texts to change misconceptions that students have in first degree equations with one unknown. Students were given situations in order to identify common misconceptions. The model starts by producing dissatisfaction events and then present an understandable and plausible explanation to the students. The result showed that awareness of preconceptions was not adequate for better conceptual understanding. Christou and Vosniadou (2005) noted that students faced difficulties when they treat numbers other than neutral number. The researchers found that the conceptual change framework provided better explanation of students' difficulties in interpreting literal symbols in algebra. They asserted that students should recognize that literal symbols represent all kinds of numerical values not only natural numbers which helps to deal with new concepts like equation, absolute value of a number and many others.

Chow and Treagust (2013) used a model of cognitive conflict strategy to foster conceptual change consists of four main elements: make students aware of their preconceptions, comforting them by anomalous data, using cognitive conflict to change student's exist knowledge and finally evaluate the results of conceptual change. It was found that cogitative conflict strategy had a positive effect on improving students' conceptual understanding, attitudes toward mathematics and achievement in algebra. The same result was found by Irwati and Ali (2018) when they investigate the effect of cognitive conflict in minimizing students' misconceptions about addition and subtraction of algebraic expression. The researchers indicated that some students stuck to their misconceptions, therefore they needed to experience more cognitive conflict tasks to recognize their preconceptions.

Motivation to Engage in Conceptual Change

In conceptual change process based on cognitive conflict, it is necessary to take into account factors such as motivation, epistemological beliefs attitudes because cognitive conflict strategy requires a higher level of cognitive engagement more than that of traditional teachings strategies (Limón, 2001). Vosniadou (2006) agreed with the criticisms that faced the classical approach of conceptual change in which metaconceptual, motivational, affective and social/cultural factors were not considered. According to Assagaf (2013), motivation is very essential factor that could induce meaningful cognitive conflict for conceptual change.

To confront the criticisms directed at classical conceptual change, Lee et al (2003) adapted the Cognitive Conflict Model by Lee and Kwon (2001) which consists of two assumptions. First, student's various characteristics like values and attitudes toward learning. Second, learning environment includes roles of peer, teacher, motivation and interest. Merenluoto and Lehtinen (2004) suggested a conceptual change model which tacking into account many factors including motivational sensitively which refers to the degree of students' interesting

of new cognitive of the phenomena. The researchers argued that learners will be more open to experiencing teaching conflict toward more radical conceptual change if they are motivated enough. It was found that this model of conceptual change had a significant relation with student's achievement in mathematics. In the current research, the treatment will answer the following three questions:
(1) Is there any significant main effect of instructional strategy (cognitive conflict instructional strategy and conventional instructional strategy) on conceptual change in algebra among Tenth Graders in the United Arab Emirates?
(2) Is there any significant main effect of motivation on conceptual change in algebra among Tenth Graders in the United Arab Emirates?
(3) Is there any significant interaction effect of instructional strategy and motivation on conceptual change in algebra among Tenth Graders in the United Arab Emirates?

Research Design
In order to acquire information for the first area, a non-equivalent control group as a quasi-experimental research design was used which provides adequate controls. The researcher adapted a Motivation to Engage in Conceptual Change Questionnaire (MECCQ) from the Motivated Strategies for Learning Questionnaire (MSLQ) developed by Pintrich et al. (1991) to measure level of student's motivation to engage in the conceptual change process and then, categorized the results into two levels of motivation: low and high. The researcher administrated Pre-Conceptual Change in Algebra Test (PreCCAT) to identify and classify common misconceptions in algebra. PreCCAT served also as a pretest.
Two intact groups of treatment (each group consists of two classes) were assigned randomly to the experimental group (X_1) and the control group (X_2). The target two groups were assigned to the MECCQ, categorized each group into two levels of motivation, pretested, administrated ten weeks of treatment (learning through cognitive conflict instructional strategy for the experimental group and learning through conventional instructional strategy for the control group), and then post tested. The research design is shown in Table 1.

Table1
Research Design

Group	Motivation	Pre-test	Treatment	Post-test
Exp group	Low	O_1	X_1	O_2
	High	O_1	X_1	O_2
Control group	Low	O_1	X_2	O_2
	High	O_1	X_2	O_2

Where,
O_1: Represents Pre-test scores of experimental & control groups,
O_2: Represents Post-test scores of experimental & control groups,
X_1: Represents cognitive conflict instructional strategy,
X_2: Represents conventional instructional strategy.

Participants
The population of the study consisted of all Grade Ten male students in public schools of ALAIN city in the United Arab Emirates. Specifically, target population was 20 classes of 543 Grade Ten male students. In addition, all Tenth Graders' teachers in all secondary schools of ALAIN city were involved in this study. Therefore, simple random sampling was conducted to choose (4) classes of Tenth Graders from two schools (two classes for experimental group from the first school (N=60) and the other two classes for control group from the second school (N=57)).

Instruments
In order to collect data for this study, the following four instruments were used

1. Motivation to Engage in Conceptual Change Questionnaire (MECCQ)
This questionnaire aims to measure student's motivation to engage in conceptual change. Based on the results of MECCQ, students were categorized into two levels of motivation: low and high. For MECCQ, the researcher adapted the Motivated Strategies for Learning Questionnaire (MSLQ) developed by (Pintrich et al., 1991). The MSLQ consists of two sections, motivation and learning strategies. The motivation section contains 31 items that evaluate goal orientation (intrinsic and extrinsic), task value, self-efficacy for learning and performance, control beliefs and test anxiety.

2. Conceptual Change in Algebra Test (CCAT)
The instrument served three areas. Firstly, CCAT was used to identify misconceptions in algebra for Tenth Graders. Secondly, this test served as a pre-test for the experimental group and the control group. CCAT also was conducted after ten weeks of treatment as a posttest. The test consists of 20 items and the range scores is between 0 and 40. For each item, a student may get a score of 0, 1, or 2. The scores are awarded based on prepared rubric that is graded on students' misconceptions.
To determine the validity of the study instruments, the MECCQ as an adapted questionnaire was sent to three experts to determine its content validity. CCAT items was presented to three experts in mathematics education to make sure that each item detects one or more common misconceptions in algebra. The experts were asked to determine whether each item of CCAT can measure conceptual change for one or more misconceptions in algebra. In order to determine the reliability of the instruments of this study, the test-retest reliability includes giving the same test on two times was used in this study. The researcher repeated the MECCQ and the CCAT two weeks later on the same sample and then calculate the Pearson correlation coefficient to measure the reliability of the instrument. The target sample included 30 students (one class) for the MECCQ and the CCAT from the population of the study. These students were not involved in the actual study later. The Pearson correlation coefficient (r) was 0.64 for the MECCQ and 0.751 for the CCAT. Since the r values for the MECCQ and the CCAT > 0.6, it indicated a strong correlation coefficient for each of these instruments (Gay & Airsian, 2003).

Data Collection
Several procedures were performed to collect data. The researcher explained all the procedures that need to be followed during the application of the study for the teachers in the targeted sample. The researcher conducted training for the participating teachers in the expanded experimental study about the different types of treatment. MECCQ and Pre-CCAT

were conducted before treatment. Ten weeks of treatment were conducted and then Post-CCAT as a posttest was administrated.

Data Analysis

Two-way ANOVA was used to answer the research questions. Regarding the Two-way ANOVA, if there is significant difference in the pretest, Analysis of Covariance (ANCOVA) will be used to ensure parity of treatment groups.

Findings

The results of two-way ANOVA test for Pre-CCAT are given in Table 2.

Table 2

Results of Two-way ANOVA Test for Pre-CCAT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Treatment Group	243.354	1	243.354	3.702	.06
Motivation Level	1078.189	1	1078.189	16.401	.000
Treatment Group * Motivation Level	89.296	1	89.296	1.358	.246
Error	7428.338	113	65.738		
Total	8801.248	116			

Based on the results in Table 2, it was found that there was no significant difference in the Pre-CCAT scores according to treatment groups, [F (1, 113) = 3.70, p = .06 (>.05). However, there was significant difference between motivation levels, F (1, 113) = 16.40, p = .00 (<.05). It was also found out that there was no significant interaction effect between treatment groups and motivation levels in the Pre-CCAT scores, F (1, 113) = 1.36, p = .25 (>.05), which means that there was no significant difference between the treatment groups in the Pre-CCAT scores according to motivation levels. Thus, two-way ANOVA test will be used to analyze Post-CCAT scores. The results of two-way ANOVA test for Post-CCAT are given in Table 3.

Table 3

Results of Two-way ANOVA Test for Post-CCAT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Treatment Group	657.873	1	657.873	9.737	.002
Motivation Level	1805.854	1	1805.854	26.727	.000
Treatment Group * Motivation Level	6.212	1	6.212	.092	.762
Error	7635.108	113	67.567		
Total	10156.923	116			

Based on the results in Table 3, it was found that there was significant difference in the Post-CCAT scores according to treatment group (i.e., instructional strategy), F (1, 113) = 9.74, p = .00 (<.05). The Post-CCAT scores of the Tenth Graders in the United Arab Emirates in the experimental group who learned algebra through cognitive conflict instructional strategy was significantly higher than their counterparts in the control group who learned algebra through conventional instructional strategy.

It was also found that there was significant difference in the Post-CCAT scores according to motivation levels (i.e., motivation levels to engage in conceptual change), F (1, 113) = 26.73, p = .00 (<.05). The Post-CCAT scores of the Tenth Graders with high level of motivation to engage in conceptual change in the United Arab Emirates was significantly higher than their counterparts with low level of motivation to engage in conceptual change.

It was found that there was no significant difference in the Post-CCAT scores according to interaction between treatment groups and motivation levels, F (1, 113) = .09, p = .76 (>.05). The results implied that there is no significant interaction effect of instructional strategy and motivation on conceptual change in algebra among Tenth Graders in the United Arab Emirates.

The results of this study show that cognitive conflict as an instructional strategy for conceptual change in algebra was effective. The Post-CCAT scores of the students who learned algebra through cognitive conflict instructional strategy was significantly higher than their counterparts who learned algebra through conventional instructional strategy. This result is in consistent with result that found by Fumador and Agyei (2018) in which the researchers noted the positive effect of diagnostic (cognitive) conflict in treating student's misconceptions in algebra for students (average age of 16 years). Also, the result of this study is in consistent with the result that found by Irwati and Ali (2018) that the cognitive conflict strategy was effective in minimizing students' misconceptions about addition and subtraction of algebraic expression and most of the learners had improved their conceptual understanding.

Motivation as a non-cognitive factor was effective for promoting conceptual change. The results of this study showed that motivation had a significant main effect on conceptual change in algebra. This result is in consistent with the result of Kang, et al (2010), and Limón (2001) studies regarding the importance of motivational factors in the process of conceptual change.

It was no significant interaction effect of instructional strategy and motivation on conceptual change in algebra. This result may be found, because the subsamples in this study were small. The hypothesis testing is easily misused because p-values are driven by sample size. Large samples will tend toward rejection of a given hypothesis, and small samples will not, given the same level (Knaub, 1987). However, there was an increase in the Post-CCAT scores for students in the experimental group more than those for students in control group in terms of motivation level (high level of motivation was accompanied by an increase in the Post-CCAT scores of the students in the experimental group more than Control group), but this increase was not statistically significant.

Conclusion

Misconceptions limit students' ability to properly understand algebra and related subjects. The study showed the presence of a variety of misconceptions in algebra among Tenth Graders, which requires addressing these conceptual errors. The conceptual change approach used in current study which include detect student's preconceptions, evaluate student's preconceptions, create cognitive conflict, achieve scientific concept and explore new problems, was effective. Motivation seems to be an essential factor that promotes conceptual change. The author recommends that the process of conceptual change be present wherever conceptual errors exist. Teachers should give enough time to promote conceptual change using effective strategies such as cognitive conflict instructional strategy. They must also encourage and motivate students towards the desired conceptual change.

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