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Application of Conceptual Change Model in Teaching Basic Concepts of Physics and Correcting Misconceptions

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Abstract

This study aimed to investigate the effectiveness of the conceptual change model (CCM) on learning the basic concepts of Electrostatics. CCM is an active teaching method that puts emphasis on children's preconception. The underlying principles of CCM are derived from constructivist theory. The growing body of research shows that tt ttttt tt kwwwlggge ttttt yyy.. ss ,,, lrr mll ssccc W rtt rrr than being useful and usable. Students encounter problems in understanding Physics concepts (such as static electricity), therefore their perception and understanding is often subject to misconception. Thus, Electrostatics was considered as the subject of this study. The study population comprised of female junior high school students. Design used in this study was the quasi- experimental method of Solomon four-group design. The samples selected conveniently and randomly were assigned to two experimental and two control groups. Researcher-made tests of academic achievement in three areas of knowledge, comprehension and application of concepts, were used as the data collection tools. Then, central and dispersion measures, the t-test and two-way analysis of variance were used to test the hypotheses. Research findings showed that CCM teaching methods are superior to the traditional way of teaching and learning physics concepts in detecting and correcting misconceptions.

Keywords: Conceptual change model, Electrostatics, Misconception, Comprehension, Application of concepts

Introduction

The effects of electricity and its applications on human life are uncovered to everyone. In order to progress in science and technology students have to gradually become familiar with this science during the school and should be trained how to use and apply its concepts (Hudson and Nelson, 1990). Electrostatics concepts have often been expressed through abstract words in most textbooks and students do not have deep understanding of the concepts. In fact, studies (e.g., Reif, 1995) indicate that many students, even those who get good scores, have ended basic physics courses with many misconceptions, non-scientific ideas and skills in solving problems and not using of what they have been taught. In short, students' knowledge about the physics has formal aspects rather than of being useful and usable (Reif, 1995). Research also shows that children face difficulties in understanding of electricity and their perception and understanding are subject to misconception (Koparan, 2010; Raduta, 1998; Turgut et al., 2011). Therefore, efforts to improve education and special attention to the misconceptions of physics and how to fix them seem necessary.

Students sometimes misunderstand or misinterpret scientific content because of persistent misconceptions that need to be overcome by science education a learning process typically called conceptual change (Lappi, 2013). Over the past three decades, many studies have been conducted in the field of students' misconceptions.

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These studies indicate that traditional teaching methods cannot be effective in reducing misconceptions. Among the solutions proposed by researchers (Burgoon et al., 2010), conceptual change view drew more attention and researches showed that a significant conceptual change in learning scientific concepts is helpful (Pinar et al., 1982; Yenilmez &Tekkaya, 2006). View of the conceptual foundations goes to philosophers and historians attempts to explain the change theory in science. Thomas Kuhn (1962) in his famous book “structure of scientific revolutions” states that performance of the internal science of system that builds a model (paradigm) occurs through shared beliefs and assumptions and discovery occurs when a phenomenon does not fit and does not match this model (Machamer, 2007). Some science educators like Viennat, Driver and Easley and McCloskey found that the history and philosophy of science are great sources to answer this question that how scientific concepts are altered in learning sciences (Vosniadou, 2007).

Conceptual change is often associated with introduction of new concepts, elimination of old concepts, introduction of new subordinate classifications, and sometimes even alteration of the whole method of classification (Thagard, 2014). According to Posner and co-workers (1982), four conditions are necessary for a concept change: 1- Students must be dissatisfied with existing conceptions. 2- New concepts should be clear and understandable. 3- New concepts must be plausible and believable. 4- New concepts should be applicable. Posner and co-workers indicated the similarities between the qualities of changes occurred in sciences and the necessity of replacing mental frameworks with scientific concepts (Posner et al., 1982).

When we speak of the students' mental frameworks we must answer to the question that what do we mean by mental frameworks? Students do not enter the classroom with an empty mind. They often have different ideas about things that are called naïve knowledge. Naïve knowledge has two features. First, it is often inaccurate compared with the accepted and formal knowledge. Second, it often hinders deep understanding of concepts (Michelene & Roscoe, 2002). Sometimes naïve knowledge can be easily changed or removed through education to students. This type of naïve knowledge is called preconception. But in some cases, misunderstandings exist even after instruction and students keep insisting on them. This kind of naïve knowledge is called misconception. There are three hypotheses about the nature of naïve knowledge that are briefly discussed here: ontological categories, naïve theories and knowledge in pieces.

Chi, Slotta and Leeuw are of the opinion that entities belong to different ontological categories like matter, processes and mental states. According to this hypothesis, Misconceptions are attributed to a mismatch between the ontological category to which subjects assign a concept and the ontological category to which the concept usually belongs. For example, in physics, most people are in trouble to understand concepts such as electricity, heat, light and force because they mistakenly put these concepts in matter class instead of processes class. In this framework, conceptual change occurs through the reassignment of a concept from one category to another (cited in Mazens & Lautrey, 2003; Ohlsson & Cosejo, 2014).

The second hypothesis is provided by Vosniadou (1992) and Carey (1991). This hypothesis is based on the fact that naïve knowledge is organized. This organization is not created at once but it is created during growth and learning. In this mental model, new acquired knowledge from the experience of others or the community is incorporated in a way that is consistent with the limitations of the basic assumptions. Larger changes, while difficult, are linked to the revision and corrections of the basic assumptions. Learners build a mental model by integrating new material from science instruction with their existing explanatory frameworks: IInformation received through instruction seems to become assimilated to the initial explanatory framework creating synthetic or internally inconsistent models (Mayer, 2002).

The third hypothesis, stated by Di Sessa, is in contradiction to two stated hypotheses DiSessa was of the opinion that the learners’ knowledge about physical phenomena does not possess organized and logical structure so that it could be considered a theory. It's more like knowledge in pieces. These pieces are named p-prims (phenomenological primitives). P-prims are small and numerous intuitive elements that are often quite context specific in their activation. In other words, phenomenological arrangements are superficial interpretations of learners about physical realities rather than being general or abstract. In this view, conceptual change is a reorganization that makes phenomenological arrangements consistent and significantly correlated (DiSessa, 2002).

In the three mentioned approaches, the emphasis is on the understanding of students’ assumptions which is necessary for the process of conceptual change. Knowing this naïve knowledge depends on the ways in which students actively participate and express their knowledge or opinions. This can be said that it is required to motivate and inspire their curiosity about the daily experiences. Effective teaching, based on the conceptual changes, must be in the way that students understand the need to change the concept in their minds and should be encouraged to do so (Vosniadou, 2008). Placing students in interesting and unexpected situations results in the replacement of wrong schemes with the best alternative (Redish, 1995). It is necessary to constantly remind students that physics is around them (Hudson and Nelson, 1990).

Conceptual change may cover several types of phenomena instead of referring to a singular type of learning (Rusanen, 2014). Researches done on the conceptual change demonstrates the high effectiveness of this method for the students learning. Among these, the Yenilmez and Tekkaya work can be cited in which the method of conceptual change texts combined with group discussion was applied to evaluate the students' understanding of plants photosynthesis. According to the findings of this research, this method has corrected a large percentage of the group misconceptions. The results underscore the idea that misconceptions are stable beliefs that cannot be easily modified or removed by traditional teaching methods. The teacher guided discussions help students to review their preconceptions and assist the teacher to analyze the student's ideas (Yenilmez & Tekkaya, 2006).

Haglund and Jeppsson (2014) reported physics teacher students' exercise on using cmmpletion problems in combination with self-generated analogies to make sense of two thermodynamic processes. The researchers found a continuity perspective on conceptual change with a focus on students' reliance on intuitive cognitive resources to be a powerful way to characterize both the students' challenges and how they cmne to terms with them (Haglund & Jeppsson, 2014).

Hovardas and Konstantinos (2006) conducted a research using word associations to evaluate conceptual change in science education. In this method some words are given to test takers and they are asked to freely associate what ideas come to their minds. This tool has been used to assess the performance before and after teaching with the help of conceptual change approach. The differences between the responses of the test takers indicate the efficacy of the conceptual change approach. Researcher suggests that this conceptual change approach is a strong framework to teach sciences (Hovardas & Konstantinos, 2006).

Moreover, Lee and She (2009) conducted a research in which the effects of conceptual change teaching practices are compared with the traditional ways of teaching. They conclude that teaching by the conceptual change improves students' scientific reasoning and even their concepts tend to be more (Lee & She, 2009).

In this regard, in this paper the effects of conceptual change model (CCM) on students' learning of Electrostatics topics will be compared with traditional methods of teaching. With this model, it is showed that some preconceptions of students could be revealed and some of their misconceptions could be understood and revised (Schmidt et al., 2006). The hypotheses of the current work are as follow:

1) CCM leads to a better educational development compared to the traditional method of teaching.
2) eeeeeets' cmmrr eeessinn imrr vvss wnnn CCM is used rather than traditional method of teaching.
3) Application of concepts improves by CCM as compared to the traditional method of teaching.
4) Tee rtte ff ttnnnnt'' micceeeeptisss is rddeeed when CCM is used to teach topics of Electrostatics.

The CCM implementing results proved to be effective in learning Electrostatics concepts. Moreover, it is found that CCM is a successful method to discover and correct the misconceptions.

Method

According to Schmidt and co-workers (2006), conceptual change model consists of six phases. 1- commit to a position or an outcome 2- expose beliefs 3- confront beliefs 4- accommodate concept 5- extend the concept 6- go beyond (Schmidt et al., 2006). This arrangement is adopted to teach some topics of elementary Electrostatics to high school students. The topics include charge up the objects, electric power, electric field and electric potential difference. The examples presented in this paper are all related to teaching one of the topics (i.e. the charging methods of the objects).

Step One: Commit to a position or an outcome

This stage may include a related-content film, historical reports or quotes, working with the devices along with asking students for a prediction or interpretation or simply with a suitable question.

We hoped that students think deeply about the subjects, remember their experiences and become aware of their thoughts at this stage. This step was very sensitive and could affect the overall learning process. Practical activities may not be the best way to learning, but mental activities are always good because thinking is an essential component of meaningful learning (Bonwell & Eison, 1991).

Implementation of the first step to teach Electrostatics

Each student was asked to write down his/her opinion about the following question on the paper. Bees contribute to the pollination of flowers by collecting pollen from one flower and carry it to another. The Bees do not pass across the pollen accidently, but in fact the pollen grains jump towards the bee at the first flower and then jump away from it at the second flower. What makes the pollen to jump?

Step Two: Expose beliefs

At this stage, each student shared his/her ideas with other members. The discussion in small groups is a secure way to discuss ideas. By listening to each other students learn to share their ideas. This activity provides the opportunity for students and teachers to view a different image of the viewpoints offered in the class. Moreover, teachers can pay careful attention to students' answers to discover their misconceptions.

Implementation of the second phase

Students were allowed to share their impressions with other members and express their conclusion as the final result of the group. At this stage they were not expected to determine accurately the charge type of the bee or pollen. They were only asked to draw simple scheme of their interpretations.

Step Three: Confront beliefs

Students' minds often feel a sense of cmpvmnience to interpret a meaning and take a logical path to follow. When suddenly new information is received that is contrary to the current thinking, the mind detects the conflict and/or inconsistency and enters a state of confusion. According to Piaget, this imbalance provides the best time for learning because the mind constantly tries to achieve balance or equilibrium (Schmidt et al., 2006). When the brain detects the inconsistency, it can dispense with new data or it can find a way to resolve this confusion by linking new information with old.

Implementation of the third stage

A sketch of the pollination process (Figure1) was given to students at this stage. Then they were asked to express a clear explanation in the framework of these drawings. At this stage, students examined the beliefs that they already had and see if they could explain the drawings using the beliefs that they had already obtained individually or as a group. In the meantime, they found out if there was a deficiency in their mind and again they seek more information to organize their thoughts and they would refer to the concepts that they had already learned and would try to apply the concepts of contact and friction and induction to describe the shape. In fact, at this stage, they were faced with their beliefs and followed whether their beliefs were true or complete. These were as follows:

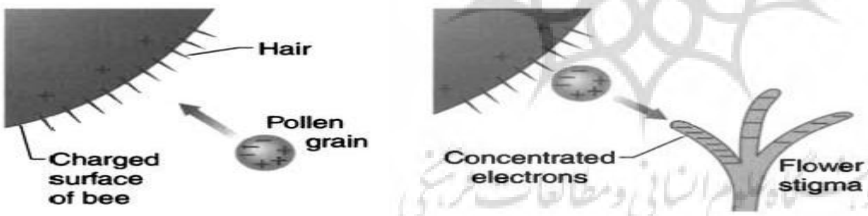

Figure 1. *Pollination by bee (Adopted from Walker, 2007)*

Step Four: Accommodate concept

In the fourth stage which is called the consistency with the concept through the ongoing participation of teachers and students to discuss what they have learned in their group, each student comes to a new understanding that this new understanding is based on new experiences and considering the ideas presented by their classmates and teachers. Each participant needs to have the opportunity to develop a revised conceptual model that unites new Information and experiences. When the newly organizational structure is developed, a more advanced conceptual reflector is from discovered concepts the minds of test takers could return to balance.

Implementation of the fourth stage

At this stage, students had the opportunity to come up with questions to adapt new information to prior knowledge. With questions such as:

1. Why is the body of a bee charged in flight?
2. What is the impact of being stigma on the ground?
3. Complete the following Concept map shown in Figure 2.

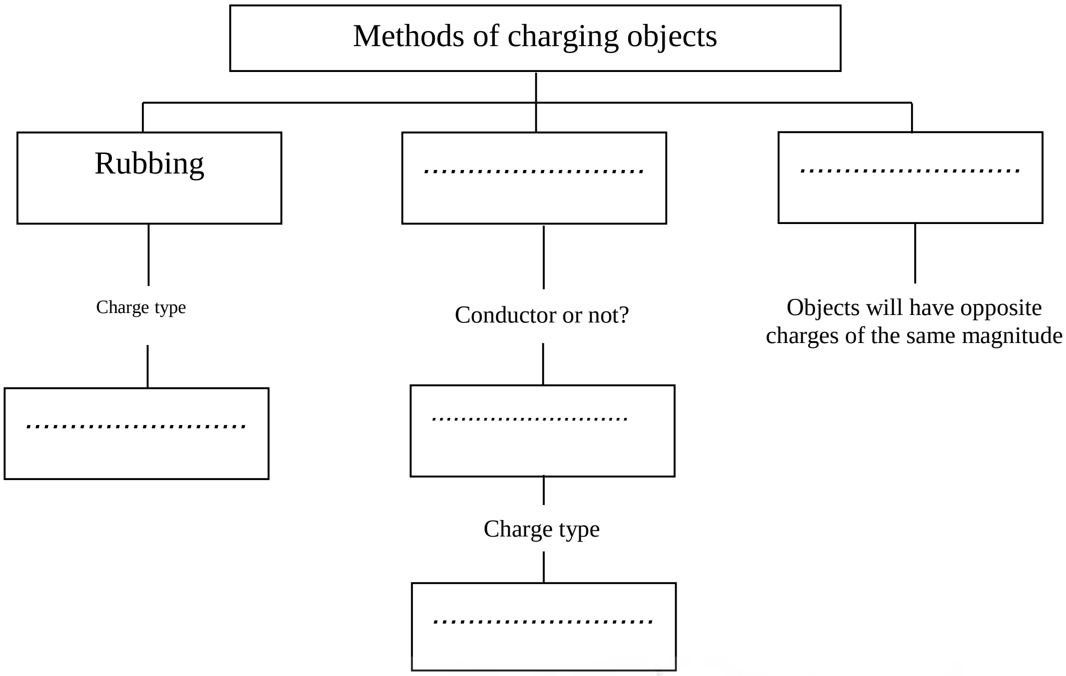

Figure 2. *Concept map*

Step Five: Extend the concept

At this step, students are encouraged to find relations between their new understandings and other experiences obtained from real life or learning environment of schools. This provides immediate opportunity for students to apply their acquired understanding to different examples, both closely and more distantly related to the original example. In this way students find their new conception fruitful (Beeth, 1995).

Implementation of the fifth stage

Students were asked if they had heard of the expression the same as the example. Here teachers can help this process by giving examples such as:

1- If a child slides down from a plastic slide and then touches someone else children may be surprised by sparks from electrical discharge.
2- If the surgeon does not wear appropriate footwear during surgery, the patient may be damaged due to electrical discharge.

Step Six: Go beyond

Students are given new opportunities for thinking about the concept. New doors are opened for creativity in posing the questions and asking further questions.

Implementation of the sixth step

By posing this question, we expected that the steps of conceptual change teaching method are repeated in the cyclic pattern again.

How could be the rain effective in pollination of flowers by bees? Why?

One other feature of this model is that it can describe all the steps in one cycle. It means that in steps such as the process of consistency, developing and going beyond students may return to the first step and delve into their new situation. For example, in the Accommodate concept process students may face challenges to pass this phase due to misconceptions. It can be said that test takers return to the first stage again to discuss their challenges. To better explain this process can be found in the diagram below.

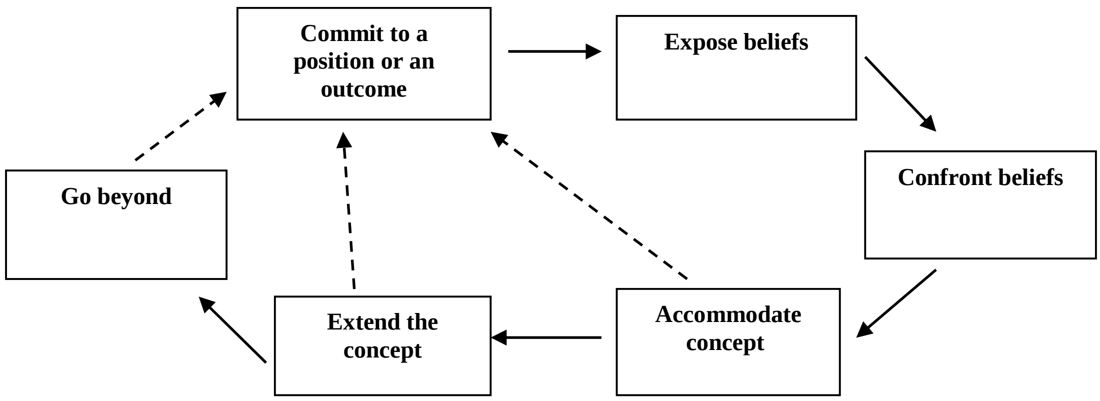

Figure 3. *Looping back within the CCM*

Participants

The population of this study was all of female junior high school students who enrolled for 2013-2014 school year. The size of the population was 252. Convenience samples were selected and randomly assigned to two experiment and two control groups of samples. In this regards, four classes from four schools were selected, from which, two classes of 19 and 20 students were selected as experimental groups and two classes of 19 and 21 students were also picked up as control groups.

Instruments

In order to gather information, a researcher made examination was chosen. Each question of the test consisted of three parts. In the first part, students selected their desired option from four available choices. In the second part, the students were asked to express a reason for their selection. In the third part, they had three options: I guessed the answer, I was not sure about the correct answer, and I was sure it is the right one to choose. This part was provided to ignore the inaccurate data.

To have a better assessment of the misconceptions extracted from the achievement test, five students from each of the experimental and control groups were interviewed. Some interview questions were selected among questions of achievement test that a large number of students had misconceptions with. Test questions were picked up according to Bloom co-workers' targets classifications. These questions assess students' learning and achievements by posing questions at the levels of knowledge, comprehension and application of concepts of Bloom's taxonomy.

To check the validity of the test, a number of experienced teachers were asked to verify the test. After consultation with the experienced teachers, some of the questions were modified or removed. The final number of questions became 20 questions. To obtain reliability, the test was performed on 56 high school students who were independent from the control and experimental groups. The Cronbach's alpha coefficient was calculated using the obtained results. The obtained coefficient was calculated to be equivalent to 0.73 which is an acceptable value for the researcher made examination.

Procedure

The design used in this study was the quasi-experimental method of Solomon four-group design. Using this method is just for the control of the cases in which taking the pre-test makes test takers aware of the experimental variables. In this scheme, there were two experimental groups and control groups. Both of the experimental groups learned Electrostatics by conceptual change model and only one group received pre-test. Both of the control groups trained with the traditional approach and only one group received pre-test. At the end of the course, all the groups were tested by the same exam. It is required to note that by traditional approach we mean a teaching method in which new concepts are brought up regardless of students' preconception. Another feature of this approach is the limited participation of students in the process of knowledge creation and they are listeners to teachers' desired content.

Findings

The analysis of the tests' results was conducted by SPSS software. In this regard, the data normalization was checked using descriptive statistics (pre-test and post-test descriptive tables are not presented here). Since then with the consideration of a two-way analysis of variance, it has been shown that students' answer in post-test was no affected by students' pre-test response. The performance of both groups in the pre-test is homogeneous. We will examine the hypotheses.

Evaluation of pre-test and post-test data normalization

The central and dispersion measures were calculated to evaluate normalization. The obtained values of tension and tilt parameters in pre-tests and post-tests for both of experimental and control groups reveal that data have a normal distribution and can be analyzed by inferential statistics.

The results of two-way analysis of variance

To evaluate the effects the performance of students in pre-test on post-test, two-way analysis of variance was used. In this analysis, pre-test and teaching methods are considered as the independent variable and the post-test scores are described as dependent variables. Thereby it has been shown that whether pre-test has a random effect on test takers in the test and control groups or not. Hence, the research should be reviewed if there are interactions between independent variables that are teaching methods and pre-test here. The results of this analysis have been identified in Table 1.

Table 1.
Results of two-way analysis of variance

Source	Type III sum of squares	Df	Mean square	F	Sig.
Pre-test* teaching methods	0.045	1	0.038	0.015	0.702

As seen in Table 1, a significant amount of the product of pre-test multiplied by teaching method is equal to 0.702 which is greater than 0.05. This amount shows that with a certainty of 95% there is no interaction between pre-test and teaching methods. The traditional teaching methods and conceptual change model can be compared using difference between pre-test and post-test scores of students in control and experimental groups who have received pre-test.

Performance homogeneity evaluation of the two groups at pre-test

To compare the performance of both the test and control groups, it is important to check the homogeneity of the performance of the two groups in the pre-test. Independent t-test was used for this purpose (If there is no significant difference between the two groups performance, they are homogeneous groups). The results of this test are given in Table 2.

Table 2.
Result of independent t-test for pre-test

Assumption	Levene's Test For Equality of variances		t-test				
	F	sig	t	df	Sig. (2-tailed)	Mean difference	Std difference
Equal variances assumed	1.032	0.317	1.125	36	0.205	1.157	0.848

In Table 2, F Levene and t values are given. Since the level of significance amount of F is greater than 0.05, the condition of homogeneity of variances is used. The level of significance amount of t is 0.205 which is greater than 0.05. Therefore, there is not a significant difference between pre-test scores of control and experimental groups and it can be concluded that the performance of two groups are homogeneous in the pre-test. Thus, according to the analysis of variance and analysis of homogeneity, the hypotheses can be evaluated.

a. The assessment of the first research hypothesis

Before we can use the t-tests to examine the first hypothesis, t-test was used to compare the scores of achievement test of pre-test and post-test scores for each control and experimental group. Therefore, t-tests were performed to check whether or not both control and experimental groups have academic achievements and its results are given in Table 3.

Table 3.
Result of paired t-test

		Mean	Std. Deviation	Std. Error Mean	t	df	Sig.(2-tailed)
Pair 1	Experimental group 1 Experimental group 2	-6.842	3.624	0.831	-8.227	18	0.00
Pair 2	Control groups 1 Control groups 2	-4.157	3.975	0.912	-4.559	18	0.00

As seen in the Table, the significance value for both groups is less than 0.05. That means there is a significant difference between the scores of the post-test and pre-test in two groups and both have academic achievements. After this study, by using independent t-tests we have been pursuing whether there is a significant difference in the level of academic achievement between experimental group trained with the conceptual change model and the control group trained with traditional methods. The results of this study are presented in Table 4.

Table 4.
Result of independent t-test for first hypothesis

Assumption	Levene's Test For Equality of variances		t-test				
	F	sig	t	df	Sig. (2-tailed)	Mean difference	Std difference
Equal variances assumed	2.523	0.121	2.617	36	0.013	2.947	1.126

F Levene and t values are given in Table 4. Since the level of significance amount of F is greater than 0.05, the condition of homogeneity of variances is used. The level of significance amount of t is 0.013 which is smaller than 0.05. So there is a significant difference between pre-test and post-test scores of the test and control groups. Since the average scores of the experimental group was higher than the average scores of the control group, we can say with 95% certainty that conceptual change model has been more effective in the context of static electricity compared to traditional teaching method and the first research hypothesis is confirmed.

b. The analysis of the second hypothesis of this study

We used the t-test like the first hypothesis to investigate this hypothesis. This means that scores for the answers in the area of conceptual understanding are investigated. Answering these questions in the test and control groups was compared and the results are shown in Table 5.

Table 5.
Result of independent t-test for second hypothesis

assumption	Levene's Test For Equality of variances		t-test				
	F	Sig.	t	df	Sig.(2-tailed)	Mean difference	Std. difference
Equal variances assumed	1.770	0.192	2.559	36	0.015	1.315	0.514

F Levene and t values are given in Table 5. Since the level of significance amount of F is greater than 0.05, the condition of homogeneity of variances is used. The level of significance amount of t is 0.013 which is smaller than 0.05. Therefore, there are significant differences between pre-test and post-test scores in control and experimental groups in the realm of conceptual understanding. The second hypothesis is confirmed because the average score of the experimental group is higher than the control group.

c. The analysis of the third research hypothesis

We used the t-tests to investigate this hypothesis. This means that scores given to answers of questions that are within the area of applying will be assessed. Answers to these questions in the test and control groups were compared. The results are shown in Table 6.

Table 6.
Result of independent t-test for second hypothesis

assumption	Levene's Test For Equality of variances		t-test				
	F	**sig**	**t**	**df**	**Sig.(2-tailed)**	**Mean difference**	**Std difference**
Equal variances assumed	0.092	0.764	1.634	36	0.111	0.789	0.483

F Levene and t values are given in Table 6. Since the level of significance amount of F is greater than 0.05, the condition of homogeneity of variances is used. The level of significance amount of t is 0.111 which is greater than 0.05. Therefore, there is no significant difference between pre-test and post-test scores in the control and experimental groups in the realm of applying and the third hypothesis is rejected.

hhis means that students' performances in test and control groups for answering the questions that are applied to the realm of applying are the same.

d. The evaluation of the fourth research hypothesis

Before investigating this hypothesis, it is necessary to discuss misconceptions obtained from the achievement test and interview.

1) More than half of the students believe that when two objects rub together, positive and negative ions are exchanged between two objects.
2) They do not understand the concept of quantum charge. They believe that the electric charge can be an arbitrary amount or a continuous quantity.
3) Due to electrical inductance the amount of charges from charged objects is deducted and added to uncharged objects.
4) The human body is constantly exposed to electrical discharge. In all circumstances the physical contact with the human body cause electrical discharge of charged object and neutralize it.
5) The electric force is only between two charged objects and there is no electrical force between objects if one of the objects is uncharged.
6) The electric field work depends on the route and more work is done if the route is longer and more curved.
7) Electrical potential as the electrical charge is higher on sharp tip of the conductors.
8) The concepts of electric field and electric potential are applied instead of each other. They did not distinguish between them.
9) Electrical potential as the gravitational potential depends on the height.
10) Electric current is stored in batteries; the current will flow in the circuit when placing the battery in the circuit.

It should be noted that most misconceptions obtained from tests and interviews were consistent with each other. Also, in the process of conceptual change teaching model, especially in the first and second stage, this method that students express their beliefs provides a good opportunity for teacher to find out some of the misconceptions.

In order to examine the fourth hypothesis of the study, a number of revised misconceptions of the pre-test and post-test for both control and experimental groups were compared with each other and their significance were verified using the chi- square test. The results are shown in Table 7.

Table 7.
Result of Chi- square test

Misconception No.	Number of modified in experiment group	Number of modified in control group	Difference	chi-square value	Significant chi-square
1	15	3	12	7.730	0.007
2	13	3	10	6.877	0.009
3	14	4	10	4.450	0.035

Misconception No.	Number of modified in experiment group	Number of modified in control group	Difference	chi-square value	Significant chi-square
4	17	4	13	8.048	0.005
5	13	4	9	4.267	0.039
6	8	7	1	0.068	0.769
7	10	5	5	2.608	0.106
8	7	5	2	6.818	0.009
9	17	5	12	7.045	0.020
10	7	0	7	5.258	0.041

The significance value of Chi- square value is less than 0.05 except for misconceptions of 6 and 7. Therefore, 8 items of misconceptions of students who are trained with the conceptual change model have improved significantly compared to the control group. So, the fourth hypothesis is accepted.

Discussion and Conclusion

This study was performed to investigate how CCM method can affect educational development, comprehension, application of concepts and misconceptions when it is compared to the traditional teaching method. Statistical analysis of the results shows that educational development and comprehension has increased by CCM method of teaching. Besides, CCM was more effective to remove or to modify the misconceptions. However, it could not increase the application of concepts. The results show that some misconceptions are resistant to change and could not be easily removed or modified even by application of CCM method.

In addition to the remarkable quantitative results, application of CCM was concomitant with some surprising behaviors of students. They were so interested in scientific details involved in simple daily phenomena overlooked before in their observations. In addition, students' contribution to discussions increased by CCM. hh is helps the teacher analyze the students' beliefs and to discover their preconceptions and misconceptions.

Ausubel (cited in Mayer, 2003) believed that to achieve deep and lasting understanding of the concepts new contents should be associated with contents that has already been learned. In his opinion meaningful learning produces its own reward. Corresponding to Ausubel, in order to increase students' motivation level teachers should add on intrinsic motivation by helping learners to satisfy their curiosity. This model begins with an applicable and new situation and continues with knowlegge of students' intellectual backgrounds. Since this model begins with a challenge and ends to another students will learn how to cope with new challenges.

The results of this research correspond to those found by Yenilmez and Tekkaya (2006), Haglund and Jeppsson (2014), Lee and she (2010), Hovardas et al., (2006). Based on the results of this study, it is suggested that teachers and the authors of textbooks should consider students' intellectual background. It is necessary to change the composition of textbooks to create the opportunity for students to interact with each other. Teachers should be more accurate in their assessments and they should not rely only on the right or wrong answers and their questions should be so that students' misconceptions can be found.

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