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The Effect of the Contradictory Events Strategy on Modifying Misconceptions in Chemistry for Tenth Grade Students in Palestine

Mahmoud Ahmad AlShamali
Educational Sciences and Teacher Training
An-Najah National University
mshamali@najah.edu

Shadi AbualKabesh
Economics and Social Sciences
An-Najah National University
Shadi.k@najah.edu

Israa Mohamed Al-Mahdi
Educational Sciences
Ministry of Education
Soso.123.93@hotmail.com

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Abstract:

This study aims at investigating the effect of using the discrepant events strategy on modifying the alternative misconceptions in chemistry of 10th grade students compared with the traditional method. The researcher used the semi-experimental method by applying the study to a sample of (74) 10th grade female students in the secondary school of girls in the district of Tulkarem, in the second semester of the academic year (2016/2017). To actualize the purpose of the study, the researcher used the alternative misconceptions test. The analysis of variance (ANCOVA) showed presence of a statistically significant difference between the means of grades of the students on the alternative misconceptions test was in favors of experimental group members. Based on the results, the study recommends that it is important to use this strategy in teaching chemistry because of its role in modifying the student's misconceptions.

Keywords: Alternative Misconceptions, Contradictory Events, Teaching Chemistry.

Introduction and theoretical background:

Questions often revolve around the factors that affect the learning process, such as the characteristics of the teacher, and what happens within his mind, and the role of the previous information of the learner in the formation of meanings. This approach is due to the constructivist theory, which ensures that a person builds his or her information internally through interaction with society, language, and the surrounding environment[3].

Constructivism has made the learner the center of the educational process, building the knowledge within it through the interaction between his senses and the outside world around him with an active process, also the knowledge cannot exist outside a person, but the individual builds it by adapting what he already knows to new knowledge[10,25].

Constructivism is a process of reception of current knowledge structures, in which learners build new knowledge structures and meanings by actively interacting between their existing knowledge structures and their prior knowledge and learning environment[35].

Hence, there is an urgent need for various strategies and educational programs, which help students to enrich their information and modify the misconceptions they have. This can be done only by the presence of a specialized teacher who gives the learner the opportunity to contribute to the development of generalizations, formulation and experience, and the use of various methods to modify the misconceptions of the learner[4].

The improvement of the educational process is linked to its ability to shift from the traditional formula that focuses on indoctrination and the transfer of information to learning that generates the students' desire of discovery through different attitudes and activities.

The formation and development of scientific concepts among students is one of the most important goals of teaching science in all different stages of life, as it occupies the second level in the knowledge pyramid after scientific facts, and the clarity of concepts and their implications is necessary for understanding, comprehension and communication[22].

The importance of the diversity of teaching methods leads to the expansion of the horizons of the teaching process, to transform learners from intruders to almost completely independent with the synchronization of the theoretical side of the applied side. Thus, the development of their attitudes, inclinations and thinking, which helps them to achieve the desired goals through modern methods

and strategies based on the constructivist theory such as discrepant events strategy[14].

The use of discrepant events drives learners to manage their learning, and urges them to explain the discrepant event to arouse suspense, which lacks many educational attitudes. Several objectives are achieved using discrepant events such as developing the capacity for scientific thinking and problem solving, playing the role of the small scientist, developing the ability to question, and the possibility of formulating hypotheses and asking past questions[5]. Discrepant events also contribute to improve the motivation towards learning science and increase conceptual growth in addition to enabling the learner to autonomy in the fieldwork[38].

Discrepant events are important in the teaching of science. They help to identify the ways in which ideas work in the minds of students, and give them an idea of the trends they take when they address a problem, to know the level of their mental stock, and the methods of their treatment of ideas that have not returned to them, which are sometimes required by the situations faced in normal life. It increases students' achievement and develop their creative thinking skills[16,21].

Given the importance of concepts in science education, researchers conduct studies and research to investigate conceptual images, composition and actual reality in the minds of learners. These studies have found that learners come to the classroom with ideas and perceptions of the reality surrounding them. These perceptions often contradict with the correct scientific perception that the learner is supposed to acquire, which contributes to the formation of misconceptions about objects, events and natural phenomena and thus hinder learners' understanding of these natural concepts and phenomena scientifically[18].

Concepts are the basic building block in the teaching and assimilation of science as they contribute to the organization of mental experience, and by learning the concepts one can understand the world in which he lives, and benefit from his experiences in dealing with this world, and building appropriate curricula, and in the transfer of learning impact to the surrounding environment[22].

Contradictory Events:

Joseph Novak, defines constructivism as the idea through which the learner builds his ideas, by making an effort to extract the correct meaning. The learner builds new concepts and distinguishes new relationships to build higher level concepts (as shown in: Al Huwaidi[14]).

The oratory of discrepant events is defined as a series of educational activities and tasks that produce unexpected and surprising results for students, and thus help the learner to reach a state of attention and alertness[17].

Discrepant events are educational activities and tasks of which results come unexpectedly and are surprising to the learner[22]. Arguably, these results are contrary to the expectations of students[27], or it is a phenomenon that occurs in a way that runs counter to initial thinking[31]. It may be referred to as unusual events used by constructivist teachers to elicit students' curiosity about the truthfulness of their previous beliefs[23].

In addition, it aims at equipping the learner with thinking skills, and the processes of science. Moreover, it helps the learner to modify the misconceptions of scientific concepts, and develops the critical thinking of learners[14].

The pillars of the strategy of discrepant events are:

The student comes to school and has special knowledge that has an impact in the formation of his own vision of how the world works. The learner in the educational situation is not a blank page but carries knowledge from which the learning process should start. Prior knowledge of the learner occurs through the process of interaction with the environment and people, the learner's previous experience is used in building his own understanding of different phenomena. Learning is an active process for the learner. The learner strongly resists any cognitive change even if the knowledge is wrong. The mind of the learner is activated by providing a position contrary to the learner's previous knowledge that makes him in the case of cognitive imbalance; the learner uses his experiences in the re-cognitive balance and understanding of new information [20].

To use the strategy by the teacher of discrepant events in teaching, it must be well prepared and planned to ensure the development of sound scientific goals and trends[32].

Teaching using the strategy of discrepant events goes through three stages: as shown in (Wilson[32]).

1- Discrepancy creation phase: in which students' attention is attracted and their motivation is provoked, and they are encouraged to ask questions about the discrepancy presented and can be presented in different discrepancy forms and followed by the opportunity for students to submit questions and discuss them. At this stage, the teacher does not judge the students' suggestions and explanations whether right or wrong. It can also be done by confronting students directly with discrepancy and discussing possible solutions to discrepancy in small groups.

2- The phase of searching for a solution to the discrepancy: After the stage of submission of

the discrepancy, students are eager to find a solution. In attempting to resolve this discrepancy, activities are developed to resolve this discrepancy, and students become active in observation, data recording, classification, prediction, experimentation, etc. At this stage students learn a lot of the scientific content of the lesson.

3- The phase of finding a solution to the discrepancy: At this stage students succeed in reaching a solution to the discrepancy themselves. As a result of these experiments and activities conducted, they eagerly find answers for many of the questions raised by the discrepancy. At this time, students learn some things about how to experiment, observe, classify, collect data and achieve other skills that relate to science processes, and students will be interested to hear the result that would therefore be fixed in their minds.

There are conditions that must be met when presenting a discrepancy event. The discrepancy event should be based on a particular problem: using familiar tools for the learner in implementing a discrepancy event, allowing the learner to observe and practice discrepancy events, Focusing on examples associated with everyday life, and showing enthusiasm when presenting the discrepancy event[11].

Misconceptions:

Science organizes knowledge and scientific communication, and therefore educators pay much attention to helping learners to learn concepts better. Each person has his or her own way of interpreting the world around him, and these ideas may be incompatible with the correct scientific knowledge, so it is the teacher's responsibility to modify them. Other names for misconceptions include wrong conceptions, alternative concepts, intuitive concepts and naive concepts[25]. Alternative perception is the most common term for many contemporary researchers in practical education and it has replaced misconception term[32].

Those interested in teaching science are paying attention to the effective role of misconceptions that students possess in limiting the acquisition of scientific concepts, or acquiring them wrongly, because the wrong perceptions formed in the mind of the learner are strongly resistant to change. The idea that the student comes to the school as a blank page and the information is taught to him as the school wants is no longer adopted, because the student comes to the school with cognitive structure of misconceptions, which should be of interest to teachers, in order to replace them with the correct scientific perceptions by identifying the causes and sources of these perceptions and how to modify them[8].

There are educational strategies that derive their foundations from the constructivist theory which focuses on the learner's role in building his personal knowledge through his interaction with the surrounding environment such as the strategy of discrepant events.

Constructivist theory assumes that learners build their own knowledge using the knowledge they have in the cognitive structure. The process of building this knowledge is influenced by past social and scientific experiences, so learners form wrong perceptions of some scientific concepts, and these perceptions differ from the correct scientific concepts[8].

The results of the studies confirm that the process of adjusting the existing perceptions of students requires the teacher to prepare tests to reveal the degree of the existence of misconceptions in the students, as well as they reveal the degree of adjustment in the various natural sciences of chemistry, physics, etc.[21]

Despite the diversity of those concepts such as density in the study of Mesi'f[24] and the concepts of light in An-Naqa[7], and topics on air pressure as in Akbas & Gencturk[2], tools can be used to diagnose the misconceptions that exist among students by the drawing method that was used in the detection of wrong perceptions about Newton's laws using the method of painting at the University of Pamiokela Kara[16].

Misconceptions are defined as an unacceptable explanation of natural phenomena provided by a student after passing certain experiences[25]. The definition of Abda[1] described it as perceptions and knowledge in the cognitive structure of students that do not agree with the knowledge accepted scientifically, nor enable them to explain and investigate scientific phenomena in an acceptable manner. Ba'ara and Tarawneh[9] defined the automatic knowledge that students acquire through their interaction with the environment, where they are expressed in contradiction with the data of modern science.

Scientific concepts are the structure of science. They help students understand.

The subject of misconceptions in science has received great attention over the past years, and Wendersee, Munters and Novak[31] identified seven starting points for those looking at the field of misconceptions, the most important of which is that the student comes to the classroom and has a set of misconceptions about things and phenomena. Misconceptions are coherent, stuck in the mind and resist changing.

The process of modifying or eliminating misconceptions requires that the student be in a state of incompatibility between the wrong concept and the correct scientific concept. A so-called cognitive conflict or mental imbalance occurs, thus helping pupils to move to a scientifically accepted concept that helps them discuss their ideas and perceptions to reach better explanations that remove their cognitive imbalances[6].

The importance of recognizing students' misconceptions in science education is that science education is an important issue that has preoccupied the thinking of science educators. Therefore, it is necessary to work for students to acquire the correct scientific knowledge and accurate scientific interpretation of different events and phenomena.

Since misconceptions are resistant to change, this demonstrates how they affect the acquisition of correct scientific knowledge[8]. Learning by using a program based on discrepant events through discovery is the best because it exposes what is contrary to the expectations of students, and a good discrepant creates a strong feelings of desire for knowledge[12]. Hence, this study comes to reveal the effect of using an educational program based on discrepant events in modifying misconciptions.

The Research Problem/Questions:

The current teaching methods based on giving information from the teacher through verbal methods are no longer appropriate, so we urgently need modern teaching methods that move the learner from memorization and indoctrination, to innovation and the generation of information based on a deep understanding of meaning[26]. All this is the responsibility of the teacher who is able to employ modern teaching strategies that achieve the integrated growth of the learner in all aspects of personality.

Through the study of the prevailing educational problems identified during the field training and teaching practice of chemistry for the tenth-grade students, it is found that there is a significant weakness among the students in the subject of organic chemistry and low educational attainment with many misconceptions. This is a result of the prevailing traditional education that depends on the transfer of knowledge from the teacher to the student without the active participation of the learner in the educational process. The process of educational reform requires engaging in modern teaching strategies that are more effective in the educational process, including discrepant events. This study attempts to investigate the impact of an educational program based on discrepant events in modifying the misconceptions of the tenth-grade students.

The problem of the study is determined in answering the main question:

What is the effect of using an educational program based on discrepant events in modifying misconceptions in chemistry among tenth grade students in Palestine?

The study stems from the importance of its topic as an important element of the process of learning and teaching, which is teaching strategies. It is expected that this study would show to teachers and educational researchers what the methods of teaching has reached an order to improve the performance of the teacher and the development of needed skills. It could also help instructional, experts, specialists, supervisors, teachers, and people of interest by providing a remedial strategy that may contribute to correcting misconceptions.

Study Terms:

Strategy of Contradictory Events: it is a series of educational activities and tasks that produce unexpected and surprising results for students, and thus help the learner reach a state of attention and alertness[25].

Misconceptions: it is the automatic knowledge that students acquire through their interaction with the environment, where they are expressed in contradiction with the data of modern science[9].

Methods and Procedures:

This aspect deals with a description of the study sample, its tools and methods of preparation and to ensure its reliability and validity, procedures, research design, variables, and statistical treatments used.

Study Methodology: The experimental method, using semi-experimental design, is used to investigate the effect of using an educational program based on discrepant events in modifying the misperceptions of tenth grade students in chemistry. The study was applied to two groups, the control group studied in the usual way, and an experimental group studied using a program based on discrepant events.

Study Population: It consists of all students of the tenth grade in the public schools of the Directorate of Education in Tulkarm for the second semester of the academic year 2016-2017, the number of students of these classes (3478) students. Of these, (1624) are males and (1854) are females.

Study sample: consists of (74) female students from two classes, in tenth grade in Tulkarm district, one of them is randomly selected to represent the experimental group and consists of (37) students who are taught organic chemistry unit using discrepant events, and the other control group consists of (37) student and they are taught in the usual/ traditional way.

Study Tools: To achieve the objective of the study, the misconception test is used, and it consists

of (40) items of multiple choices with four alternatives, all related to the information contained in the unit of organic chemistry from the book of chemistry taught for the second semester (2016-2017). One correct answer was adopted, and one mark was given for each correct answer, thus the highest mark is (40) and the lowest mark is zero. The validity of the test was verified by presenting it to a group of specialists in the curricula and methods of teaching science in Palestinian universities. The test is applied to a pilot sample from outside the study sample, in order to find the average time required to apply the test, and it is (40) minutes.

After correcting the test answers of the pilot sample, the coefficients of difficulty and discrimination are calculated. Difficulty coefficients ranged within the acceptable limit (0.25-0.80), while the coefficient of discrimination is within the acceptable limit (0.20-0.50). The test was re-applied to the same sample two weeks after the pretest exam to calculate the reliability of the test, which is (0.80), an educationally acceptable ratio.

Study Procedures:

The study procedures are as follows:

1. After reviewing the educational literature, the study tool was built and verified for its validity and reliability.
2. Determining the population and sample of the study.
3. Applying the tests to the pilot sample to determine the time taken to answer, and calculate the degree of difficulty and discrimination coefficients for each item of the tests and the coefficient of reliability.
4. Applying the tests to the experimental and control groups before starting the experimental treatment.
5. Applying experimental treatment on the study sample where the teaching material for the experimental group is taught using the strategy of discrepant events, and the treatment is implemented by (16) lessons.
6. Applying the tests to the experimental and control groups after the completion of the experimental treatment.
7. Data collection, statistical processing and identification of results.
8. Interpreting and discussing the results of the study and making a set of recommendations.

Study design:

The design of the study can be expressed as follows:

G1: O1 X 'O1 G1: Experimental group

G2: O1 - 'O1 G2: The control group

O1: pretest misconception, 'O1: misconception post-test.

Statistical Treatments:

To achieve the study's objective and test its hypotheses, the Statistical Package for Social Sciences (SPSS) program is used to calculate the mean averages and standard deviations of the two study groups' scores (experimental and control) on the misconception test. ANCOVA analysis of the results of the students of the study sample in the two groups (experimental control) is used to detect the presence of a statistically significant difference attributed to the teaching method.

Study Results and Discussion:

The aim of this study is to investigate the effect of using an educational program based on discrepant events in modifying the wrong perceptions of the tenth grade students compared to the normal method. The following is an analysis of the data and the results reached according to the study variables and design.

To answer the study question; "what is the effect of using an educational program based on discrepant events in modifying the misconceptions in chemistry among the tenth-grade students?" means and standard deviations is calculated for the degrees of students of the study sample on the test of misconseptions according to the method of teaching variable, table (1).

Table 1: Arithmetic Means and Standard deviations of students' scores on the pre and post-test of misconseptions of the experimental and control groups according to the teaching method.

Group	Number	Pre-Test		Post-Test	
		Mean	SD	Mean	SD
Control	37	17.24	4.63	25.05	11.38
Experimental	37	16.70	5.76	28.97	7.27

It is noted from table (1) that the mean of the scores of students who studied using the tutorial based on the discrepant events on the post-test is (28.97), which is higher than the mean of students who studied in the normal way (25.05). To find out whether there is a significant difference between the two means at the level of ($\alpha = 0.05$), the associated variance analysis (ANCOVA) is performed. Table 2 shows the results of this analysis.

Table 2: ANCOVA results for students' scores on the post-test for the experimental and control groups according to the teaching method.

Varience Source	Sum of Squares	DF	Mean of Square	F	Sig
Pre-test	798.288	1	798.288	988.4	.002
Teaching method	335.278	1	335.278	4.151	045
Error	5743.577	71	80.769		
Sum	6816.986	73			

We note from Table (2) that there is a statistically significant difference at the level of significance ($\alpha = 0.05$) between the students' scores on the post-test attributable to the method of teaching in favor of the experimental group. The statistical value (F) (4.151) is statistically significant (0.045) which indicates that the teaching method explains 5.5% of the modifying of misconseptions among students and table (3) shows the adjusted arithmetic means for the test of misconceptions.

Table 3: Adjusted Arithmetic Means for Misconception Test.

Group	Adjusted mean	SD
Experimental	29.14	1.47
Control	24.88	1.47

In table (3), the adjusted mean value of the experimental group is greater than the adjusted mean of the control group. This indicates a statistically significant difference on the misconception test attributed to the teaching method and for the benefit of the experimental group who studied using the educational program based on discrepent events.

This indicates that the educational program has a positive impact on the modification of the misconseptions formed in the tenth grade students in chemistry. This result can be explained, that the use of the educational program based on discrepent events motivated students to learn in a new way, and this method depends on the theory of constructivism, which is interested in knowing the knowledge structure formed by the student and modify it through creating a contradiction between what the student knows and what the reality is, which leads to an imbalance that drives him to seek balance through following the problem-solving skill. Unlike the usual method of conservation and repetition, the educational program based on discrepent events helps the student to build knowledge of hisown and makes sure that it is correct.

These results were consistent with Sukjin[29], who uses discrepent events in conceptual growth and demonstrated the superiority of the experimental group studied by the discrepent events strategy over the control group studied in the usual way. It is also consistent with Khellah study[21], which uses the cognitive contradiction and Posner strategies to modify the misconceptions of physical concepts, and shows the superiority of the experimental group studied by the discrepent events strategy over the control group who studied in the usual way.

Recommendations:

In light of the findings of the study, where it pointed out the effectiveness of the educational program based on discrepent events in modifying misconceptions, the following is recommended:

1. To use discrepant events in teaching science in general and chemistry in particular, because of its impact in modifying the misconception among students.
2. To hold training courses for science teachers during their preparation and rehabilitation and training them to use discrepant events and equip them with the requiered skills to design their own educational activities.
3. The need to prepare tests to detect the misconception of students to find out the reasons for their formation and develop remedial plans for them.
4. To conduct other studies dealing with discrepant events as an independent variable in different subjects and for different grades and educational levels.

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أثر استراتيجية الأحداث المتناقضة على تعديل المفاهيم الخاطئة في الكيمياء لدى طلبة الصف العاشر في فلسطين

محمود أحمد الشمالي
العلوم التربوية واعداد المعلمين
النجاح الوطنية
mshamali@najah.edu

شادي خليل ابوالكباش
الاقتصاد والعلوم الاجتماعية
النجاح الوطنية
Shadi.k@najah.edu

إسراء محمد المهدي
العلوم التربوية
وزارة التربية والتعليم
Soso.123.93@hotmail.com

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الملخص:

يهدف هذا البحث إلى دراسة أثر استخدام استراتيجية الأحداث المتناقضة على تعديل المفاهيم الخاطئة البديلة في كيمياء الصف العاشر مقارنة بالطريقة التقليدية. استخدم الباحثون المنهج شبه التجريبي بتطبيق الدراسة على عينة من (74) طالبة بالصف العاشر بالمدرسة الثانوية للبنات في محافظة طولكرم في الفصل الثاني من العام (2017/2016). واستخدم الباحثون اختبار المفاهيم الخاطئة البديل لتحقيق الغرض من الدراسة. ويظهر تحليل التباين (ANCOVA) وجود فرق ذي دلالة إحصائية بين متوسطات درجات الطلاب في اختبار المفاهيم الخاطئة البديلة لصالح أعضاء المجموعة التجريبية. أوصت الدراسة، بناءً على النتائج، بأهمية استخدام هذه الاستراتيجية في تدريس الكيمياء نظرًا لدورها في تعديل المفاهيم الخاطئة لدى الطالب.

الكلمات المفتاحية: مفاهيم خاطئة بديلة، أحداث متناقضة، تدريس الكيمياء.