THE PLACE OF CONFLICT MAPS AND V-SHAPE LEARNING STRATEGIES ON CONCEPTUAL CONFLICTS RESOLUTION AMONG PRE-SERVICE FEMALE TEACHERS IN CHEMICAL KINETICS

By

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Abstract
Conceptual conflict is the understanding that learners have that is incompatible with scientific knowledge. Learners must recognise this contradiction between their beliefs and the existing scientific knowledge to bring about re-organisation of their thoughts for more complex and meaningful understanding. The effectiveness of conflict maps and V-shape teaching methods on resolving conceptual misconceptions among pre-service female teachers was investigated. Seventy-seven (77) students were randomly sampled from Emmanuel Alayande College of Education, Oyo, Nigeria. The students were randomly assigned to the two teaching methods based on the subject combinations. A 20-item multiple-choice test was developed to measure students' achievement before and after the treatment. The data were analysed using Wilcoxon Signed Rank. The results indicated that both methods were effective for conceptual conflicts resolution and no superiority between the two methods using Mann Whitney test. The teaching methods are recommended for conceptual change, identification of misconceptions and meaningful learning in science.
Keywords: V-shape, conflict maps, conceptual conflicts, conceptual change, cognitive structure, scientific concepts, chemical kinetics and pre-service teacher

1 Introduction

In a social setting, conflict is disagreement of opinions, ideas or interest among people. Conflict is inevitable in human existence. The absence of conflict usually depicts no meaningful interaction among people. Conflict usually leads to emotional disturbance and effort should be made to resolve conflict by parties involved, for the purpose of peace and to maintain and strengthen relationship.

In teaching and learning process, cognitive conflict occurs. Cognitive conflict is based on Piaget's (1985) theory of cognitive development. Cognitive conflict is a perceptual state in which there is discrepancy between one's cognitive structure (mental representations) and the environment (external information). The problem (conflict) arises if the learner's pre-knowledge is at variance with the acceptable scientific knowledge. Piaget identified three ways by which knowledge is built and developed in the learners from learning environment. These are: assimilation, accommodation and equilibration. To Piaget, assimilation is the connection of the new information to an existing cognitive schema (mental representations) without re-organisation of the cognitive structure. This is because similarities exist between the existing cognitive structure and the new information from the environment. That is, equilibration occurs (absence of conflict). When the existing schema does not have any relationship with a new experience, there is disequilibrium (conflict). The learner's cognitive structure must be re-organised to fit in the new information into the cognition. This process is called accommodation. The equilibration is attained either by assimilation and or accommodation. In learning process, knowledge is built through connection and reorganization of cognitive structure. The resolution of cognitive conflict is a critical process, if ineffective, it leads to inappropriate conception (misconception) or alternative conception which is at variance with established scientific facts and principles (concepts). A state of confusion occurs on the part of the learner, when misconceptions are not effectively resolved. Effective resolution of misconceptions in eliminates or reduces misconceptions, improves conceptual understanding and performance in learning (Bawaneh, Mdzain & Ghazali, 2010; Rahim, Noor & Zaid, 2015 and Adeoye, 2016).

1.1 Conceptual Change

Students' misconceptions impede learning of new concepts. Teachers must use appropriate teaching models, resources and strategies to modify the inadequate conceptions inconformity to scientific principles and theories (conceptual change). There are many models proposed and used by researchers for conceptual change (Tsai & Chang, 2005 and Chi, 2008) which are modifications of Posner, Strike, Hawson & Gertzog (1982) model. The Posner et al (1982) is a flexible model that does not identify strict roles to be assumed neither by the learners or teachers nor any specific teaching method to be employed to bring about conceptual change. The model recognises four mental processes that are essential for conceptual change: *dissatisfaction, intelligibility, plausibility* and *fruitfulness*. *Dissatisfaction* refers to a learner being displeased with his or her conceptual constructs (misconceptions or alternative concepts). *Intelligibility* refers to clarification of a new concept that is principally understandable and believable. *Plausibility* is the validity of a new concept that is to be connected with the previous knowledge to resolve conflict while f*ruitfulness* is the meaningfulness and effectiveness of a new concept. The conceptual conflict resolution approach presumes conflict between two conceptions (understanding): One already established in a learner's cognitive structure and a new concept based on scientific principles. This conflict is resolved when the student realises that he/she holds a misconception and valid, meaningful concepts are present to resolve it (Bawaneh et al, 2010 and Chih-Chiang & Jeng-Fung, 2012).

1.2 Conflict Map and V-shape Learning Method

Conflict map is a conceptual change instructional strategy proposed by Tsai & Chiang (2005) which are represented by series of critical or conflicting events that relate to accurate scientific concepts. Conflict maps help students to attain a balance between the conceptual schemes already held and perceivable information in the environment. The teacher's role is to create conceptual conflict around the students' alternative conceptions by presenting them with a situation in the environment that contradicts these concepts. Students work in small groups on conflict-resolving activities and scientific explanations without the teacher given them an accurate answer. The teacher later presents accurate scientific concepts to replace any students' misconception. The teacher reinforces students' scientific explanations by explaining major concepts and supporting it with practical scientific principles.

According to Tsai et al (2005), there are two conflicts to be resolved during conceptual change process. First, the conflict between the new perception and the students' alternative conceptions and the other exists between students' alternative conceptions and the scientific concept. The two conflicts must be independently resolved for meaningful understanding. The resolution can be achieved discrepant events, critical events or explanations and relevant perceptions that explicate the scientific conceptions (Chih-Chiang et al, 2012).

V-shape learning strategy was proposed by Gowin & Novak (1984) with the willingness to improve and develop experiments and activities that enhance scientific concepts. Gowin & Novak (1995) indicated that V-shape instructional method outlines the interaction between the conceptual structure in a discipline and its procedural structure (inquiry). The representation of the V-shape method by Gowin et al (1995) has conceptual side at the left side which includes concepts, principles, rules and theories. The methodological side on the right side includes experimenting, recordings, transformations, knowledge and value demands. The two intersect at the centre in a V-shape. The V-shape method corresponds to Ausubel's meaningful learning approach that links theory and practical to deal with events and phenomena (Bawaneh et al, 2010).

There are limited studies on V-shape and conflict-map learning methods available to the Researcher especially in chemistry. Demircioglu, Ayas & Demircioglu (2005) studied conceptual conflict strategy for teaching acids and bases and found significant effect of students' achievement and positive attitude to learning over traditional method. However, Baddock & Bucat (2008) indicated the respondents' resolution of the intended conflicts but failed to attend to the key features of the demonstration and conflict in chemistry. Tsai (2008) examined the effort of the use of conflict maps on changing concepts of simple electric circuits and found to be effective over traditional method. Baz & Bawaneh (2008) also indicated the effectiveness of conflict maps on electric energy and mechanical waves and other related applications. Bawaneh et al (2010) investigated the effectiveness of conflict maps and V-shape teaching methods on science conceptual change among eighth-grade students in Jordan. The results indicated the effectiveness of the teaching methods and found neither V-shape nor conflict map superior in facilitating conceptual change.

Roth & Roychon (1993) explored the effect of using the V-shape and concept mapping methods on the conceptual understanding of science and attitudes towards science learning in physics. The results showed that the use of concepts maps enhanced students' understanding, lessened learning difficulties, and produced positive attitudes toward science learning than did the V-shape method. Esiobu & Soyibo (1995) and Zaitoun (2002) indicated the effectiveness of V-shape over traditional methods.

2 Statement of the Problem

Deep understanding of scientific concepts in learning plays a significant role in students' organization of learning experiences, linking concepts to their sources, facilitating concept retrieval and promoting adequate understanding of scientific concepts (Bawaneh et al, 2010 and Adeoye, 2016). In spite of the importance of scientific concepts learning, many students have inconsistent conceptions with established scientific knowledge (Baz et al, 2008; Garcia-Lopera, Catalayud & Hermandez, 2014 and Adeoye, 2016).

Analysis of Senior Secondary School Examination (SSCE) Nigerian students' results in May/June West African Examination Council (WAEC) from 2002 – 2012 indicated less than 50% of the candidates who sat for the examinations passed with credit grades and above for chemistry except for years 2005 and 2010 with 53.59% and 50%, respectively. This is an indication that students have inadequate understanding of some concepts in chemistry. Adeoye (2016), Agogo & Onda (2014), Ahiakwo and Isiguzo (2015) and Adesoji, Omilani & Dada (2017) identified difficult chemistry topics as electrolysis, redox, chemical equilibrium and kinetics at all levels of education. The reasons for the learning difficulties among others are lack of practical activities, poor teaching method, abstract and mathematics nature of some chemistry topics. In chemical kinetics, students learning difficulties include inability of students to differentiate between rate and time of reaction, graphic representations of endothermic and exothermic reactions and explain concisely the effect of concentration, temperature and other factors affect reaction rate (WAEC, 2012 and Ahiakwo et al, 2015) Ahiakwo et al (2015) indicated 90 % of senior secondary school and university students had misconceptions in chemical kinetics. Also, Cakmakki, (2010) and Tan & Taber (2011) showed that pre-service teachers have misconceptions in science as indicated in their achievements. Adesoji & Babatunde (2008) and Muhammad (2014) showed that the male students have good understanding of scientific concepts than their female counterparts in science. This study therefore addressed the effectiveness of conflict maps and V-shape learning methods on the pre-service female teachers' prevalence scientific misconceptions in chemical kinetics.

3 Purpose of the Study

The purpose of the study was to determine if the pre-service female teachers hold the same misconceptions reported by WAEC chief examiners' reports after their two years of learning science. The effectiveness of V-shape and conflict map teaching methods for resolution of the female students' conceptual conflicts in chemical kinetics was investigated.

Specifically, the study examined the:

a. Prevalence scientific misconceptions held by female students.
b. Effect of conflict map teaching method on female students' conceptual change.
c. Effect of V-shape teaching method on female students' conceptual change.
d. Effectiveness of conflict map and V-shape teaching methods on female students' conceptual change.

4 Research Hypotheses

The following research hypotheses were formulated and tested for the study.

1. There was no significant difference between the pre-test and post-test scores of the pre-service female teachers taught using conflict maps in conceptual change.
2. There was no significant difference between the pre-test and post-test scores of the pre-service female teachers taught using V-shape method in conceptual change test.
3. There was no significant difference between the post-test scores of the pre-service female teachers taught using conflict maps and V-shape methods in conceptual change test.

5 Methodology

5.1 Research Design

Quasi-experimental design of pre-test, post-test was employed to determine the effectiveness of conflict maps and V-shape learning methods on pre-service female teachers. Population for the Study

The population for the study was all year two Integrated Science pre-service female teachers in the Colleges of Education, Nigeria. This population was selected because the chemical kinetics is taught at this level as ISC 227.

5.2 Samples and Sampling Technique

Eighty two (82) integrated science female students were randomly sampled and were randomly assigned into the two treatment groups: Conflict map and V-shape learning methods. Seventy-seven (77) of the sampled students successful attended the treatment and wrote the pre and post-tests.

5.3 Research Instrument

Conceptual Change Achievement Test (CCAT), a modification of Cakmakci & Aydogdu (2011) contained twenty multiple-choice questions of which the students were to tick the right option. In addition to this, there were instructional packages for conflict map and V-shape learning methods to engage the students in the learning of the chemical kinetic concepts. The instructional packages had the same contents but were differently designed to reflect the conflict map and V-shape learning methods. The contents were on rate of reactions, endothermic and exothermic reactions, effects of temperature, concentration/pressure, catalysts, nature of reactions on rate of reactions.

5.4 Validation and Reliability of the Research Instruments

The CCAT, and the instructional packages were given to three Science Educators to determine the construct, content and face validation. The instruments were reconstructed based on their comments. The modified instruments were pilot-tested using test-retest method a week interval on twelve female integrated science pre-service female teachers that were not among those sampled for the study. The instructional packages were also rated by the validators and their inter-rater values were determined. The reliability of CCAT was determined using Pearson Product-moment correlation with the reliability value of 0.83. The inter-rater values for instructional packages for conflict map and V-shape were 0.81 and 0.80, respectively using Scott's π.

6 Research Procedure

The CCAT was administered to the students a week before the treatment. The students were taught for four weeks of two (2) hours per week. The CCAT was re-administered to the students immediately after the treatment. The students in the treatment groups co-operatively learnt the concepts in small group. The researcher moderated the students' discussions at the end of each lesson. The procedural steps in conflict map were:

- raise questions for discussion
- carrying out practical activities (discrepant events and target scientific concepts)
- discussion of the findings from the activities carried out.
- write down their findings in the provided practical booklet

The procedural steps for V-shape included

- focus questions (conceptual side)
- theoretical discussion of the questions

- practical activities were carried out (methodological side)
  The models of the learning methods are presented in Figures 1 and 2.

7 Data Analysis and Results

The statistical analyses were carried out using means, standard deviations and non-parametric equivalent paired t-test, Wilcoxon Sign rank Test was used to compare the pre-test post-test scores of the students taught using conflict map and V-shape on conceptual change achievement test. Mann Whitney U test which is the non-parametric equivalent test for 2-independent sample t-test was employed to determine the effectiveness of conflict map and V-shape method on the students' conceptual change in chemical kinetics.

Table 1: Descriptive Statistics of the Students Achievement by Treatment

Teaching Method		Number of Student	Minimum Score	Maximum Score	Mean Score	Standard Deviation
V-Shape	Pre-Score	44	3.00	9.00	6.43	1.37
	Post-Score	44	8.00	16.00	11.98	1.97
Conflict Map	Pre-Score	33	4.00	9.00	6.97	1.42
	Post- Score	33	9.00	16.00	12.61	2.16

Table 1 indicated that the post-test mean achievement scores of the students taught with conflict map and V-shape learning methods were greater than the pre-test mean achievement scores. The mean gain scores for conflict map and V-shape were 5.64 and 5.55, respectively. The mean gain scores indicate that students' misconceptions have been moderately resolved though not completely. The conflict map and V-shape learning methods were therefore effective for cognitive conflict resolution in chemical kinetics.

The post-test mean achievement scores of the students taught with conflict map was 12.61 while that of V-shape learning method was 11.98. The achievement of the female students in the conflict map treatment group was slightly greater than the counterparts in V-shape learning method group.

To determine the significant effects of conflict map and V-shape teaching methods on conceptual conflict resolution, the test of normality was carried out to find out whether a parametric test or the non-parametric test should be used. The normality assumption was examined on the two variables using Kolmogorov-Smirnov test of normality on Statistical Package for Social Sciences (SPSS). The results are shown on Table 2.

Table 2: Results of Normality Tests

Test	Statistics	Df	Sig.
Pre-Score	.231	77	.000
Post- Score	.153	77	.000

The results on Table 2 showed that normally distributed with p-value (0.000) which is less than alpha-level (0.05), hence, the population from which the data set came from is not normally distributed.

Test of Research Hypotheses

Table 3: Wilcoxon Signed Rank Test of Mean Rank and Sum of Rank Difference of Post-Score and Pre-Score of Students by Teaching Method

Teaching Method	Number of Student	Mean Rank	Sum of Mean Rank	Z	Asymp. Sig. (2-tailed)
V-Shape (Post-Pre-test Score)	44	22.50	990.00	5.797	.000
Conflict Map (Post-Pre-test Score)	33	17.00	561.00	5.050	.000

The results on Table 3 showed that the post-test scores in both V-Shape and Conflict Map learning methods are greater than the pre-test scores because mean rank and sum of rank values are positive. The two teaching methods have positive effects on resolving female students' conceptual conflicts and promote conceptual change in chemical kinetics. The significant difference of the between the pre-test and post-test scores by learning method was determined.

The null hypothesis I which stated that there is no significant difference between the pre-test and post-test scores of the female students taught using V-shape method on conceptual change achievement test is thereby rejected since the p-value (.000) is less than alpha level (0.05) as shown on Table 3 . Hence, there is significant difference between the pre-test and post-test scores of the female students taught using V-Shape learning method on conceptual change achievement test.

The null hypothesis 2 which stated that there is no significant difference between the pre-test and post-test scores of the female students taught using Conflict Map method on conceptual change achievement test is rejected since the p-value (0.000) is less than the alpha level (0.05) as shown on Table 3. Hence, there is significant difference between the pre-test and post-test scores of the female students taught using Conflict Map learning method on conceptual change achievement test.

Table 4: Wilcoxon Signed Rank Test of Mean Rank and Sum of Mean Rank Difference of Post-Scores and Mann-Whitney U Post-Scores of Students by V-Shape and Conflict Map

Teaching Method	Number of Student	Mean Rank	Sum of Mean Rank	Mann-Whitney Score	Z	Asymp. Sig. (2-tailed)
V-Shape	44	36.19	1592.50	602.500	-1.285	.199
Conflict Map	33	42.74	1410.50			

The mean rank of the post scores of the 44 female students taught with V-Shapes is 36.19 while sum of mean rank 1592.50. The mean rank of the 33 female students taught using conflict Map is 42.74 while the sum of mean rank. The mean rank of conflict map was greater that of the V-shape. To test for the null hypothesis 3, Mann-Whitney U test of the non-parametric equivalent test for 2-

independent sample t-test was employed and the results are showed on Table 4. Since the p-value (0.199) is greater than alpha level (0.05), the null hypothesis 3 is not rejected. Hence, there is no significant difference between the post-test scores of V-shape and conflict Map learning methods on the female students' conceptual change.

8 Discussions and Implications of the Findings

The prevalence female students' misconceptions in chemical kinetics before the students were exposed to the learning methods were inadequate understanding of:

- endothermic and exothermic reactions
- the concept of catalyst on the rate of reactions
- effects of concentration and surface area on the rate of reactions
- the resultant temperature of two similar solvent with different temperature.

The traditional method (lecture method) of learning Integrated Science is responsible for the students' illogical reasoning and inadequate understanding of students in chemical kinetics (WAEC, 2011 and 2013).

Results from Table 2 on the V-shape and conflict map learning methods indicate difference in the pre-test and post-test scores for both variables. The post-test scores were found to be greater than pre-test scores of the students in conceptual change achievement test attributable to the learning methods. The differences were found to be significant as shown from the results presented on Table 4. This implies that the learning methods were successful in achieving conceptual change among students. This finding is consistent with reports of Esiobu & Soyibo (1995) and Novak (2002) indicated that effectiveness of V-shape over traditional methods.

The effectiveness of V-shape teaching method on the students' conceptual change is due to structural format of the teaching strategy. The teaching procedure are characterised by organisation that promote clarity and coherence of experimentation which emphasises concepts formation in choosing object or event to be observed, recorded and transformed to solve problems in the knowledge domain. The teaching method also enables the students to discover interrelated concepts that are derived from the observed object and events and to provide suitable answers to the question raised. Meaningful learning occurs as the students actively interact with one another and verbally discussed their conceptions. The conflicting conceptions are modified or eliminated.

Conflict map is also effective in that the conflict events in the teaching method allow state of imbalance in the students' cognitive structures. These stimulate the students search of the accurate scientific concepts for modifications. The critical events also authenticate the target scientific concepts. Furthermore, active interactions of the students with materials to be learnt in practical life and with other students in the teaching and learning process resulted into accurate associations of relationship among facts, principles and concepts for meaningful learning. This finding is line with Tsai (2003), Tsai et al (2005) and Baddock et al (2008). Bawaneh et al (2010) found that both V-shape and conflict map are effective for conceptual change.

9 Conclusion and Recommendations

The results of this study had shown that V-shape and conflict map were effective in resolving students misconceptions in science. The teaching methods are recommended for meaningful learning of scientific concepts at all levels of education. The teaching resources and their organizations must satisfy Posner's et al criteria (*dissatisfaction*, *intelligibility*, *plausibility* and *fruitfulness*) for conceptual change to be effective.

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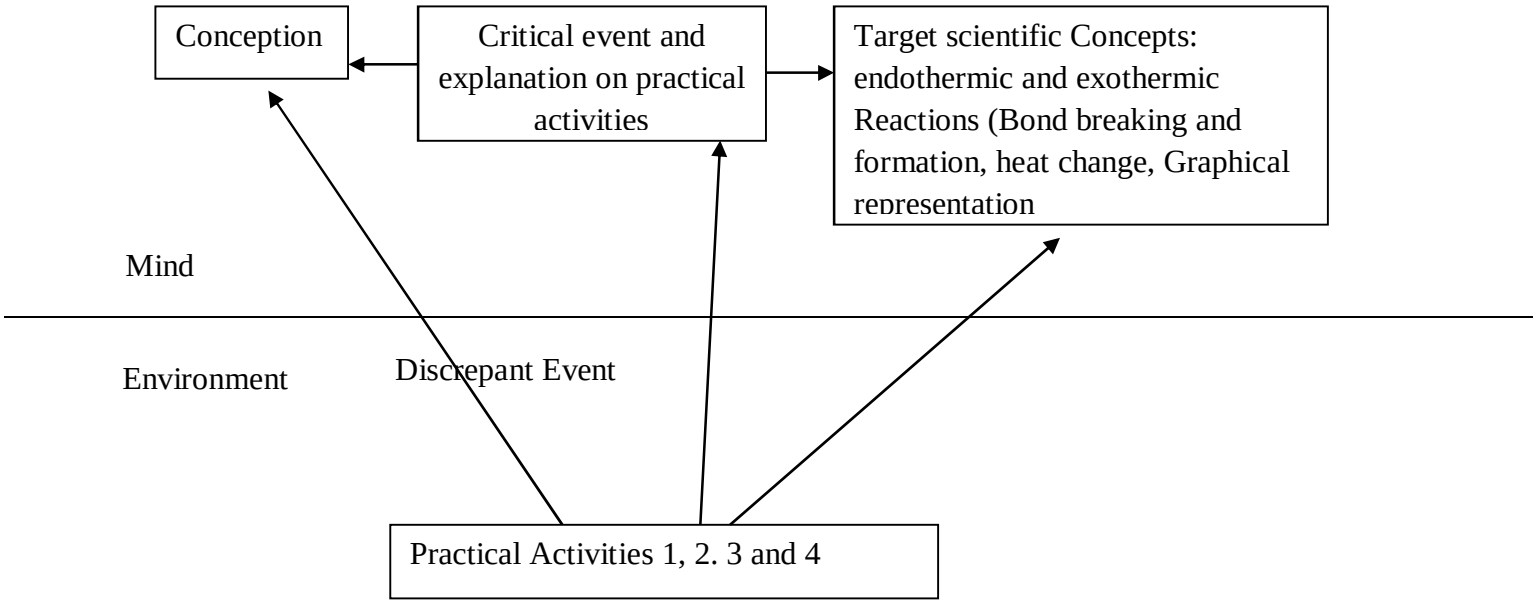


Figure 1: Sequence of conflict map in endothermic and exothermic reactions

Question: What are the differences between endothermic and exothermic reactions?

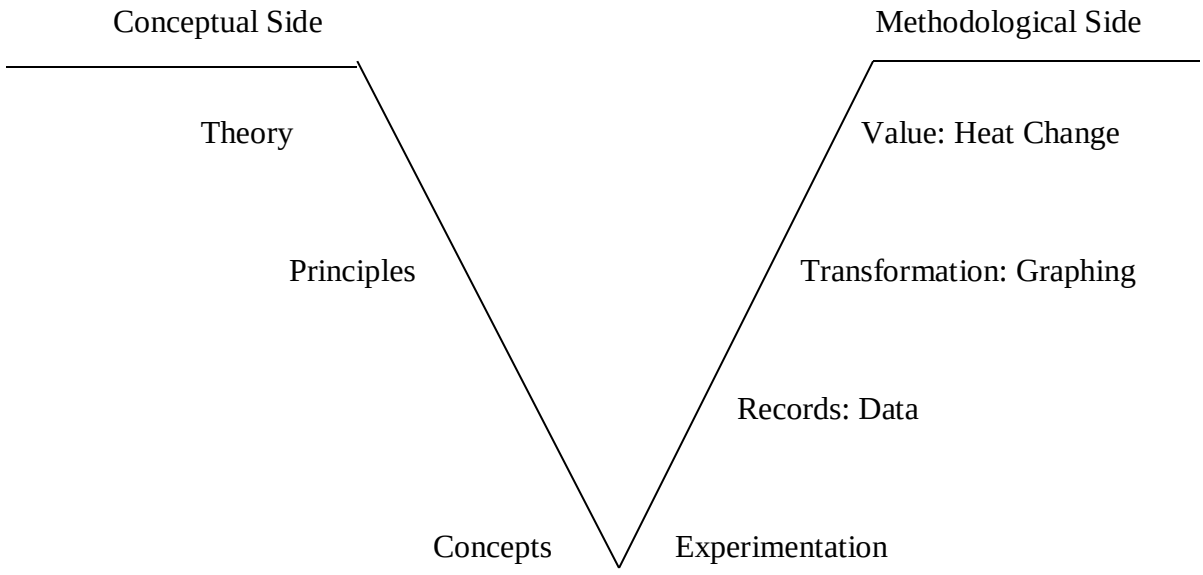


Figure 2: V-shape instructional sequence on endothermic and exothermic reactions

Example of Practical Activity

Activity 1: Put about 2 cm^3 of distilled water into a test-tube and take its temperature. Add 2 pellets of NaOH into the water into the water. Stir the mixture carefully with a thermometer and record the lowest or highest temperature of the mixture. Repeat the experiment by addition of 2 spatula-full of ammonium chloride to the water in the test-tube.

Examples of the CCAT items are:

1. The chemical equations given below represent two hypothetical reactions with different activation energies (Ea) at the same temperature. What would you say about the rate of these reactions?

   Reaction 1 $Y_{(aq)} + P_{(aq)} \longrightarrow C_{(aq)}$ Ea = 92 KJ mol^{-1}

   Reaction 2 $T_{(aq)} + V_{(aq)} \longrightarrow Z_{(aq)}$ Ea = 480 KJ mol^{-1}

   Tick (√) one

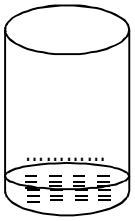
   A. Reaction 2 is faster than Reaction 1
   B. Reaction 1 is faster than Reaction 2
   C. The rate of reactions are the same
   D. It is not possible to compare the rates of these reactions because there is not enough information in the question.

2. The following reaction occurs at room temperature (298K)

$$T_{(aq)} + D_{(aq)} \longrightarrow R_{(aq)}$$

The reaction is set up under two different sets of initial conditions

First set of conditions



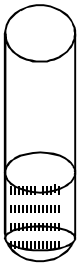
Initial amount of

T = 10ml; 2mol/dm^3

Initial amount of

D = 10ml; 2 mol/dm^3

Second set of conditions



Initial amount of

T = 10ml; 2 mol/dm^3

Initial amount of

D = 10ml; 2 mol/dm^3

Both beakers contain same amount of chemical species of T and D. However, the shapes of the beakers are different. In each of the two cases compare the reaction rates. Tick (√) one

A. The reaction under first set of conditions is faster than the reaction of the second conditions.

B. The rates of reactions are the same

C. The reaction under second set of conditions is faster than the reaction under first set of conditions

D. The rates of the two reactions cannot be compared.