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# Comparison of effect of kwl educational strategy and concept mapping strategy on students' critical thinking

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KWL Strategy, Concept Maps, Educational Strategy, Critical Thinking.

**Abstract**

**Purpose**: The purpose of this study was to compare the effect of KWL educational strategy and conceptual mapping strategy on students' critical thinking.

**Methodology**: This research was based on a quasi-experimental design with pre-test and post-test with two experimental groups and one control group. The statistical population consisted of all male students of the third grade high school of Miandoab in 2016-17. Three classes were selected through multistage cluster sampling. Two classes were randomly selected as experimental group and one class as control group. One of the experimental groups was taught in KWL and the other in a conceptual map. The control group was also trained in a conventional way. The pre-test and post-test data were used to collect data from the California Formation B Questionnaire.

**Findings**: To analyze the data was used one-variable covariance analysis. The findings of the study showed that education through the Kwl strategy and conceptual mapping strategy is effective on critical thinking students ($P<0.001$). It was also determined that the effectiveness of KWL strategy on students' critical thinking was more than conceptual mapping strategy ($p <0.001$).

**Conclusion**: Based on this study, both cognitive strategies and metacognitive strategies reinforce students' thinking. However, due to the findings of this research and related studies, it is better to use metacognitive strategies along with cognitive strategies because using metacognitive strategies, students monitor their learning process and become more aware of complex issues and points and they get more aware. Based on these findings and previous research, it is recommended that modern educational methods such as KWL and concept maps be used in teaching.

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## 1. Introduction

Critical thinking is one of the topics that has been discussed since the era of Greek philosophers such as Plato and Socrates, and many definitions have been presented such as, critical thinking is the objective analysis of facts to form a judgment (Abel & Freeze2015). One of the most important needs of the age of communication is the thinking skills, so that many scholars believe that critical thinking is an essential requirement for learners to participate actively in social, educational, and political areas (Peeters, Zitko, Vaidya, 2016). The ability of critical thinking to learners during education is not created without the assistance of teachers and only by listening to lectures. Teachers should provide opportunities for practicing skills and students 'methods of critical thinking. This is possible by conducting research and reviewing critiques by sharing their own problem-solving methods with students, participating in training seminars, teaching skills and teaching methods appropriately (Yarmohammadi Vasel, 2016). With commercialization of education, the importance of critical thinking has been lost so as the essence of learning. Learning has become selective, with few objectives in mind. Recent day's trend in education is bringing back everything into limelight and there has been too much study about everything to find the best possible ones. Critical thinking in classes has received much attention in recent days (Momeni, Salehi, Sadeghi, 2017).

While common educational methods in schools provide students with a lot of theoretical information, they will be unable to solve the smallest problems of society in the future. Traditional teaching in schools provides students with a large amount of information and concepts, but it is unable to create critical thinking and meaningful learning. Therefore, for the development of critical thinking, the role of teachers as the information transmitter needs to be changed, and students need to increase their skills in thinking and reasoning rather than acquiring and preserving information (Ogle, 2005). Educationalists have tried to identify ways in which they can enhance critical thinking skills. One of the most useful ways to improve the critical thinking of students is to use cognitive and metacognitive strategies in teaching (Amin, Setia, Sihombing, 2014). Cognitive and meta-cognitive educational strategies increase self-awareness, thinking and academic achievement (Apaydin, 2017). Conceptual map and KWL are new and advanced strategies that create meaningful learning in students. The KWL strategy is a strong metacognitive strategy for reading, first introduced by Ogle in 2009. This strategy is a specific strategy for comprehension that is used to ask a question. The purpose of the strategy is to enable teachers to access students' previous knowledge (Dieu, 2016; Ogle, 2011). The KWL strategy is based on the theory of schemas. This strategy helps students to learn new scientific content by using query and accessing prior information through valid sources. This strategy can be useful for students to become independent in learning (Riantika, Setganingsin, 2014).

The KWL strategy table consists of three parts (Hamid Sitti, 2016): 1- The first column, 'K', is for what the students already know about a topic.2- The next column, 'W', is for students to list what they want to learn about the Topic during the reading. This step is also to be completed before the reading.3- The third column, 'L', is for what the students learned from the reading. This step, of course, is done after finishing the reading. In the KWL strategy the teacher and students begin the process of reading and learning by brainstorming together about what they know (the K in K-W-L) about a topic. The teacher guides students to probe their knowledge statements and to find conflicting or partial statements of what they know. The teacher writes on the blackboard, overhead projector, or computer what the students think they know writing down their ideas just as they volunteer them. The teacher's role is not to correct or evaluate but to encourage and stimulate students to think broadly about what they bring to the study. With a variety of ideas being shared, the teacher can easily ask what the students want to know (the W in K-W-L). Again, it is the students' role to think of real questions, and the teacher's role to write down what they say. These questions form the second column on the worksheet or blackboard. Finally, they write what

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they have learned in an essay form, so they have additional opportunities to consolidate their learning (Tok, 2013).

Various studies have been conducted in many countries on the KWL strategy. Maulida and Gani (2016) in an experimental study found that the KWL strategy was effective in student's Reading Comprehension Achievement. Phromphithak (2015) has shown that the KWL strategy is effective on the academic achievement of math and students' attitude toward math. Dieu (2016) in a research study has shown that using this strategy in teaching English can enhance too Passive students for getting more active, This research also shows that the KWL strategy improves the Passive students' attitude towards learning English. Taheri and Mohammadi (2016) have shown that the KWL strategy is effective on students' comprehension in reading English language texts. Mahmud Hana, Warsono, Faridi (2015) have shown that the KWL strategy is effective on students 'reading skills. Kumari and Jinto (2014) in an experimental research have shown that the KWL strategy can improve the students' metacognitive skills and academic achievement in social science. Mihardi, Harahap, Abdullahsani (2013) studied the impact of KWL strategy and collaborative learning strategy on students' creativity. This research has shown that the KWL strategy is more effective than collaborative learning in creativity.

Concept maps were developed in 1972 in the course of Novak's research program at Cornell where he sought to follow and understand changes in children's knowledge of science (Novak & Canas, 2008). Since then, researchers in the broad aspects of this strategic approach have been introduced during their studies. A concept map is a diagram showing the relationships among concepts. It is a graphical tool for organizing and representing knowledge. In fact, these are instruments that help with organizing and structuring knowledge. Conceptual maps are very effective; it lets students represent their understanding of domain knowledge in a well-organized format. In concept mapping, users construct two-dimensional, visually-based representation of concepts and their relationships (Asan, 2007). The concept map representation encodes propositions describing two or more concepts and their relationships, in implied natural language sentences. In educational settings, concept mapping exercises have been used to encourage students to actively construct an understanding of concepts and relationships within domains of interest. It was designed to support the learner's effort by externalizing concepts and propositions known to the student, making them visually apparent to facilitate their connection with newly acquired concepts. Concept maps have been used by teachers to assess students' understanding, by students to compare their knowledge and collaboratively renew their understanding, and by experts as a vehicle for modeling and sharing their knowledge (Henige, 2012).

Novak (1998) has highlighted the importance of hierarchical structures within the conceptual maps. Concepts are represented in a hierarchical manner; the most general are positioned in the superior part of the map, while the specific concepts, less general ones are positioned in the lower part of the map. Research regarding cognitive aspects of learning in scientific domains proved that expertise in one field correlates with the development of an integrative and interconnected structure of basic concepts from that field. Cognitive psychology places emphasis on understanding how the mind works, on how learners learn, and on meaningful learning (Apaydin, 2017). The constructivist learning theory clearly states that every learner actively builds or constructs her or his own private understanding of the world. More simply, knowledge is constructed in the mind of the learner. For real understanding to occur, the teacher must actively involve the learner in a preliminary activity to elicit these preconceptions (Chan, 2017). Connections from this preexisting knowledge can be made as learners continually build and test their knowledge. Students are actively involved because they construct the concept maps. The performance of experts is explained by the superior organization of their knowledge. Experts have an extended knowledge base that is also organized in elaborate and integrated structures, while novices have a small knowledge base with a less coherent organization (Mih, 2011).

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Novak's work is based on the cognitive theories of Amusable (assimilation theory), who stressed the importance of prior knowledge in being able to learn new concepts: "The most important single factor influencing learning is what the learner already knows. Ascertain this and teach accordingly. Concept maps are a way to develop logical thinking and study skills by revealing connections and helping students see how individual ideas form a larger whole (Dolati Miandoab, Mostafaei, Ghaderi, 2013).

In a concept map, each word or phrase is connected to another and linked back to the original idea, word or phrase. They are a way to develop logical thinking and study skills, by revealing connections and helping students see how individual ideas form a larger whole (Akeju, 2011). Various studies have shown that conceptual maps have been effective in various educational areas such as reading, understanding and comprehension of texts, academic motivation, academic achievement and critical thinking. (Dolati Miandoab, et al, 2013). The purpose of this study is to investigate and compare the effectiveness of the KWL strategy and conceptual map on critical thinking of students and to determine whether there is a difference between students in the three groups trained by KWL, conceptual map and traditional method in critical thinking or not?

## 2. Methodology

The statistical population of this study is all male students of the third year of high school in Miandoab, who were studying in 2017-18. A multi-stage cluster sampling was randomly selected from three classes. Then, these three classes were randomly assigned to two experimental groups and one control group. The same teacher was used to train. Before the first training session, a pre-test was obtained. For 8 weeks, experimental group 1 was trained by conceptual map and experimental group 2 with KWL method and control group with traditional method. After completing 8 weeks of training, all three groups received post-test. California Critical Thinking Test Form B was used to measure critical thinking in pre-test and post-test. Khalili (2008) obtained the reliability of this test using the Kuder- Richardson formula of 20, 62%. In this study, reliability of the questionnaire was calculated using Cronbach's Alpha of 0.79.

## 3. Findings

To investigate the question, one-variable covariance analysis was used and the pre-test was used as the Covariate variable.

**Table1.** Descriptive statistics of the experimental group and the control group in the pre-test and post-test critical thinking scores

| | Mean | | STD deviation | | | |
|---|---|---|---|---|---|---|
| | pretest | posttest | pretest | posttest | pretest | posttest |
| Kwl Group | 16.6 | 20.96 | 9.34 | 1.97 | 1.80 | 3.88 |
| Concept mapping Group | 16.22 | 18.40 | 1.02 | 1.36 | 1.04 | 1.87 |
| Control Group | 15.85 | 16.38 | 1.35 | 1.34 | 1.82 | 1.53 |

According to the table (1) the mean scores for critical thinking have increased (kwl group 4.36, conceptual map group 2.18 control groups 0.53). One-variable covariance analysis was used to examine the significance of the difference between the dependent variable between the experimental groups and control group with the aim of eliminating the effect of variance.

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**Table2.** The same test table of the regression line slope

| source | Sum of squares | df | . sum of squares | F | Sig |
|---|---|---|---|---|---|
| Corrected Model | 335.955[a] | 5 | 67.191 | 45.181 | 0.000 |
| intercept | 8.022 | 1 | 8.022 | 5.394 | 0.023 |
| group | .800 | 2 | 0.40 | 0.269 | 0.765 |
| Pre-test | 70.301 | 1 | 70.351 | 47.306 | 0.000 |
| Group*pre-test | .058 | 2 | 0.029 | 0.019 | 0.981 |
| error | 96.665 | 65 | 1.487 | | |
| total | 25572.00 | 71 | | | |
| Corrected totlal | 432.62 | 70 | | | |

According to Table (2) Regarding the level of significance obtained for the interaction of a pre-test with an independent variable (Group*pre-test) that is equal to 0.981; the interaction between test conditions and co-variables is not significant. Thus the regression slope homogeneity assertion is established.

**Table3.** Leven's test of equality of error variance

| F | df1 | df2 | sig |
|---|---|---|---|
| 3.785 | 2 | 68 | .28 |

According to table (3) Leven's test of equality condition of variances is established. (Sig = 0.28).

**Table4**. Test of between subject effects

| source | Sum of squares | df | Mean square | F | sig | Partial eta square |
|---|---|---|---|---|---|---|
| Corrected Model | 335.897 | 3 | 111.946 | 77.55 | 0.000 | 0.776 |
| intercept | 8.889 | 1 | 8.889 | 6.156 | 0.016 | 0.084 |
| Pre-test | 78.512 | 1 | 78.512 | 54.386 | 0.000 | 0.448 |
| group | 179.495 | 2 | 89.748 | 62.16 | 0.000 | 0.650 |
| error | 96.723 | 67 | 1.444 | | | |
| total | 22572.00 | 71 | | | | |
| Corrected total | 432.62 | 70 | | | | |

As can be seen in table (4) the calculated ANCOVA value is significant. This means that there is a significant difference between the groups.

**Table 5:** Pairwise Comparisons

| group (I) | group (J) | Mean Difference (I-J) | Std.error | Sig |
|---|---|---|---|---|
| Kwl Group | Concept map | 2.230* | .345 | 0.001 |
| | control | 3.941* | .358 | 0.001 |
| Concept map Group | Kwl | -2.230* | .345 | 0.001 |
| | control | 1.711* | .369 | 0.001 |
| Control Group | Kwl | -3.941* | .358 | 0.001 |
| | Concept map | -1.711* | .369 | 0.001 |

According to Table (5) the mean difference is between the KWL group and the concept maps group (2.23, score), KWL group with the control group (3.941, score), concept maps group with the control group (1.711, score) was statistically significant. Therefore, it can be said that the KWL strategy and conceptual map strategy are effective on students' critical thinking. And the effectiveness of the KWL strategy on critical thinking is more than a conceptual mapping strategy. One-Way Covariance Analysis was performed. The independent variable has three levels: training with KWL strategy, training with conceptual mapping strategy, and conventional training. The dependent variable was the level of students' critical thinking. Pre-test scores were entered into the analysis as a covariate variable. The result of covariance analysis was significant. Assumptions of covariance analysis including linearity, homogeneity of regression slope and equality of variances were found. ($F2.67 = 62.2$, $P < .001$, partial eta = .65).

The Square of partial eta showed that there is a strong correlation between the effect of training and critical thinking. The type of training explains 65% of the variance of critical thinking. BonFerroni's test

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was used to evaluate the differences between the moderated averages. There was a significant difference in the level (P <0.001) between the kwl group (M = 20.96, SD = 1.96) and the concept map group (M = 18.4, SD = 1.3) with the control group (M = 16.38, SD =1.25). There is also a significant difference between the two groups of KWL and conceptual maps at less than 0.001. The impact of the KWL strategy on critical thinking was more than the conceptual mapping strategy (mean difference of 2.23 for the KWL group). As a result, it can be said that the KWL strategy and conceptual map strategy are effective on students' critical thinking and the effectiveness of the KWL strategy on critical thinking is more than conceptual mapping strategy.

## 4. Discussion

Findings of this study showed that using KWL strategy and conceptual map strategy as a teaching-learning strategy have a positive effect on students' critical thinking. The results of single-variable covariance analysis showed that there is a significant difference between the mean scores of students' critical thinking who have been trained with the kwl strategy and have been trained with the traditional method. This finding is in line with the findings of Maulida & gani (2016), Phromphithak (2015), Dieu (2016), Kumari and Jinto (2014), Mihardi, et al (2013), and Amin, et al (2014). According to experts, students 'familiarity with the nature and process of thinking can accelerate critical thinking and develop students' intellectual abilities. In other words, increasing the knowledge of thought, its strategies and its content will strengthen the students' cognitive and metacognitive abilities.

In this regard, we can say that more opportunity will be given to criticize the thoughts and opinions of others if the learning environment is more diverse in terms of facilitating the interaction between the participants and the amount of access to learning resources. Therefore, the learning environment of constructivism seems to be more capable of enhancing critical thinking skills (Aghili & Fotohinia, 2016). The KWL strategy enhances metacognition in students because it helps students become aware of their thoughts and knowledge. Therefore, this will enhance students' critical thinking. Seif (2016) believes that if the class conditions are such that students are aware of their thoughts; critical thinking will be strengthened.

Also the results of single-variable covariance analysis indicated that conceptual mapping strategy is effective on students' critical thinking. The findings of this study are in line with the findings Yar Ahmadi (2016) and Sadeghi Gandamani (2016) and Momeni, et al (2017). It can be said When students use a conceptual map, they think about the subject of learning and learn concepts by linking new concepts with previously known concepts. When students use a conceptual map, they think about the subject of learning and learn concepts by linking new concepts with previously known concepts. Researchers believe this training method can be a good stimulus to the learning process and lead to improved critical thinking skills and creativity. One of the benefits of learning through a conceptual map is the promotion of critical thinking in learners. (Krishan, 2017).

In fact, conceptual maps increase the critical thinking of learners by interconnecting new information and learned concepts and organizing data in mind. Therefore, this educational method can be a good alternative to traditional teaching methods. Regarding the effect of education on the increasing of critical thinking, most studies indicate that environmental factors, such as the method of teaching the learner in developing critical thinking, are very influential. Therefore, using modern teaching methods, cognitive, metacognitive and critical thinking skills can be enhanced by learners.

The results of covariance analysis showed that the effectiveness of the concept mapping strategy and the KWL strategy on critical thinking were not the same; students' mean scores who were trained with KWL strategy were more than those who were trained with conceptual mapping strategy. In explaining this finding, it can be said that KWL is a metacognitive strategy (Tok, 2013); and a conceptual map is a cognitive strategy (Saif, 2016). Cognitive strategies are methods that help us combine new information

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with pre-learned information and prepare them for long-term memory storage. Metacognitive strategies are tactics to monitor cognitive strategies and guide them and the most important meta-cognitive knowledge benefit is that it enables the learner to be aware of his / her learning activity and how to progress his / her work instantly and identify his / her strengths and weaknesses (Seif, 2016). Therefore, metacognitive strategies seem to be effective in enhancing critical thinking. This finding is consistent with the findings of Tok (2013), Kumari & Jinto (2014), Safarzadeh & Marashian (2015), Roozkhoon, Bagheri, Yamini (2013); Al-taie (2016), Utami & Refnaldi (2014).

In general, both cognitive strategies and metacognitive strategies reinforce students' thinking, however, due to the findings of this research and related studies, it is better to use metacognitive strategies along with cognitive strategies because using metacognitive strategies, students monitor their learning process and become more aware of complex issues and points and they get more aware. Based on these findings and previous research, it is recommended that modern educational methods such as KWL and conceptual maps be used in schools.

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