CHAPTER 6

SUMMARY, IMPLICATIONS AND CONCLUSION

6.0 Introduction

This chapter will summarise the findings of the research. The implications of the findings are also discussed. Suggestions for future studies are also given. Lastly, a conclusion is put forward.

6.1 Summary of research findings

The quantitative and qualitative results for the present study revealed that, on the whole, the brainstorming technique appears to be a suitable and appropriate educational technique for enhancing creative and critical thinking skills among selected second-grade intermediate Iraqi students.

The results of the study for the creative thinking test found that the use of the brainstorming technique for teaching physics seems to be more effective than the traditional method in the enhancement of overall creative thinking and in the sub-skills of fluency, flexibility, and originality among the selected Iraqi second grade intermediate students. The brainstorming technique provided students in the experimental group learning environment urged them to think, and the problems presented challenged their thinking and encouraged them to ask questions and generate ideas that helped to formulate hypotheses and express their self experiences in pursuit of appropriate solutions to these problems. During the brainstorming sessions, it could be

seen that opportunities were provided to help students try and discover knowledge for themselves.

In contrast, the low level of students' performance in the traditional group in the test of creative thinking skills could be due to the focus given by the physics teacher to teach facts and information more than to teach students how to think. This focus to academic achievement is based mainly on remembering and retrieving information, adoption of the lecture method to teach physics and relying on the textbook as the only means to understand the subject. All these factors most probably do not encourage and stimulate students to employ creative thinking skills but to employ lower cognitive skills. As a result, traditional educational methods may hinder the development of mental abilities and do not lead to the preparation of students to be able to think in a variety of new ways.

Secondly, the results of the present study for the critical thinking test found that the use of the brainstorming technique for teaching physics appears more effective than the traditional method in the enhancement of overall critical thinking and in the sub-skills of recognizing assumptions, interpretation and evaluating of arguments among the selected secondary Iraqi second grade intermediate students. The brainstorming technique appears to have the power to make students' thinkers' and critics, able to make judgments, test hypotheses, present arguments, and interpretations independent from the textbook and teacher's control. The physics teacher must understand that helping learners acquire critical thinking skills does not come through lectures and explanation of the text, but in guiding the learner to research and discover experiment and interact among themselves and the teacher. This can be achieved by providing students with problem solving physics tasks to challenge their thinking getting them to a state of alertness and attention. The qualitative results complemented quantitative data

and it could be said that the brainstorming technique contributes in enhancing creative and critical thinking skills among student during the learning of physics.

The quantitative and qualitative results for the present study showed that the positive perceptions of the selected Iraqi second-grade intermediate students for learning physics via the brainstorming technique in terms of application of knowledge and skills, communication, independent learning and features of learning. The students felt that the brainstorming technique provided more freedom and less pressure in class, encourages cooperative learning, communication skills and self expression, as well as a better understanding for physics.

6.2 Implications of the Study

Based on the findings presented in the present study, several implications for the stakeholders (e.g., scholars, policy makers, teachers, students) are given. First, there were several implications for the science teachers. Several previous studies (Cheng, 2004; Holubová, 2010) found that many teachers (in – service teachers and pre- service teachers) believed that brainstorming was a unsuitable technique for teaching physics as it would be difficult to manage the classroom and time. Moreover, some teachers believed that three factors of (evaluation apprehension, free riding, and production blocking) made the brainstorming an inefficient technique for teaching science (Wang, Li, et al., 2006). Procedures of applying the brainstorming technique in the classroom are usually incorrect due to ignorance related to some of the brainstorming stages and therefore could make brainstorming an invalid technique for learning physics (Goldenberg & Wiley, 2011; Holubová, 2010). The basic brainstorming technique utilized in the present study follows three stages, namely problem identification, idea generation and idea evaluation (as described in Chapter 4). In order to activate student's

mental abilities (creative and critical thinking skills), the researcher of the present has extended another step in the third stage which involves selecting and acting upon the best ideas. For example, in science, the students can run an experiment and determine if the hypothesis is proven or not (Jessop, 2002). In this stage, a learner stimulates both the left and right sides of the brain during the learning process to produce ideas to cope with the situation and restore equilibrium during problem solving. During the brainstorming sessions, the selected Iraqi students asserted that in the third stage of selection of ideas and practical experiments they need to blend between creative and critical thinking to solve the physics problem. Both the qualitative and quantitative data show that that selected Iraqi second-grade intermediate level students improved their skills of creativity and critical thinking skills most probably as a result of utilizing the procedures of brainstorming technique which involved six steps (problem identification, idea generate, idea evaluate, idea select, and implementation). Therefore, physics teachers when using the brainstorming technique should not ignore these six steps (three stages) in teaching physics in order to help students improve their mental skills. The present study has demonstrated that the brainstorming technique can be implemented at the secondary level in Iraq. It appears that this education technique can produce a positive impact on students' enhancement of creative and critical thinking skills in physics.

Several researchers (Aizikovitsh-Udi & Amit, 2011; Dagher & BouJaoude, 2011; Holubová, 2010; Kind & Kind, 2007; Sawyer, 2011) have uncovered the inability of students to think creatively and critically in science (physics). In the context of the present study, it could be seen that students have begun to enhance creative thinking skills (fluency, flexibility, and originality) and critical thinking skills (inference, recognizing assumption, deduction, interpretation, and evaluating arguments) during learning physics via the brainstorming technique. Based upon the findings of the present

study, students have the potential to enhance creative thinking skills and some of the critical thinking sub-skills during solving physics problems. The mixture of individual and group brainstorming techniques used in the present study could be taken as an optimal procedure to avoid the impact of various inhibitory processes. This approach is supported by (Brodbeck & Greitemeyer, 2000; Brown & Paulus, 2002; Paulus & Paulus, 1997; Starko, 2009). Students are the centre of learning. It is also recommended that teachers should provide guidance during teaching via the brainstorming technique and be as organizer and facilitator for students.

At the beginning of the present study, some students rarely engaged themselves in group discussion during the brainstorming session (e.g. Ghassan and Amir). At the end of the present study, many students seemed to like learning physics via the brainstorming technique. Several students suggested to the teacher to continue leaning physics via brainstorming technique in the future because they gained better understanding of physics content, felt freedom and less pressure, improved in self expression, and enjoyed the opportunity in cooperative and collective learning (as described in Chapter 5).

The present study has also provided procedural steps on how the brainstorming technique can be used enhance creative and critical thinking skills in a science (physics) classroom. However, there were two of critical thinking skills (inference and deduction) which appeared not to have enhanced. This could be because the students may not have made an effort during the brainstorming session or it can be said that it could have been difficult for the teacher to supervise a group of eight. Based upon the situation in the present study, this would imply that for future research, teachers should set rules with students, specifically at the stage of evaluation of ideas in order to prevent them from rushing this part of problem solving.

The implication of the use of the brainstorming technique in the present study is also important as activities must be well planned to achieve good results, but some students commented the leader of group was weak in time management. Therefore, perhaps it would be better to train the leaders of groups at the beginning of class.

Teachers themselves need training related to the brainstorming technique in order to infuse creative and critical thinking skills in their science (physics) classrooms (Fanona, 2012). However, as mentioned in several previous studies (Cheng, 2004, 2011; Harbi, 2002; Paulus & Yang, 2000; Wood, 1970), teachers untrained in the brainstorming technique may not be confident to use this 'new' teaching method to infuse creative and critical thinking skills in their science classroom. The researcher of present study found that the physics teacher did not have any experience in teaching via the brainstorming technique. In the context of the present study, the teacher conducted several practice sessions before integrating the complementary activities in her science classroom. All activities were successfully organised by her in the science classroom. This would imply that training can help teachers to acquire the necessary pedagogical knowledge to infuse creative and critical thinking skills.

The above discussion might imply that, to sustain the effort (for now and in the future) to enhance creative and critical thinking skills in the science classroom, it is important to consider pre-service and in-service science teachers' readiness, as well as to prepare them to improve from being a novice to an expert. Therefore, policy makers should consider making the brainstorming technique within the methods of teaching science curriculum in colleges of education in Iraqi universities and to train students on how to apply it in the teaching process. Development of the teachers' guide books can also include how to use the method of brainstorming with practical examples.

6.3 Suggestions for Future Studies

The real value of research does not involve only to come up with solutions to problem (under study), but also in highlighting new problems worthy of research and study.

The researcher of the present study focused on two classes of a selected Iraqi school only. Therefore, the researcher of present study suggests conducting the following studies in future.

i. Conduct a similar study of the current study to find out the impact of brainstorming technique at different levels, such as primary school, teachers' institutes and at the tertiary level (faculty of education), not only for physics but also for different subjects. Taking into consideration other variables such as gender and cultural background;
ii. The impact of brainstorming technique in the development of other higher order thinking skills such as scientific and reflective thinking among students of various educational levels and subjects, and
iii. Conduct a comparative study between the brainstorming technique and other educational methods or techniques for various higher order thinking skills (critical, creative, scientific and reflective thinking and such.)

In summary, there are several questions which can be explored explicitly in future research. Specifically, researching into students from different backgrounds and levels of education, the extent to which the creative and critical thinking skills could possibly be developed, as well as better support for students to engage in group brainstorming technique should be considered. Next, the researcher makes a conclusion of the present study.

6.4 Conclusion

Physics depends on higher mental skills more than on memorizing and remembering. The cognitive effectiveness of the brainstorming technique has been investigated throughout this study. From the research, it appears that the brainstorming technique has the potential to improve secondary Iraqi physics second-grade intermediate students' creative thinking. At the same time, it was also found that students' critical thinking was impacted positively, as has been students' motivation and interest in learning physics. This could be because the brainstorming technique allows for the analysis of the problem into multiple elements of facts, concepts and generalizations, principles or theories and to recognize the interrelationships among them.

The brainstorming technique used in this research has indicated that it has a high potential for contributing to the improvement of learning, and it seems to help convert from rote-learning to learning with thinking; from passive learning to active learning; from surface learning to deep learning; and from forced learning to meaningful learning. The brainstorming technique appears to be able to shift the minds of students from rote learning and memorizing to a notion where they see value in engaging at a higher level cognitive activity like creative and critical thinking that comes through brainstorming technique. It seems that the physics content was imparted more easily by utilizing the brainstorming technique compared with the traditional teaching method which is dominated by the memorization of knowledge content and examinations.

The clear procedures of the brainstorming technique used in this study allowed teachers to follow the flow of ideas in the minds of students. As the student is the centre of the teaching-learning process, the teacher was able to pay attention and follow-up the questions and reasons put forward by the students in class and support the problem solving process through creative and critical thought.

The brainstorming technique was perceived positively by the students and this increased the activity of the students in the classroom and has made them think positively and there is more precision and clarity in the students' answers. The students appear more self-directed and independent as learners. All of these attributes are likely to contribute to lifelong learning. Moreover, students had the opportunity to improve communication skills, and also how they might deliver their own judgments and opinions effectively - an important characteristic for life in today's challenging world.