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Developing critical thinking disposition by task-based learning in chemistry experiment teaching

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Abstract

The purpose of this study was to examine whether using task-based learning in chemistry experiment teaching can develop students' critical thinking dispositions in high school. The California critical thinking disposition inventory was used as a data collection tool. One-way ANOVA was employed to examine whether there were significant differences on the overall and subscales scores of CCTDI between the two classes. Results showed that there were significant differences on the overall and self-confidence sub-scale of CCTDI between the two classes in the posttest. The positive findings provide an effective way for chemistry teachers to develop students' critical thinking disposition.

Keywords: Critical thinking disposition; task-based learning; chemistry experiment teaching.

1. Introduction

In this changing and challenging world, it does not demand the teaching of soon-to-be obsolete facts, but, rather, the fostering of critical thinking at all levels of education. Critical thinking is vitally important in workplace decision making, leadership, clinical judgment, professional success and effective participation in a democratic society and a crucial aspect in the competence citizens need to participate in a plural and democratic society, and that enable them to make their own contribution to that society (Miedema & Wardekker, 1999; Ten Dam & Volman, 2003).So teaching students how to think critically is an essential issue in education (Astleitner, 2002; Facione, 2007; Paul, 1995). Developing students' critical thinking has been assumed to be one of the primary educational goals. In science education, critical thinking is also an important issue. Development of critical thinking is one of the primary elements of science literacy. Chemistry education, just as other discipline in both science and arts strives to facilitate the development of students' critical thinking through the appropriate instructional approaches. The research on developing students' critical thinking in chemistry education mainly focus on how curriculum (teaching material), teaching methods, the discipline background and the academic achievement of the students influence on critical thinking. Hardy, Clifford A.(1970) compared students of CHEM

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Study chemistry and traditional chemistry in terms of achievement in chemistry and level of critical thinking, found that CHEM Study students achieved at a significantly higher level than traditional students, but there was no significant difference between the groups with respect to level of critical thinking. Fiasca, Michael Aldo (1966) studied the influence of textbook on critical thinking. The results indicated that students' critical thinking hadn't obvious difference. Scholar Charell, Gcorgc (1970) studied the influence on critical thinking between open experiment and traditional experiment in university chemistry curriculum. All these above indicated that there was still a long way to run in developing students' critical thinking in chemistry teaching.

Although, there is consensus about the importance of critical thinking, differences of opinion exist as to how critical thinking should be taught. Some insist that there is no standard approach to facilitating critical thinking, while others advocate the use of specific strategies. Brown (1997) voices the current opinion that critical thinking must be taught in the context of specific subject matter, in such a way that transfer to other domains is possible. Educators begin to pay more attention to students' learning with their personal, social, and environmental contexts, and the integration of critical thinking. There is some evidence that active learning approaches are effective in developing critical thinking, like problem-based learnin, task-based learnin, WebQuest, and so on (Agnes Tiwari, Patrick Lai, Mike So & Kwan Yuen 2006). However, the findings are inconclusive. In a qualitative study conducted in Australia, nursing students who completed a four-week PBL experience within a 'traditional' discipline-structured nursing program reported that they developed their critical thinking skills. They stated the PBL approach promoted critical thinking and problem solving, active participation in the learning process and the integration and synthesis of a variety of knowledge (Cooke and Moyle, 2002). A recent study by Tiwari et al. (2006) used an experimental design where students in the first year of the BScN program were randomized to PBL or traditional education. The PBL students scored significantly higher on critical thinking compared to those educated in the traditional stream of the program. The possibility of contamination, due to discussion and sharing of experiences between the two groups of students studying in the same program, limits the applicability of the findings. Critical thinking includes critical thinking skills and critical thinking disposition. Many psychologists claim that dispositions toward critical thinking can also be encouraged to develop (Facione et al., 1997). There is some evidence that active learning approaches like problem-based learning are effective in developing the students critical thinking disposition. However, researches on developing students' critical thinking disposition by active learning and teaching approaches in chemistry teaching are very fewer. In this study, we aim to determine whether there is a difference in the critical thinking dispositions among students of experimental class studying in a TBL program compared to those enrolled in a traditional teaching program in chemistry teaching.

1.1 What is Task Based Learning ?

Task-based learning is a learning model which has similarities with problem-based learning but also has its own unique attributes. It is an integrated system with a multidisciplinary teaching and learning approach and offers the students rich learning opportunities in different disciplines (Harden et al., 1996; Harden et al., 2000). In the teaching process of TBL, students are often placed in complex situations. The students should analyze problem by themselves and learn the necessary knowledge to solve problems. And sometimes, they need cooperative of groups to solve the problem. Teachers take the real-life tasks and problems as teaching materials to stimulate students to think. In this learning model, students learn in complex situations and teachers cultivate their interest of learning and initiative of learning. Meanwhile, students construct their own knowledge framework. In TBL, the focus for the learners is actual tasks which stimulate the interest of students. In TBL, the learning is built round the task. The task stimulates further learning by the student. TBL is not simply the learning that is required to perform the tasks or that which results from doing the task. In TBL, tasks are the focus for learning, not the objectives of the student's learning. Mastery of the task may or may not be an objective. TBL involves acquiring an in-depth understanding of basic. TBL recognizes the need to know not only how to do something but also the principles or basis underlying the required action. It involves, too, the development of generic competences relating to the task, such as working as a member of a team. Education takes place, according to Whitehead (1932), only when the third stage of learning--generalization--occurs. In TBL, learning is transferable from the initial context of the task, which is the focus for the learning, to another context: there, the principles, knowledge and skills can be applied. Contrast to the passive receiving knowledge from teacher-centered class, this style of teaching provides student with active, student-centered learning. Teachers are no longer the persons who impart knowledge, and students are no longer the persons who receive knowledge. The teachers are not only the companion, participants but also the supervisor, mentor who monitor the students' thinking. The students can learn how to search literatures about the content of learning， formulate thinking, make inference and solve problems. Morever, they are willing to do so. At present, the TBL is mainly applied in medical education. There are fewer about the TBL applied in chemistry teaching.

1.2 What is Critical Thinking?

About the conception of critical thinking, there is not an accordant idea. So there are various definition of critical thinking**.** Different people define and study the critical thinking in different ways, so there are many definitions of critical thinking. For example, Paul defines critical thinking as a skill of taking responsibility and control of our own mind (Paul, 1996). Watson and Glaser define critical thinking as a composite of attitudes, knowledge, and skills (1980). McPeck think that critical thinking could be defined as a propensity and skill to engage in an activity with reflective skepticism (1981). Robert Ennis defines critical thinking as a logical and reflective thought which focuses on a decision in what to believe and what to do (Ennis, 1985).However, Siegel suggests that "a critical thinker is one who is appropriately moved by reasons: she has a propensity and disposition to believe and act in accordance with reasons; she has the ability to assess the force of reasons in the many contexts in which reasons play a role (1988)." On the whole, we think that critical thinking defines as a processes of thinking, which is that the individual initiatively think, and make a personal evaluation of the judgments about the having learned knowledge of the authenticity, accuracy, process, theory, method, background, arguments, and then make a reasonable decision-making about what he do and what he believe. According to Watson and Glaser (1980),the conception of critical thinking has three major parts: (1) an attitude of enquiry that involves an ability to recognize the existence and an acceptance of the general need for evidence in what is asserted to be true; (2) knowledge of the nature of valid inferences, abstractions and generalisations in which the weight of accuracy of different kinds of evidence are logically determined; and (3) skills in employing and applying the above attitudes and knowledge. Critical thinking was also considered as results-oriented, rational, logical, and reflective evaluative thinking, in terms of what to accept (or reject) and what to believe in, followed by a decision what to do (or not to do); then to act accordingly and to take responsibility of both – the decisions made and their consequences (Zoller, 1999). Critical thinking can be seen as reflective and reasonable thinking that focuses on deciding what to do or believe (Ennis, 1985). Ennis' conception of critical thinking has three major parts: 1) Critical thinking starts as a problem-solving process in the context of interacting with the world and other people; 2) It continues as a reasoning process, informed by background knowledge and previously acceptable conclusions, and it results in drawing a number of inferences through induction, deduction, and value judging; and 3) The critical thinking process ends in a decision about what to do or believe. Indeed, critical thinking capabilities can be divided into two categories which is critical thinking disposition and critical thinking skills. And a critical thinker should demonstrate some abilities and dispositions. According to Ennis, he define the critical thinking disposition is the critical spirit. The critical thinking spirit is the motivation that critical thinkers used to apply critical thinking abilities to the thinking of others and to their own thinking. People who have critical thinking dispositions exhibit a probing inquisitiveness, a keenness of mind, a zealous dedication to reason, a hunger or eagerness for reliable information, and are more apt to use their critical thinking skills than are those who do not have a critical thinking disposition (Facione, 2007). These critical thinking dispositions can be described Inquisitiveness, Open-mindedness, Systematicity, Analyticity, Truth-seeking, Self-confidence, Maturity Inquisitiveness is "one's intellectual curiosity and one's desire for learning even when the application of the knowledge is not readily apparent". Open-mindedness is "being tolerant of divergent views and sensitive to the possibility of one's own bias". Systematicity is being "organized, orderly, focused and diligent in inquiry". Analyticity is "the application of reasoning and the use of evidence to resolve problems, anticipating potential conceptual or practical difficulties, and consistently being alert to the need to intervene". Truth-seeking is "being eager to seek the best knowledge in a given context; courageous about asking questions; and honest and objective about pursuing inquiry, even if the findings do not support one's self-interests or one's preconceived opinions". Self-confidence means having "trust in one's own reasoning processes". Maturity is "to be judicious in one's decisionmaking".

The Chinese new National Chemistry Curriculum Standard (2003) states that the teachers should pay attention to improve students' critical thinking and the students should have stronger question consciousness and independent thinking ability. Critical thinking is necessary for the full understanding of theories, evidence and the core issues and debates in the domain of chemistry and other disciplines. The purpose of this study was to investigate whether using the task-based learning can develop students' critical thinking disposition in chemistry experiment teaching.

2. Methodology

2.1 Research design

In this study, we adopt a pre-test and post-test experimental design with an experimental class and a control class. In the experimental class, the task-based learning was used in chemistry experiment teaching. On the other hand, the students in the control class received the traditional teaching. The California Critical Thinking disposition inventory was used at the beginning and end of the two classes. The results of the pretest and posttest were compared to see whether there were some significant differences in the critical thinking disposition for the students of two classes. The design of the study can be diagrammed as follows:

O_1-------X------O_2 --------Experimental Group
O_1-------Y------O_2 --------Control Group
O_1-----pretest O_2----- posttest
X—use the teaching model of task-based learning
Y—use traditional teaching

2.2 Participants

The subjects sampled in this study were 121 students ages ranged from 17 to 19 years at Grade 3 in YuJin Middle School in Xian in Shaanxi Province in China. There were 60 students in the experimental class and 61 students in the control class.

2.3 Instrumentation

The California Critical Thinking Disposition Inventory

The CCTDI was developed by Facione et al. (1992). It is a multiple-choice attempt to assess critical thinking dispositions and most likely useful for self-appraisal and anonymous information for use in research. It includes 75 items. The format of the CCTDI is a 6-point Likert scale of agree–disagree response alternatives. The total score represents the sum of the seven subscales. The seven subscales include:1)Truth-seeking—targets the disposition of being eager to seek the best knowledge in a given context, courageous about asking questions, and honest and objective about pursuing inquiry even if the findings do not support one's self-interests or one's preconceived opinions. 2) Open-mindedness—measures one's tolerance of divergent views and sensitivity to the possibility of one's own bias. 3)Analyticity—assesses prizing the application of reasoning and the use of evidence to resolve problems, anticipating potential conceptual or practical difficulties, and consistently being alert to the need to intervene. 4) Systematicity—measures being organized , orderly, focused, and diligent in inquiry. 5) Inquisitiveness—a measure of one's intellectual curiosity and desire for learning even when the application of the knowledge is not readily apparent. 6) CT self-confidence—measures the trust one places in one's own reasoning processes. CT self-confidence allows one to trust the soundness of one's own reasoned judgments and to lead others in the rational resolution of problems. 7) Maturity—targets the disposition to be judicious in one's own decision making. The CT-mature individual is one who approaches problems, inquiry, and decision making with a sense that some problems are necessarily ill-structured, some situations admit of more than one plausible option, and many times judgments must be made based on standards, contexts and evidence which preclude certainty. Scores on the seven CCTDI scales can range from a minimum 10 to a maximum of 60. A score of 30 and below on any of the seven scales indicates consistent opposition or weakness to that given disposition while a score of 40 or higher represents a positive endorsement of that attribute. The overall score of CCTDI range from 70 to 420. An overall score of 280 is the average point of critical thinking disposition. An overall score more than 280 indicates a positive inclination toward critical thinking; overall scores less than 210 indicate a negative inclination toward critical thinking. Overall scores ranging from 210 to 280 indicate low-average; overall scores ranging from 280 to 350 indicate high-average; and above 350 indicate a highly positive inclination toward critical thinking. The higher the score is, the stronger the critical thinking disposition is. In terms of the CCTDI, critical thinking dispositions have then been established having the potential to advance understanding and assessment of professional judgement in education (Facione and Facione, 1996; Facione et al., 1994). Worldwide, many researchers have used the CCTDI to investigate critical thinking dispositions (Thompson and Rebeschi, 1999; Walsh and Hardy, 1999). Primarily it has been applied in colleges, in the context of nursing education (Facione et al., 1994). It has also been applied in high schools and proved fairly feasible and credible (Giancarlo and Facione, 1994).

The CCTDI was translated into Chinese and modified by Luo and Yang in 2001. Its Cronbach α is 0.86. Chinese and English CCTDI showed similarity for content validity and reliability for inquisitiveness (Luo and Yang, 2001). Primarily it has been applied in colleges and high schools. In this study, in order to evaluate the efficacy of using the task-based learning model in chemistry to enhance the critical thinking dispositions, we used the Chinese version of California Critical Thinking Dispositions Inventory (CCTDI).

2.4 Treatment

To ensure that the treatment administered to participants in the experimental and control class was similar, the same curriculum and lesson plans were used and the same teacher conducted the lesson. Students' learning level of proficiency was also similar.

Brown argues that critical thinking must be taught in the context of specific subject matter, in such a way that transfer to other domains is possible. She argues that we cannot expect children to progress in the development of thinking unless we give them something to think about, in other words, unless we engage them in serious learning about meaningful, rich, domain-specific subject-matter. Brown points out the importance of using real-life problems. Two reasons are given for this. On the one hand, this is supposed to be motivating and stimulates students' active involvement. On the other hand, these are precisely the kind of ill-defined, messy, complex problems for which critical thinking is needed anyway (see also Halpern, 1998; Kennedy et al., 1991). Few guidelines exist, however, on how to achieve this. In almost all studies on instructional procedures focussing on secondary and higher education 'discussion' and 'dialogue' play a key role (see also Commeyras,1993).

Task-based learning is a learning model which offers the students rich learning opportunities in different disciplines. In the teaching process of TBL, students are often placed in complex situations. The students should analyze problems by themselves and learn the necessary knowledge to solve problems. Teachers take the real-life tasks and problems as teaching materials to stimulate students to think. Some authors refer to literature supporting the notion that small-group teaching is helpful for developing critical thinking. Dennick and Exley (1998) discuss four methods of small-group teaching that enhance critical thinking: focused discussion, student-led seminars, problem-based learning, and role play. Dennick and Exley (1998) discuss the advantages of small-group teaching for developing critical thinking. In the process of chemical experiments teaching, students can study and discuss the experimental phenomena and the result of experiments. We suppose that using the TBL and small-group teaching can enhance the critical thinking of students in chemistry experimental teaching. In this experimental study, we use the contrast method. In the experimental class, the chemical teacher use small-group teaching and task-based learning to develop the CCTDI of students. However, in the control class, the chemical teacher use the traditional teaching. Five experiments such as esterification，the preparation of silicic acid, the preparation of ferrous hydroxide, the fading phenomena about the reaction water and sodium peroxide and alum purified were selected as the main instructional material from the textbook Chemistry for senior middle school published by People Education Press of China edition (2001). In the experimental class, students did the five experiments by TBL and small-group learning approches. Based on teaching contents and teaching targets, the chemistry teacher gave the experiments topics as the actual tasks and arranged roles for students.

Sixty one students were divided into ten groups. Every student took different task in each group. For example, the first student formulated the schedule for completing the task and supervised the execution. The second student collected the materials relative to the knowledge about the experinent and assigned the materials to other students in the group. The third student sorted the materials from the second student and analyzed the materials. The fourth student designed the experiment. The fifth student prepared the experimental apparatuses and experiment reagents. The sixth student show the experimental plan to other students in the experimental class which based on the results of the group's discussion. Before doing the experiments, each demonstrator from the ten groups showed their experimental design in five minutes. The teacher evaluated on each experimental design and performance of the ten groups. After dicussion, the teacher and students reached to a consensus and determinated the optimum experimental plan for the ten groups and then the students did chemical experiment. Because TBL needs to give students timely evaluation to stimulate learning motivation and interest of students. After the lab work, the teacher immediately assessed behaviors of the students in doing the experiment including skills, mastering knowledge, learning style and so on.

In the process of doing chemical experiments with TBL, students were stimulated to participate in the learning process. Students would face complex situations and experience generating the problem, propose hypothesis, choose experimental apparatus, operate experiments, evaluate experiments, apply the chemical knowledge to solve the real-life problems and so on. The learning process had some important characteristics: inquiry, openness, generating and so on in which students studied and discussed the experimental phenomena and the result of experiments. In the process of doing experiments, students in experimental class must analyze the phenomena of experiments, accept the different viewpoints, have curious and desire for the experiments. All above characteristics are very helpful to cultivate students' critical thinking disposition. However, in the control class, the teacher used traditional teaching approach in chemistry experiment teaching. The whole teaching process is as follows: Before entering the lab, the students must make sufficient preparation for the experiment. In the lab, after the teacher told students experimental principle, manipulation, procedure, safety, attentions and so on, students began to do the experiment. When the experiment finished, the experimental reports were requied. This whole empirical study lasted two months.

2.5 Data analysis

The primary outcome measure was the critical thinking disposition of students. The collected data were analyzed with SPSS software (ver. 16.0). One-way ANOVA were used to compare CCTDI scores between the task-based learning model and traditional education programs. A test of hypothesis with p-value < 0.05 was considered as significant.

3. Results

Descriptive statistics on the results from the CCTDI between the experimental class and control class were reported in the Table 1. Both pre-test and post-test CCTDI mean score of all the participants were over 280 and less 350, indicating that the overall critical thinking disposition of the students attending the test was at average level (Luo and Yang, 2001). In the pretest, critical thinking disposition mean scores were 284.4 for students enrolled in the TBL model learning compared to 281.0 for the students in the traditional teaching. However, in the posttest, critical thinking disposition mean scores were 295.81 for students enrolled in the TBL model learning compared to 287.33 for the students in the traditional teaching. The results revealed that the posttest mean scores ($M = 295.81$) was obviously higher than the pretest mean scores ($M = 284.4$) in the experimental class. However, there was only a slight increase in the mean score of the control class. In other words, these suggested that the students of experimental class performed well after receiving the task-based learning. The table 1 also showed the mean scores of the seven subscales. In the experimental class, before using the task-based learning in chemistry experiment teaching, mean scores on the CCTDI subscales, open-mindedness (O), analyticity (A), systematic (S), inquisitiveness (I), were above 40 which indicated a positive inclination toward the scale's target disposition (Luo and Yang, 2001). And mean scores on the CCTDI subscales truth seeking (T) self-confidence (C) maturity (M)) were below 40. However, after using the task-based learning, the results showed that mean scores of the CCTDI subscales were above 40 except self-confidence (C) and maturity (M)), especially the scores of truth seeking (T) were enhanced from below 40 to above 40. In other words, using the task-based learning in chemistry experimental teaching could enhance the truth seeking of students. There was an interest finding. In the control class, the pretest mean scores of self-confidence were 37.18. However, the postest mean scores of self-confidence were 36.28 which indicated that the students' self-confidence descended which need to make further research. The minimum and maximum scores also reflected that students of the experimental class performed better than the control class.

Table 1 Descriptive Statistics of CCTDI Scores of Two Classes Both Pretest and Posttest

Group Variable	pretest					posttest			
	min	max	mean	SD	N	min	max	mean	SD
Truth-seeking									
Exp	22.00	52.00	38.05	6.78	60	25.00	63.00	41.61	7.32
Control	21.00	55.00	38.31	8.49	61	24.00	57.00	40.44	7.54
Open-mindedness									
Exp	31.00	54.00	43.20	4.93	60	31.00	52.00	43.85	4.84
Control	28.00	53.00	42.63	5.49	61	33.00	55.00	43.84	4.89
Analyticity									
Exp	24.00	55.00	43.25	5.88	60	33.00	57.00	45.51	5.57
Control	26.00	61.00	43.81	6.13	61	26.00	55.00	44.43	6.41
Systematicity									
Exp	31.00	63.00	41.49	6.47	60	27.00	54.00	41.87	5.97
Control	20.00	52.00	40.25	7.47	61	26.00	57.00	41.48	6.74
Self-confidence									
Exp	26.00	55.00	37.43	5.58	60	28.00	52.00	38.39	4.68
Control	25.00	48.00	37.18	6.31	61	21.00	49.00	36.28	6.73
Inquisitiveness									
Exp	31.00	58.00	43.98	7.19	60	34.00	56.00	46.57	5.36
Control	24.00	57.00	42.18	7.34	61	24.00	57.00	44.62	6.97
Maturity									
Exp	24.00	52.00	37.02	7.14	60	26.00	52.00	38.02	5.44
Control	21.00	52.00	36.37	7.42	61	21.00	49.00	36.66	7.07
Total									
Exp	248	351	284.4	21.86	60	251	355	295.81	18.30
Control	214	338	281.0	24.10	61	243	355	287.33	23.64

Note:This is where the authors provide important information about the CCTDI scores.

A one-way design ANOVA was performed to identify whether there were significant differences between the experimental class and control class on the overall and the subscale mean scores of CCTDI in the pretest and posttest (Table 2). The results revealed that no statistically significant differences were found in the overall CCTDI ($p > 0.05$) scores and the sub-scales between the control class and experimental class in the pretest which suggested that the CCTDI of all participant were similar. However, there were statistically significant differences between the control class and experimental class on the overall CCTDI ($p < 0.05$) scores in the posttest. And statistically significant differences were also found between the control class and experimental class on the “self-confidence” sub-scales of CCTDI ($p< 0.05$) (Table 2) in the posttest. In summary, significant differences were found in the critical thinking disposition between the control class and experimental class. These results suggested that using the task-based learning could develop students’ critical thinking disposition in chemistry experiment teaching.

Tab 2 One-way ANOVA Comparing the Students of Experimental Class with Control Class in the Pretest and Posttest

CCTDI	Pre- or Post-test	Sum of Squares	df	Mean Square	F	Sig.
Truth-seeking	Pre-test	1.972	1	1.972	.033	.856
	Post-test	41.320	1	41.320	.748	.389
Open-mindedness	Pre-test	9.214	1	9.214	.336	.563
	Post-test	.000	1	.000	.000	1.000
Analyticity	Pre-test	11.346	1	11.346	.312	.577
	Post-test	40.164	1	40.164	1.119	.292
Systematicity	Pre-test	44.187	1	44.187	.899	.345
	Post-test	4.721	1	4.721	.116	.734
Self-confidence	Pre-test	1.837	1	1.837	.052	.821
	Post-test	136.402	1	136.402	4.057	.046*
Inquisitiveness	Pre-test	93.864	1	93.864	1.776	.185
	Post-test	162.959	1	162.959	3.867	.052
Maturity	Pre-test	12.181	1	12.181	.229	.633
	Post-test	56.467	1	56.467	1.419	.236
total	Pre-test	335.576	1	335.576	.631	.429
	Post-test	2199.377	1	2199.377	4.922	.028*

Note: Significant at the $p<0.05$ level. *$p<0.005$

4. Discussion

In our study, results showed that there were significant differences between the control class and experimental class on the overall CCTDI ($p< 0.05$) scores in the posttest. Our findings provide additional support that the task-based learning was an effective learning approach for developing critical thinking dispositions of students in chemistry experiment teaching(Candan Ozturk, 2008). Scores on the critical thinking disposition of the students in the two classes were in the medium range in both prettest and posttest. There were no significant differences between the control class and experimental class in the pretest. However, after completion of the task-based learning model in chemistry experiment teaching in the experimental calss, difference in the critical thinking disposition points scored by the students was found to be statistically significant in the two classes. This added support also to the contention that the task-based learning can enhance the ability of students to integrate theory with practice and engage in critical thinking (Irma Virjo,2001). However, it was noteworthy that the students of experimental class didn't achieve the score of 300 that is considered the threshold for high disposition for critical thinking. There were significant differences between the experimental class and the control class on the "self-confidence" sub-scales of CCTDI in the posttest. In the process of students' learning, they should believe in their reasoning and ability to make rational decisions which is important for them. So we can use the task-based learning to develop the self-confidence of students. There was an interesting finding. In the control class, the posttest mean score of self-confidence was lower than the pretest mean score. We thought that the main reason about this phenomenon was the limitation of the traditional teaching in chemistry experimental teaching. In the process of traditional teaching approaches, different students would meet different problems, but there was not a setting in which the teacher and the students could communicated and discussed sufficiently, the problems which the students met couldn't be solved in time, students might feel the lab work very hard for them, some students could lose self-confidence. But with TBL, students interacted with other students and teacher. And when they did the experiment, problems they met could been solved in time, they could feel more confident. The lack of difference in the other sub-scales is worthy of further investigation. This suggested the need for continuing efforts by educators to emphasize the development of critical thinking disposition within TBL. In summary, significant differences were found in the development of critical thinking disposition between the students of two classes. The students of experimental class had significantly higher critical thinking disposition scores on completion of TBL compared with the students of control class.

5. Conclusions

In our society, it is generally recognized that the ability to think critically becomes more and more important to success in life as the pace of change continues to accelerate and as complexity and interdependence continue to intensify. Education is our principal means of preparing students—our future citizens—for an active and responsible life within our modern technologically based society, school should become the home for the fostering and development of critical thinking. Critical thinking is an important issue in secondary education, and educators have continued to focus on developing students' CCTDI. Therefore, more research on teaching model is needed that focuses on the development of CCTDI in students. In recent years, TBL has been used to improve students' critical thinking disposition. And in many researches, we found that many teaching approach didn't enhance critical thinking disposition of students. In this research, the results showed that there were significant differences in dispositions toward critical thinking between the experimental class and control class in the posttest. And this indicated that after completion of the task-based learning model in chemistry experiment teaching, the students' critical thinking disposition improved significantly. Moreover, there were significant differences in self-confidence between the experimental class and control class in the posttest. Overall, the qualitative datas suggested that the task-based learning could be helpful to develop or enhance critical thinking disposition of students in chemistry experiment teaching. These suggested that TBL was an active teaching approach in fostering CCTDI of students. Additionally, the positive findings in this study provided an effective way for teachers to develop students' critical thinking disposition. However, students did not achieve high levels of CCTDI in the TBL models and didn't differ significantly on sub-scales of systematicity, open-mindedness, truth-seeking, analyticity, inquisitiveness and maturity. This suggested the need for continuing efforts by educators to study the development of students' CCTDI within PBL in chemistry experiment teaching.

References

Agnes Tiwari, Patrick Lai, Mike So, & Kwan Yuen. (2006). A comparison of the effects of problem-based learning and lecturing on the development of students' critical thinking. *Medical Education, 40*, 547–554.

Beth B.Kern. (2000). Structuring financial statement analysis projects to enhance critical thinking skills developments. *Journal of accounting education, 18*, 341-353.

Candan Ozturk, Gonca Karayagiz Muslu, & Aklime Dicle. (2008). A comparison of problem-based and traditional education on nursing students' critical thinking dispositions. *Nurse Education Today, 28*, 627-632.

David Ben-Chaim, Salit Ron, & Uri Zoller. (2000). The disposition of eleventh-grade science students toward critical thinking. *Journal of Science Education and Technology, 9*, 149-159.

David Carless. (2007). The suitability of task-based approaches for secondary schools: Perspectives from Hong Kong. *System, 35*, 595–608.

David R. Carless. (2003). Factors in the implementation of task-based teaching in primary schools. *System, 31*, 485–500.

Hasan ozkan, Berna degirmenci, & Berna musal. (2006). Task-Based Learning Programme for Clinical Years of Medical Education. *Education for Health, 19*, 32-42.

Huan Zhang, & Vickie Lambert. (2008). Critical thinking dispositions and learning styles of baccalaureate nursing students from China. *Nursing and Health Sciences, 10*, 175–181.

Irma Virjo, Doris Holmberg-marttila, & Karimattila. (2001). Task-based learning (TBL) in undergraduate medical education. *Medical Teacher, 23*, 56-58.

Julie Ernst, & Martha Monroeb. (2006). The effects of environment-based education on students' critical thinking skills and disposition toward critical thinking. *Environmental Education Research, 12*, 429-443.

Luo Qing-xu, & Yang Xin-hui. (2001). Revision for the Chinese-version CCTDI. *Psychology Science, 3*, 47-51.

Nancy Lampert. (2007). Critical thinking dispositions as an outcome of undergraduate education. *The Journal of General Education, 56*, 17-33.

Nuraihan Mat Daud, & Zamnah Husin. (2004). Developing critical thinking skills in computer-aided extended reading classes. *British Journal of Educational Technology, 35*, 477–487.

Paul Hagerm, Ray Sleet, Peter Logan, & Mal Hooper. (2003). Teaching critical thinking in undergraduate science course. *Science & Education, 12*, 303–313.

Robert H. Stupnisky, Robert D. Renaud, Lia M. Daniels, & Tara L. Haynes. (2008). The Interrelation of First-Year College Students' Critical Thinking Disposition, Perceived Academic Control, and Academic Achievement. *Research High Education, 49*, 513–530.

Ron E.McBride, Ping Xing, & David Wittenburg. (2002). Dispositions Toward Critical Thinking: The preservice teacher's perspective. *Teachers and Teaching: theory and practice, 8*, 29-40.

Rone. Mcbride, Ping Xiang, David Witteburg, & Jianhua Shen. (2002). An Analysis of Preservice Teachers' Dispositions Toward Critical Thinking: A cross-cultural perspective. *Asia-Pacifi c Journal of Teacher Education, 30*, 131-140.

Sharon Bailin. (2002). Critical Thinking and Science Education. *Science & Education, 11*, 361–375.

Thomas F. Nelson Laird. (2005). College students' experiences with diversity and their effects on academic self-confidence, social agency, and disposition toward critical thinking. *Research in Higher Education, 46*, 365-387.

Uri Zoller, David Ben-Chaim, & Salit Ron. (2000). The disposition toward critical thinking of high school and university science students: An interintra Israeli- Italian Study. *International Journal of Science Education, 22*, 571- 582.

Ya-Ting C. Yang, Timothy J.Newby, & Robert L.Bill. (2005). Using socratic questioning to promote critical thinking skills through asynchronous discussion forums in distance learning environments. *The American Journal of Distance Education, 19*, 163-181.

Zhou Qing, Wang Xiang, & Yao Li-na. (2007). A preliminary investigation into critical thinking of urban high school students in a Chinese city. *Frontiers of Education in China, 2*, 447-468.