Mathematics Education Candidates' Orientations toward the Infusion Approach in Teaching Mathematics and Thinking Skills

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Abstract

The purpose of this study was to investigate mathematics elementary education candidates' orientations toward teaching thinking skills in United Arab Emirates University through teaching mathematics. Results showed that after studying a course in 'strategies for teaching thinking skills', all the candidates believed that they have to teach thinking skills when they become teachers. Two approaches in teaching thinking skills were investigated; the explicit (infusion) and the implicit approaches. Less than half of the candidates showed a clear explicit or implicit orientation. The rest possessed a new view orientation related to either the 'frequency' or the 'degree' of using the explicit approach. The 'frequency' related view suggested a mixed approach using both the implicit and the explicit approaches. The degree related view suggests that teaching thinking explicitly should be to some 'degree'. Some recommendations have been presented.

Introduction

Teaching thinking skills is a current crucial issue in most educational systems these days. The assumption exists that a skilled thinking process leads to more efficient learning of subjects and to effective connections to students' daily life (Adey & Edmiston,2001; Adey & Shayer, 1994; Harrigan & Vincenti, 2004; Kirkwood, 2000; Nisbet & Shucksmith, 1986; Perkins & Grotzer, 1997; Thompson, 2003). Also, research has provided evidence that thinking skills can be improved (Feuerstein, 1980; Goodson, 2000; Perkins, 1989; Sternberg, 1984).

An examination of the literature related to teaching thinking shows that two main approaches in teaching thinking are suggested. The first approach relates to teaching thinking skills independently of any specific content. Thinking skills here are taught directly as a separate course. The goal is to help student to develop cognitive abilities and thinking strategies through thinking about general issues in life. A second approach based on teaching thinking skills through teaching the discipline content is supported. In this approach, two options exist; the *infusion* or explicit approach refers to thinking skills being taught manifestly using the discipline's content. The embedded or the implicit approach involves thinking skills being taught in indirect ways without a direct focus.

Problem

This study is concerned with the orientations of the students who plan to be mathematics and science teachers in elementary schools in relation to the teaching of cognitive strategies. Specifically, the study aims to answer the following question:

What is the orientation of mathematics/science major candidates in the school of education who studied the *Strategies for Teaching Thinking Skills* course toward: a) teaching thinking skills through teaching mathematics and science. b) the explicit approach in teaching thinking skills?

Method

Sample

The sample contained 48 students from four sections who studied the *Strategies for Teaching Thinking Skills* course in three semesters during the 2004-2005 school year. These students were females in their 3rd, 4th, and 5th years who intended to be mathematics and science elementary teachers. All candidates studied with the same instructor (i.e., the author). All participants

studied a previous independent course in thinking skills as a general requirement for all students at the university.

Procedures

At the end of the course the students in the sections were asked to write down the answers for the following questions: When you become a teacher, do you believe that you have to teach thinking skills? Do you think you will really teach thinking skills? If your answer on the question 3 is NO, explain why? If your answer is yes, are you going to adopt the explicit approach in teaching thinking? Explain your answer. The candidates were asked not to write down their names in order to give their opinions freely. Data was collected from math/science major students from four sections during three semesters. The data that were collected during the first semester of this study were compared with other similar data collected from the same students but through the final exam where there was a question asking the students their own opinion about the explicit and implicit approaches to teaching thinking. The answers (as a group) in both data sets were consistent which may indicate that the study tool is reliable.

Strategies for Teaching Thinking Skills Course

This course is designed to teach education college candidates how to teach thinking through teaching the subject discipline. The focus of the course is to examine two cognitive instruction approaches, the explicit or infusion approach and the implicit or embedded approach. The two approaches are explained, many illustrations or examples are given and all the tasks of the course (i.e., observing a classroom, redesigning a unit and teaching a lesson) were related to these two approaches.

One third of the course was assigned to the implicit approach and two thirds of the course assigned the explicit approach. In the implicit part, candidates learn that the implicit approach or the indirect way depends on teaching thinking skills through the content without spelling out that these are thinking skills. Students learn about the strategies that create the thoughtful classroom (i.e., physical environment, interaction, facilitation, courtesy, reflection). Students learn how to teach thinking skills through discussion, questioning, active learning, problem solving, projects….etc. In the second part of the course the focus is on the explicit approach. Candidates learn that in this approach teacher explains the thinking skill and explain its role in life in general. After the students understand what the skill is about, the teacher applies it on the discipline content. Candidates are trained in redesigning mathematics and science lessons in order to teach thinking skills explicitly, this includes adding objectives related to teaching specific thinking skills such as: 'student will realize the assumption behind some behaviors', 'student will decide whether the assumption is supported by good reasons', 'students will learn to generate possibilities skillfully in the context of solving a problem', redesign new activities, materials, methods in order to achieve the new objectives that are related to both the discipline content and thinking skills. They will also redesign the assessment methods in order to assess the students' learning.

Results

Results show in Table 1 that all candidates believe that they have to teach thinking skills and they think that they will really teach thinking skills when they become mathematics and science teachers.

As Table 1 shows, around one third of the students said that they will not use the explicit approach in their teaching. The analysis of their explanation shows that the candidates who do not support the explicit approach and prefer the implicit approach. These candidates think that focusing on teaching thinking skills and to the process of how thinking occurs will direct attention away from subject matter content. Also they think that the explicit approach is not

practical because it needs a lot of effort and time; it requires redesigned curricula and well-trained teachers

Table 1: Students' Distribution on the Closed Questions

	Yes		No	
	#	%	#	%
When you become a teacher, do you believe that you have to teach thinking skills?	48	100	0	0
Do you think you will really teach thinking skills?	48	100	0	0
Are you going to adopt the explicit approach for teaching thinking skills?	33	69	15	31

These candidates think that the implicit approach can be applied in the early elementary stage. Likewise, they believe it may be difficult to apply the explicit approach with early elementary students.

Two of these candidates explained their preference to the implicit approach by saying that knowledge and thinking cannot be separated. This may indicate that these students can not see the explicit approach as a way to teach thinking and mathematics/science content in an integrated as opposed separate way.

Around two thirds of the students said that they will use the explicit approach in their teaching. However, the explanations that they provided reflected that just few students (15%) will follow this approach completely as they studied during the course. The rest of the students (54%) mentioned that they do not think that they will follow this approach completely and in the way that they studied during the course.

The 15% students who said that they support completely the explicit approach think that in this approach they can hit two birds with one stone (learning the content and improving thinking skills) whilst the implicit approach can help in the meaningful and understanding learning but cannot teach thinking skills. Some of the students mentioned that this approach gives more opportunity for the lessons to be varied and interesting.

The transference of the learned thinking skills to other subjects and life in general is one issue that has arisen during the course and accordingly in the candidates' answers. The students who completely support the explicit approach think that this approach gives more chance to students to transfer thinking skills and use it somewhere else.

We noticed from the responses that some candidates who completely supported the explicit approach were concerned about some issues like awareness, teacher training, curriculum and textbooks. These candidates suggested that if we want to succeed we have to put more effort into using the explicit approach. Table 2 displays some of students' answers.

As mentioned above, more than half of the students chose the explicit approach but with some changes and suggestions. A quarter of the candidates planned to use the explicit approach but not

in a continuous way. These candidates planned to use a new approach where they will use mixture of the implicit and the explicit approaches.

Fourteen candidates (29%) said that they would teach thinking explicitly but not in the same way as they did in the course. They said that they would focus less on the thinking skill and more on the mathematics/science content.

Conclusion and Recommendations

The purpose of this study was to determine whether school of education candidates who studied the strategies in teaching thinking have a positive view regarding teaching thinking through teaching mathematics and science subjects and whether they support teaching thinking skills explicitly.

The results showed that all the candidates think that they will teach thinking skills through teaching mathematics and science in the future. One can deduce from these results that mathematics and science major candidates who studied a course in teaching thinking have in general some positive orientations toward teaching thinking.

Two approaches to teach thinking were identified and studied in a one semester course entitled *Strategies in teaching thinking skill.* These approaches are; the explicit approach and the implicit approach. The results showed that the orientation of more than half of candidates who participated in this study do not fall into these categories. Rather, they possess either a mixed orientation that involves both explicit and implicit approaches in teaching thinking or they possess a new view orientation related to the degree of using the explicit approach. Less than half of the candidates showed a clear explicit or implicit orientation. One may deduce from this result that the candidates were assorted in their approach to teaching thinking. This result can be supported by what Yildirim (1994) has found related to teachers' theoretical orientations toward teaching thinking.

One third of the candidates did not support the explicit approach at all and they preferred the implicit approach. These candidates think that the implicit approach leads into deep understanding of the subject and this helps students to improve their cognitive processes. They perceived thinking and knowledge as interrelated that can not be separated as the explicit approach try to do. These candidates think that devoting too much attention to explicit teaching of thinking skills and to the process of how thinking occurs can be counter-productive because it may direct attention away from subject matter content.

Results showed that around two thirds of the candidates supported the explicit approach. However, most of these candidates have not adopted the explicit approach in the same way they studied during the course. Analyzing these candidates' explanations has revealed new views of the explicit approach. These views related either to the *frequency* or the *degree* of using the explicit approach. Regarding the *frequency* related view, some candidates suggested that teaching thinking skills through teaching mathematics and science should not be in continues way. It is better to adopt a mix approach where in some lessons, teacher can use the explicit approach and in others use the implicit approach.

Some other students supported the explicit approach but in a way that teaching thinking explicitly should be to some *degree*. These students provided us with a new view of the explicit approach. This view sees this approach as *interval* and not as a specific fixed *point*. Interval that ranged between two extremes points; one point represent teaching thinking skill in a completely

explicit way as represented during the course. The other extreme point is teaching the content without spelling out anything regarding the thinking skill (i.e., no direct statements, questions, clarifications related to any thinking skills). On this interval one can move to be either on the middle or closer to one of the two extremes points.

According to the results of this study some recommendations can be presented as follows:

1. More reflections and investigations are needed regarding the views related to the *frequency* or the *degree* of using the explicit approach.

2. The question of *how can we speak to early elementary students in order they can understand the language that use the terms and strategies of thinking?* Should be considered. There is a need to create materials, ideas, lesson plans, statements and questions for teachers to use in order to teach thinking skills explicitly for the early elementary students.

3. Teachers training programs related to teaching thinking skills explicitly using the subject matter should concentrate on the integration of teaching thinking skills *and* teaching the subject content. Teachers have to be aware that when they teach mathematics and science using the explicit approach of teaching thinking, they are not teaching two separate entities but they are teaching two interrelated aspects that each gain strength from the other. Teachers have to understand that teaching thinking explicitly through their subject suppose to lead to the meaningful learning of the subject.

4. Teachers have to be aware that the explicit approach does not require casting out current lesson plans. Many current lesson plans can be modified to change the language and the focus of the lesson without losing the specific content. This can increase the demands of the big efforts and arrangements that this approach requires.

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