Concept Journaling to Increase Critical Thinking Dispositions and Problem Solving Skills in Adult Education

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ABSTRACT

Adult learners should be exposed to critical-thinking dispositions and problem-solving skills in order to successfully use and apply these skills. Students of mathematics demonstrate a preference for skill based instruction and will often skip over word problems that require critical thinking skills in order to solve the problem. Mathematics at its best requires students to think critically. In the following study, I evaluate and reflect on the introduction of concept journaling techniques into mathematics strategies classrooms, and its impact on critical-thinking dispositions and problem-solving skills. I also present previous research in the fields of critical-thinking dispositions, problem-solving skills, and the purpose of justification of students’ statements/writing, mathematical communication, assessment, and concept journaling within a mathematics learning environment. The results of the study demonstrate the value of concept journaling in a mathematics classroom.

INTRODUCTION

Winn (2004) believes that, “Teachers must instill in students a familiarity with critical-thinking - otherwise, our society will have to pay a terrible price in the long run for uncritical teaching” (p. 497). Winn indicates that critical-thinking dispositions and problem-solving skills are essential for everyday life. Adult learners should be exposed to critical-thinking dispositions and problem-solving skills in order to successfully use and apply these skills. Winn says, “Relatively few teachers and professors are using the kinds of materials and the discussion strategies that would build in their students a mental set and a taste for critical-thinking” (p. 496).

Noddings (2004) believes that many students who graduate high school may have never encountered critical-thinking dispositions. As an adult educator I have noticed that when students come to tasks requiring critical thinking, or problem-solving skills such as word problems, they often skip over them or ask, “How do we do the word problem?” Many students rarely use the ability to think critically when situations call for careful thought (Rapps, Riegel, & Glaicer, 2001). I want to better understand why students avoid these dispositions and have difficulty coping with them, thus the impetus for this study. In addition, I would like to develop ways to motivate and engage them in these dispositions. My action research case study looks at adult students’ ability to further develop critical-thinking dispositions and problem-solving skills inside the classroom, using a strategy and set of techniques that I call concept journaling (see definition below).

Setting

My action research took place at a university in a suburb of the southeastern United States. One mathematics strategies class of 28 students was asked to participate in the research, with 25 students completing all pretests and posttests. The strategies class was diverse as the classroom consisted of students of different cultures, socio-economic levels, and races. Every student in our state is required to
complete a mathematics course in order to receive credit needed to graduate from either high school or college-level degree programs.

Purpose of the Study
The purpose of my study was to evaluate and reflect on the introduction of concept journaling techniques into mathematics strategies classrooms, and its impact on critical-thinking dispositions and problem-solving skills. I also attempted to advance previous research in the fields of critical-thinking dispositions, problem-solving skills, and the purpose of justification of students’ statements/writing, mathematical communication, assessment, and concept journaling within a mathematics learning environment.

Research Question
Does incorporating a learning strategy such as concept journaling aid in the fostering of critical-thinking dispositions and the intensifying of problem-solving skills?

Definitions
1. Concept Journaling: Concept journaling is a type of learning strategy using graphic organizers, journal reflections, ideas, drawings, symbols, or other appropriate techniques to communicate and express thoughts, concepts, or topics, in this case as they relate to mathematics. The object of concept journaling is to increase student’s critical-thinking, problem-solving skills, and therefore understanding about particular topics.
2. Critical-thinking: Facione and Facione (1997) define critical-thinking as a skill in which, “purposeful self-regulatory judgment manifests itself in giving reasoned consideration to the evidence, context, standards, methods, and conceptual structures within which a decision is made about what to believe or what to do” (p. 1). The definition is broad enough to encompass the key characterizes of critical-thinking, namely inductive/deductive reasoning, problem-solving, reflective skepticism, and dialectical thinking (Chan, Dixon, Sullivan, Tang, & Tiwari, 1999).
3. Standards: National Research Council (1999) implies a content standard that describes what students should know and be able to do in a subject like mathematics. Tate (2003) suggests there are at least two levels of content standards. At the national level, the standards developed by the National Council of Teachers of Mathematics (2000) are examples of content standards and at the state level, the state’s content standard is developed modeling the national standard.

BACKGROUND
Students’ ability to form and use critical-thinking dispositions and problem-solving skills is vital for use in everyday life (Consiglio, 2003). Students need these skills in order to become valuable members of society. Consiglio states, “Teachers need to keep in mind that it is part of our [teachers’] job to develop critical-thinking skills, the curriculum needs to be composed of authentic, open-ended problems that will develop our student critical-thinking skills to the next level” (p. 3).

As mathematics educational standards begin a movement away from skill-and-drill and rote memorization, it becomes apparent that educators need to focus on teaching “real math” (O’Brien & Moss, 2004). Battista (1999) believes that in many classrooms, mathematics is presented as a teacher-centered, lecture form of instruction. For many teachers and students, the process teachers go through on an everyday basis to teach math to students is repetitive - the teacher lectures, the students write notes, the
teacher assigns meaningless problems - there is no connection between the students, teacher, subject matter, or to real-world experiences (Battista, 1999). Students are not able to apply what is learned in math to other content areas nor are they able to apply what is learned to the next topic taught in math (Schafersman, 1991).

As an ever changing society, the classroom should continue to stay up-to-date. Teachers should be encouraged to create applicable lessons, lessons that are hands-on, thought-provoking, stress critical-thinking dispositions, and problem-solving strategies (Borko & Elliott, 1999). Battista (1999) envisions that in a successful math classroom environment, “teachers need to provide student with numerous opportunities to solve complex and interesting problems; to read, write, and discuss mathematics” (p. 427).

In-class writing is one way to foster mathematical understanding (Consiglio, 2003). For students to understand topics they must be able to think independently and to move from learning skills to application of the skills. For the purpose of my study, concept journaling serves as a type of application strategy students use to enhance critical-thinking dispositions and problem-solving skills.

**Concept journaling.** Concept journaling begins with a central idea that allows the writer to generate new material, which then provides the opportunity for deeper thinking. The process allows learners the opportunity to fit new ideas together into schema. When students are presented with a journaling topic that requires them to process learned material differently and make connections with previously learned skills, students are more apt to acquire the skill and to apply it in the future. The Counseling Service of the University of Victoria (2003) states, “the requirements of summarization, as with journals, helps aid memory and encourages high level critical-thinking” (p. 1).

A math journal allows students to express thoughts, ideas, and feelings into written communication (Pogrow, 2004). When students in a math classroom are required to maintain their own mathematics concept journal, the journaling process begins to increase the students’ understanding of the math concepts. The students’ thought process begins to deepen and the mathematical ability of students continues to increase (Knapp, 2006). Borko and Elliott (1999) state, “portfolios [type of journal] make it possible for teachers to identify accurately the learning needs of individual students … to review the appropriateness of curriculum goals and content, and to evaluate the quality of their own teaching” (p. 395). The written communication then provides insight for teachers in the development of the students’ critical-thinking dispositions, problem-solving strategies, and thoughts about mathematics in general (Dougherty, 1996).

**Communication problems in mathematics.** Pogrow (2004) states, “teaching students to solve word problems is so difficult because it involves the interaction of two symbolic systems, language and mathematics, and many of the students are weak in one or both systems” (p. 300). Pogrow’s research implies that mathematics is a language students must learn to appreciate and use for communication in order to be successful mathematicians. As with any language, people must communicate with others to fully organize and understand the concepts within the language. Once students learn to be flexible with mathematical language, they become capable of applying algorithmic knowledge to solve problems and increase critical-thinking dispositions. When students construct their own understanding of how language and math interact, they become able to solve problems, even word problems. The language of mathematics becomes a tool that students can use to continue to think mathematically (Pogrow, 2004).

As with any effective teaching model, it is critical for instructors to develop an instructional plan (Wiggins & McTighe, 1998). They believe it is essential for educators to communicate together in a way that allows the curriculum to become part of a true learning environment. Undeniably teachers have vastly different ways of introducing material, giving instruction, and assessing students’ academic ability.
on particular topics. As the county implements scope and sequence subject guides, benchmark tests, and suggested activities, teachers are able to have individuality within the lessons they teach, yet have parameters to aid them in the ultimate design of their lessons. An important goal as educators is to present material to students in such a well-organized way that it in turn results in the strengthening of students’ overall knowledge of a particular topic (Wiggins & McTighe, 1998).

Summary

There is an extensive amount of research about the importance of students learning to critically think and problem solve. Many researchers believe that when students learn to implement these dispositions they become more aware of real-world mathematical experiences. One way I am suggesting to increase critical-thinking disposition and problem-solving skills is through the use of concept journaling and my study adds to the literature in that area. Concept journaling is a process. Hopefully, over extended experiences in journaling, students’ critical-thinking dispositions, problem-solving skills, and attitudes about mathematics might significantly improve.

METHODOLOGY

My goal through action research was to look at and perhaps develop strategies and techniques that might increase critical-thinking dispositions and problem-solving skills utilizing concept journaling. Throughout the project students’ reflections and responses in regard to concept journaling techniques were documented. I chose to use Collaborative Interaction Group Action Research (CIGAR) as my methodology because it provided a thick rich description of my research and had the flexibility to include quantitative support for my subjective conclusions (Saurino, 1998; Saurino, Saurino, & Crawford, 2005). The CIGAR method followed a prescribed cycle that was designed specifically for working instructors and included a minimum of cumbersome strategies allowing me to concentrate on answering my research question. The recursive steps in the cycle of CIGAR used in the study included a planning phase, baseline data collection, interventive actions, reflection and adjustment of interventions, repeat of baseline data collection, and cycle reflection phases. The study was conducted collaboratively and written from the perspective of the instructor. The following process was required to complete the research:

Planning Phase: During the planning phase, I developed the research question that was of interest to me as the instructor for my research question. Also, a timeline was established for interventions, data collections, and reflections.

Baseline Data Collection Phase: During the baseline data phase, I looked at the current situation inside the classroom. Students were not able to successfully answer mathematical problems, especially word problems that required critical-thinking disposition or problems solving skills.

Intervention Phase A: A pre-test on a math concepts unit was given and assessed. Unit A was taught with no changes in teaching from my teaching of previous years. Unit A consisted of eight sections. Students were taught strategies pertaining to number systems, polynomials, and factoring. Lecture/discussion, pairs/groups, individual seat work, and self-discovery were teaching strategies, methods, and/or techniques used during the teaching of Unit A. The students were familiar with and had been exposed to each of the teaching styles previously. A post-test on Unit A was given and assessed at the end of the unit.

Reflection – Intervention Phase A: Six random students were interviewed. These students were asked a set of questions (described below) inquiring about their personal opinions concerning mathematics and the unit taught. Two high-average students (Student A and B), two average (Student C
and D), and two below-average students (Student E and F) were interviewed about their perception of mathematics and the unit taught. The data were utilized for reflections about the teaching of the unit and as comparison with the data from Phase B.

**Intervention Phase B:** A pre-test on a math concepts unit was given and assessed. Unit B was taught with the incorporation of concept journaling utilizing selected journal prompts that correlated with the daily lessons taught. Students were challenged to find relationships between previous journaling experiences and the ones assigned in the math strategies class. Students were encouraged to write as they think, being sure to answer the writing content prompt. A post-test on Unit B was assigned and assessed.

**Reflection – Intervention Phase B:** The same six students were interviewed again, and asked the same questions inquiring about their personal opinions toward mathematics and the unit taught. Also, all students were asked to reflect about concept journaling.

**Cycle Reflection –** I compared and contrasted the assigned pre-test and post-test scores of both Unit A and Unit B to assess the level of overall understanding and mastery of material with the incorporation of journal writing. I compared and contrasted the interviewees’ answers related to the two units and the concept journaling reflections.

**Data Analysis**

The quantitative data scores of the pre-test and post-test of Unit A and Unit B were organized and typed into Fathom, a computerized statistical analysis program. The mean, median, and standard deviations were generated from calculating both Unit A and Unit B pre-test and post-test scores individually and then the pre-test and post-test scores were compared. A discussion of the analysis is included in the results.

The qualitative data, including interviews, journals, observation and field notes were coded and organized into categories utilizing standard qualitative methods. The categories were then analyzed and example quotes chosen to represent the categories. These excerpts are included in the results.

**RESULTS**

**Quantitative Results**

**Unit A Findings.** The pre-test for Unit A was administered in February and the identical post-test was administered in March. All students were given the pre-test and post-test. No student was absent for a long period of time nor were there any non-participants in the classroom. Using Fathom the pre-test data concludes that the mean score of the twenty-five students was 11.04, the median was 7, and the standard deviation was 6.6047962. The pre-test scores had four outliers, one student scored a 19, two scored twenty-two, and the highest was 33. As for the post-test data the mean increased to 82.47, indicating a substantial increase of about 71 percent. The median was 87, significant because the standard deviation of 12.165525 was still well above the passing score of 70 percent. The data indicated that all students’ scores drastically improved from pre-test to the post-test.

**Unit B Findings.** The pre-test for Unit B was administered in March and the identical post-test was administered in April. Unit pre-test and post-test was identical. Unit B consisted of four sections covering rational equations and functions. Unit B was taught in the same teaching style as Unit A with the exception of incorporating journal writing strategies and techniques. Each student was given a three-pronged folder with a journaling rubric to use for their journaling. All students were given the pre-test and post-test. Using Fathom, the pre-test data concluded that the mean score of the twenty-five students was 38.2, the median was 40, and the standard deviation was 16.82508. As for the post-test data, the mean increased to 82.56, indicating a substantial increase of 44.36 percent. The median was 85, also significant
because the standard deviation of 12.227292 was still well above the passing score of 70 percent. As with Unit A, all students’ scores dramatically improved from pre-test to post-test.

Comparison of Unit A and Unit B Data

In comparing the post-test statistics of Unit A and Unit B the mean score slightly increase by .56 from Unit A to Unit B, indicating the mean scores of the post-test increased the average score for each student by less than one percent, not a significant amount, but the fact that the material was more difficult and the small time factor add to the significance of any increase. In addition, teacher observation and the interviews showed increased interest, motivation, and use of critical thinking and problem solving skills. The standard deviation was smaller in Unit A by .061767. A higher standard deviation score suggests that the post-test scores were spread further apart in Unit B than in Unit A. There was four percentage point gain in the percentage of students scoring an eighty or above on the Unit B post-test compared to the Unit A post-test, which tells us that more students passed Unit B post-test with a score of an 80 or higher.

Qualitative Results

Two high-average students (Student A and B), two average (Student C and D), and two below-average students (Student E and F) were interviewed about their perception of mathematics and the unit taught. The six students were asked a total of six questions each.

Interviews from unit A. Interviews were conducted after each unit was taught. Excerpts that were typical responses follow:

Question 1: What do you like about math?

Some responses included:

Student A replied, “…depends on the teacher”

Student C answered, “It challenges you and when you learn something new and you understand it, it can be really good feeling”

Student F replied, “When I get an answer right”

Question 2: What do you dislike about math?

A few responses included:

Student B replied, “Problems that take up a lot of time”

Student C replied, “It can be really hard at times”

Question 3: How is math you completed in public school different (or same) from the math you completed in our strategies course?

Some responses include:

Student C replied, “It is somewhat the same, like the basics”

Student E replied, “...more challenging than 2 + 2”

Question 4: Do you think math is hard? Why or why not?

Some responses included

Student A replied, “I ask a lot of questions in math when I do not understand it, which helps a lot. I just do my work and seem to do well”

Student F replied, “Math is easy if you know what to do because then you just fill in numbers. If not, the equation it would be very hard to do”

Question 5: What do you think would help you learn math?

Typical responses included:

Student B replied, “Playing games or other group activities that would make learning fun”

Student D answered, “I think if I actually put my mind into the work”

Student F replied, “Formula sheets”
**Question 6: What did you notice about this Unit taught?**

A few responses included:

- Student A replied, “$Ax^2 + Bx + C$ was used throughout”
- Student B replied, “We did a pre-test before”
- Student F replied, “There was a lot of fractions”

*Interviews from unit B.* The same students from Unit A participated in the interviews after the completion of Unit B. Typical responses follow:

**Question 1: What do you like about math?**

Some responses included:

- Student C replied, “That it challenges you and makes you think about it and how you get your answers”
- Student D answered, “I like how math sometimes is a challenge”
- Student E replied, “I like the fact that it is challenging and that it deals with just about every aspect of life. Math makes you think more. People need to do that and the journal helped”

**Questions 2: What do you dislike about math?**

Responses included:

- Student B replied, “It takes up a lot of time”
- Student C replied, “Sometimes it can be very time consuming”

**Question 3: How is math you completed in public school different (or same) from the math you completed in our strategies course?**

Some responses included:

- Student A replied, “Your class is faster paced and public school is easier – no variables”
- Student C replied, “It is different material but you have to use some of the things you learned in [public] school”

**Question 4: Do you think math is hard? Why or why not?**

A few responses included:

- Student B replied, “No, once you know how to do one problem in a section you know how to do them all”
- Student C replied, “It can be in some parts but that just means you have to study more to understand the material”

**Question 5: What do you think would help you learn math?**

Typical responses included:

- Student A replied, “Hands-on activities”
- Student C answered, “I think I need to learn more study habits like the journal because I need to study more”
- Student D replied, “One thing that would help me in math is journaling”

**Question 6: What did you notice about this Unit taught?**

Responses included:

- Student A replied, “It has a mixture of stuff and was more interesting”
- Student C replied, “I have been doing it since middle school but I never wrote about it before – that really helped me learn”
- Student E replied, “This unit was a lot more challenging than what I have learned over the years, and was more interesting”
- Student F replied, “I like the addition of my journal, I studied it more”
Students’ Journal Reflections

The last journal prompt required all twenty-five students to reflect on mathematics journaling. The topic prompted students to answer the following questions: Did you like journaling in math? Why or why not? Would you like to continue to journal in math? Some of replies are as followed:

- “I liked how it tested me and I liked how you [instructor] incorporated the days work into the problem”
- “I must admit that the journal was pretty fun to do”
- “I think it helped me learn how to understand different math problems. It made us explain things, so if we did not know how to do it, we had to learn how.”
- “I really did not like doing the big thinking but, I have never liked doing a whole lot of thinking and work like this, but it is a good idea”
- “I did not like journaling because I do not like explaining with words.”
- “I really liked journaling because it challenges you to think harder.”
- “I like journaling, I think it is fun and it helps me understand the problems a lot more.”
- “I do not mind if we continue journaling.”

Results indicated that there was an increase in critical thinking especially related to problem solving and that more problem solving (i.e. word problems) occurred. Even though there was only a slight increase in average grades over this short-term study, there was significant positive response to the addition of responsive journaling and a noted affect on critical thinking dispositions and problem-solving skills. Continued study related to concept journaling and similar strategies and techniques would be indicated.

CONCLUSIONS

Research Question Answered

After reviewing the qualitative and quantitative data from the study, students’ journal reflections, and my own observations and field notes from the classroom I believe the incorporation of concept journaling positively affected the students’ critical-thinking dispositions and problem-solving skills. By the end of Unit B, students did not ask, “Do we have to do the word-problem?” Instead they read the problem, pulled out the important information, underlined the question(s) that were being asked, and developed a plan in order to successfully solve the problem.

Direction for Further Research

Certainly more research is needed in order to better answer my research question about incorporating a learning strategy inside the classroom such as concept journaling. Because of the short-term duration and small population of the action research, more research would provide addition data and different content areas should also be explored to see how the techniques work with other contents. Perhaps future research might utilize two classes, one being the control and the other being the experimental group, to better isolate the effect of the interventions. It would also be interesting to see a study that incorporated similar strategies over a longer term, developing critical-thinking dispositions and problem-solving skills over several years to observe the increase of these high-ordered thinking skills. Also, research is needed to discover other strategies and techniques that might be included in curriculum as the real winners will be the students.
REFERENCES


