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Building Confidence in Low Achievers through Building Mathematics Vocabulary

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Math in the Middle Institute Partnership

Action Research Project Report

in partial fulfillment of the MAT Degree

Department of Mathematics

University of Nebraska-Lincoln

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Building Confidence in Low Achievers through Building Mathematics Vocabulary

Abstract

In this action research study, I investigated the use of vocabulary strategies and the effectiveness of the strategies in building confidence in low achievers. My subjects were twenty-three eighth grade mathematics students. They were introduced to vocabulary activities and then were asked to use them in class through the use of note-taking graphic organizers, group class discussion, and partner work. I assessed their confidence and use of vocabulary through a pre and post survey, class work, notebook checks, and student interviews. I discovered that the use of vocabulary strategies built the confidence and increased the achievement of my students. As a result of this research, I plan to continue to use vocabulary strategies in my teaching.

Introduction

According to Metropolitan Achievement Test (MAT) results, over half of my students are below grade level in the subject area of math. Many of these students are in a second math class everyday, which is known as Math Intervention (MI). MI is an extension of the students' regular math class. It provides time for students to preview upcoming lessons, time to relearn lessons, and time for enriching activities. Students also get the chance to receive more individualized instruction due to small class size and a Special Education cooperating teacher. A majority of my students are in both classes. There is a significant difference in how they behave, react, and participate in the regular class versus the MI class. In both classes this group of students get very nervous and anxious when asked to use math vocabulary or to explain using math vocabulary. As stated by student T, "I hate it when I have to explain something. I feel so stupid (Teacher Journal, February 2008).

My research project focused on strategies to build their confidence in the area of math. In this group of students, there has been a break down in education, which has lead them to believe that they are not capable of doing math or doing math well. My vocabulary strategies focused on teaching them to become better mathematicians.

The National Council for Teaching Mathematics (NCTM) process standard that my research addressed was communication. The communication standard states:

> Instructional programs from pre-K through grade twelve should be able to-
> - Organize and consolidate their mathematical thinking through communication
> - Communicate their mathematical thinking coherently and clearly to peers, teachers, and others
> - Analyze and evaluate the mathematical thinking and strategies of others
> - Use the language of mathematics to express mathematical ideas precisely (*NCTM*, 2000, p. 268)

Each part of the communication standard addresses the goals of my research. My goal was that students would be able to organize their mathematical thinking and be able to communicate mathematical thoughts. Using the language of mathematics to express a concept with precision ideally building the students confidence and knowledge of the subject area. All of these are connected to the usage of mathematical vocabulary.

Another NCTM standard that was addressed is representation. The *Principals and Standards for School Mathematics* shows that students pre-K through grade twelve should be able to "Create and use representations to organize, record and communicate mathematical ideas" (*NCTM, 2000*, p. 274). Translating the language of mathematics was key to being able to correctly represent a math objective. Being able to tie all of the above standards was an awesome task, but one that in the end built the mathematical confidence and knowledge of my struggling students.

Research shows that "If students know and understand the language of math, that this will help them achieve" (Thompson & Rubenstein, 2000, p. 571). I then asked myself that if knowing the language would help them achieve would it also build their confidence in the area of math? I believed it would. Through surveys and interviews, I hypothesized that an understanding of student confidence before strategies are used can be compared to student confidence after strategies had been used.

Problem Statement

Ideally I want all of my students to be at or above grade level in the area of math and to be confident mathematicians. One part of this is being able to speak and understand the language of the subject area. Another is being able to explain the mathematic processes and concepts to others using math vocabulary. Will this ever happen? Can all students meet this goal? In the

reality of things it is probably not possible that all will meet it, for some it will take time, more time then they will have with me. I am in hope that I can start the process. All teachers want to be part of starting the process for all to achieve and gain confidence. Our job as teachers is to prepare our students for their futures. I do feel it is important for my students to have the confidence and knowledge to go and do anything they may choose.

Overall the lack of confidence in my math students plays a large factor in the success of that student. The best teacher always tries to build up his or her students and part of this is reassuring each of the students that they are completely capable of doing the math and doing it well. I hoped to build strong successful mathematicians, by teaching them the language of mathematics, by using strategies that challenged not only my students but also myself, and to build the math vocabulary and comprehension of the math vocabulary.

Literature Review

The purpose of my action research project was to increase the confidence of my students in the area of mathematics by teaching the language of mathematics through vocabulary. In my review of the literature, I found several themes to be present in many research articles. The first of the themes focused on strategies that would help students who struggle with mathematics vocabulary. The second theme was research that supports a change or increase in the understanding of mathematics through vocabulary. Research also presented strategies that would help improve students' perception of themselves. A theme that I did not anticipate but found to be common was the need to relate mathematics language to everyday language.

Students who struggle to use vocabulary

I found considerable research that addressed students who struggled with mathematics vocabulary. In the articles there were many common things that researchers found why students

may struggle. It seemed as though mathematics was a challenge because the vocabulary in math is very specific. For example, both Rubenstein (2007) and Kotsopoulos (2007) stated very specific words that have very precise meanings in mathematics. Rubenstein and Kotsopoulos both have done studies, in Tampa Florida, on strategies to build mathematics vocabulary. Both authors found that students struggle with these words because they only hear them in mathematics and it takes great effort to relate or use them in everyday language. Therefore, students do not gain a comfortable understanding and use of the words.

In a study done with six hundred elementary students, Olander and Ehmer (1971) found that students who had been given a very extensive vocabulary test did not do well when given long lists of words to memorize. They did find growth by most students when the vocabulary was tested in multiple-choice tests where the word(s) were put in the correct context. Students did recognize the true definition, but did not necessarily have a complete understanding of the word and the operation relating to the word.

Thompson and Rubenstein (2000) suggested a number of strategies that could help students get through the potential pitfalls of mathematics vocabulary. They speak of general, oral, writing and visual strategies that can be used to help all students' gain better understanding of mathematics and the mathematics vocabulary. The researchers found with middle school students the general strategy of building the concept first was the easiest to apply. This strategy is also the one most mathematics teachers use. The examples given for the visual strategies were very interesting. Many I had seen used in classrooms that were teaching social studies and language arts, but never in mathematics. The webs and visual depictions of the words were new to me in relation to teaching mathematics (See Appendix E). These visuals will help better organize students' ideas and concepts.

Increased understanding

The data did not always show that through learning the vocabulary, there was a gain of understanding in mathematics. Reynolds and Walberg (1992) conducted action research that will be similar to my action research. They found that the strategies used did not show significant evidence of improvement. The researchers did see some change, but not a significant growth among girls and boys. The strategies did show more improvement with just the girls, which was not what was predicted.

Most authors did show students had an understanding of the words through the use of several strategies. The strategies were used to help all students gain a better understanding of the vocabulary in mathematics. In a study done with 3,116 middle school students Reynolds and Walberg (1992) found a correlation between better understanding the vocabulary and gaining a better understanding of the mathematics. All the other researchers provided evidence that there was an increase in student understanding of the vocabulary. Reynolds and Walberg (1992) provided very detailed data compared to the other researchers. Although they had collected and analyzed a lot of data, their data did not show significant growth in achievement.

Student conception

It was difficult to find information that related to increasing student conception in the area of mathematics. The articles I did find discussed how students feel that there are people who are good at mathematics or not. I found this interesting because I do hear this from my own students and their parents. Kloosterman and Cougan (1994) studied sixty-two elementary students. They found that this very influence plays a great part in the beliefs of students and influence of human behavior. They also found that most students wanted to be good at mathematics and have better self-confidence. Students also needed to feel that they were capable

of doing just that. Reynolds and Walberg (1992) found that “self-concept has often been employed as an operational indicator of motivation”(p. 308). This says to me that how a student feels about themselves and ability directly ties to how well they are motivated to do work. Hackett and Betz (1989) had similar findings in a study with two hundred fifty college students.

In the book *Adding It Up* (Mathematics Learning Study Committee, 2001), another factor found was that if the student feels what is being studied is useful and worthwhile, they ask themselves will the effort pay off? I hear my own students ask, “Will I need this?” “Will I use this?” or “This is too much work.” This tells me that the connection is key. Mathematics vocabulary and concepts need to relate to the students’ lives. In my research, I will need to tie this together with the vocabulary strategies that I will use.

Mathematics language related to everyday language

All of the articles referred to in the first section concerning strategies concluded that there needs to be a connection made for students to everyday language to gain a full understanding of the vocabulary. Thompson and Rubenstein (2000) show a full-page list of words and why the words are pitfalls in mathematics. The list shows the relationship to everyday language and how different the definitions can be related to mathematics language.

Rubenstein (2007) suggests people challenge themselves with some of the mathematics words in relation to everyday language. This strategy will help teacher vocabulary grow as well as student vocabulary. The challenge is being able to use mathematics vocabulary when speaking everyday language. Rubenstein showed several mathematics words and how they are misused and misunderstood because of students’ limited understanding of the everyday use of the same words. The challenge is giving them enough information and confidence to use the vocabulary in everyday life.

This is also shown in an article by Kotsopoulos (2007) where the words are like a foreign language. She also suggests that we as teachers speak the words to students thinking that they have a complete understanding. When really they don't and we don't take enough time to teach the word meanings.

Literature review conclusion

All of the research and strategies used were very informative. I have learned that a variety of strategies are needed to help all students. Thompson and Rubenstein (2000) had great visuals that helped explain the strategies they had used. The use of visuals for underachieving students will be very helpful. Kotsopoulos (2007) and Rubenstein (2007) have shown that I need to make a definite effort to connect content and vocabulary to the students' everyday lives. This connection will help to build students' conception in mathematics. The use of vocabulary strategies will build students' conception, which in turn will help students achieve.

Purpose Statement

The purpose of my action research project was to investigate the effect of teaching the language of mathematics through vocabulary and building the confidence of my students. I examined the following themes: the number of vocabulary words students can correctly define in words or other representations, the quality of vocabulary usage in oral explanation, the confidence level of students in using correct vocabulary, the confidence level of students in the area of mathematics. This study attempted to answer the following research questions:

- What will happen to students' confidence in mathematics after they receive vocabulary instruction?
- What will happen to students' vocabulary usage in class discussions after they receive specific vocabulary instruction?

- What does my teaching look like when I challenge and support students in vocabulary instruction?

Methods

The instruments used to collect data for my research were student surveys, student work, and student interviews. All of the data collected was organized in file folders and kept in a file folder box. A pre-survey was given in early February and a post-survey in late April (See Appendices A and B). It was evident by the high percentage in my first survey that students were selecting the “no choice” possibility as their answer. Many of them were choosing this as an easy out, a choice they did not really have to think much about. On my post-survey I took that option out, hoping to get a better read of what the students were actually feeling. To analyze this data, I found the percentage for each choice that was given by the student’s pre-survey and post-survey and compared them. Due to time constraints and need for more data, a student questionaire was given in March to a randomly selected group of six students (See Appendices C and D). The students came in during their lunch to fill it out. Student statements were collected with this questionaire. Many of my students struggle with reading and comprehension, so I read aloud both the surveys and student questionaire.

Throughout the semester work was collected from the same group of six students. Samples of student homework that tied in with the vocabulary activities that we had done in class were also gathered. Math notebooks where students had used and placed the graphic organizers that we had made and used in class were included in my data collection (See Appendix E). The graphic organizers were used to organize student thoughts. They were used in a variety of ways. For example, the 5-box organizer was used to introduce lessons and the flow chart worked very well for reviewing lessons. The “What It” organizer could be used at any point in the lesson. A

tally was kept to see if students were using the vocabulary strategies that I had given them. Chapter tests were also part of my data collection. An assessment was made on the six students' chapter tests, to see if they had mastered, received an 80% or better, on more objectives this semester versus last semester.

Teacher journaling was done throughout the week. A quick journal would be written at the end of each day to reflect on the daily lesson. On Friday a detailed journal was written to reflect on my lessons and experiences during the week, and how they related to my research questions.

Student interviews were conducted in April with the same six students that I had been using throughout my research. The students were asked to come in during lunch to complete the interview. Originally I had planned to have students come in individually to complete the interviews, but due to a lack of time there were two sets that came in as pairs. Student statements were recorded of their thoughts on the use of vocabulary strategies and their confidence using them in math.

Findings

My average day of teaching throughout my research did change slightly from previous semesters. I found myself spending more time during my plan period collecting and organizing the vocabulary information that would be used in class. In my daily warm-up students would focus on vocabulary versus performing steps to a math problem. The class would share input relating to the daily warm-up. This served as a lead into a new topic or review over previous topics. Throughout my lessons graphic organizers were provided to guide students through note taking. Through the use of guided questioning, the lessons became student led. The class would use prior knowledge to discover the concepts in the lesson. As a class we would often spend

three-fourths of the class period discussing the vocabulary, using the vocabulary, and looking at examples of the vocabulary. The class would also take time to reflect and discuss the homework, a quiz, or a test from the previous day.

I observed the confidence in my students grow throughout my research. Students were volunteering to come up and do problems, where they would have to use and show their knowledge of math and math vocabulary. Most often it was the students from Math Intervention (MI) who volunteered. Data showed that three out of every four students who volunteered were students who were also in MI. I am not sure if it was the fact that they were getting the information twice as much as others or the use of the vocabulary strategies that gave them more confidence.

In my interview with student C I asked if he felt his attitude towards math had changed. He stated “Yes, I felt like it was easier because I was understanding and doing my work” (Student Interview, April 2008). He also stated that he felt knowing the vocabulary was important “because then I knew what to do and what it (the homework question) was asking” (Student Interview, April 2008).

Through data from the pre-survey and post-survey, students felt more comfortable sharing their math ideas in class. The percentage increased by 10 or more in agree and strongly agree categories. This shows that the students’ confidence or possibly comfort level had increased between the surveys.

Students were volunteering more often to discuss math problems in front of their peers. To me, this showed that students had increased their ability to use the math vocabulary. This was also found through my student interviews; all of the students could choose two or three math words that we had learned in class to discuss and give examples of how the word could be used.

In comparing my pre-survey and post-survey information on the question, “How easy is it for you to use math vocabulary to explain your answer,” I found that there was not a significant jump in the average but that the average was in the high Ok to Easy range. “This was nice to see that students did feel that they could use the vocabulary that we had been learning and using in class”(Teacher Journal, April 2008).

When looking at students’ objectives mastered I did notice that there was not a significant increase. In fact the number of objectives mastered stayed about the same for most of the students and decreased for five of my special education students. I found myself wondering, “Is using these vocabulary organizers working? I feel like their test scores are not going up”(Teacher Journal, March 2008). After comparing prior years objectives mastered, I noted that in eighth grade normally there is a drop in the number of objectives met during second semester. My data shows that the drop was less than had been seen in prior years.

Throughout my research I was quite challenged in supporting the use of the vocabulary strategies. It was very time consuming to plan lessons, especially day one of a lesson. “It seems like it takes twice as long to plan a lesson. My strategy of showing what it means, what it looks like, and how it is used seems to help the students get a better understanding but it takes so much time to plan and teach” (Teacher Journal, February 2008). “Taking more time in planning my lessons and teaching the lessons using the vocabulary strategies seemed to go much smoother than lessons prior to my research” (Teacher Journal, April 2008). “Today the kids were really into learning about geometry. Students T and L volunteered for the first time in a long time. It was nice to see the smile on each of their faces when they were correct” (Teacher Journal, March 2008). ”It seems like more kids are eager to share their prior knowledge. I am surprised at how fast some of the knowledge comes back. They were even cheering each other on when someone

would give correct input. I even saw some looks of disgust when they didn't get to share before someone else. I love to see the enthusiasm" (Teacher Journal, March 2008).

Conclusions

Although my research findings did not show any significant connection between the use and knowledge of math vocabulary and building confidence, I have seen growth from my students. The data I found was similar to the findings of Rubstein (2007) and Kotsopoulos (2007). Students do struggle with mathematics vocabulary because most of the vocabulary is very specific to math. With the use of the graphic organizers, students were able to connect these words to math and other meanings. As I found in the book *Adding It Up* (Mathematics Learning Study Committee, 2001), it did help if the students felt the subject or material was useful and worthwhile. Using the five-box organizer and the flow chart organizer, I related the vocabulary and math to real life, finding that this also helped students retain the information (See Appendix E). I also spent extra time on the pitfall words that were found by Thompson and Rubenstein (2000). In the geometry unit, the words listed were ones students did struggle with and needed more explanation. For example, the words: square, prism, pi, and volume had many different meanings to my students. It was interesting to hear their definition and how the mathematical definition related to what their prior knowledge of the word was.

Students' confidence of mathematics and the use of the math language appears to have grown. As I found in the literature, this was difficult to gage. Not only was it difficult for me as a researcher, but I also found that the students I felt were very confident were not. Student A stated, "I feel like math continues to be hard" (Student Interview, April 2008). When I noticed a student who was giving more input in class and helping those around her, that led me to believe she was confident. This is not what she shared in her interview. Student T at one point in time

would never think about saying a word in class and now he is one of the first to volunteer. “It is so great to see T raising his hand so much in class” (Teacher Journal, March 2008). My data did not show evidence of growth in students’ confidence and I continue to be unsure of how I could collect the evidence to show this.

Implications

Although my study did not show any significant growth, I will continue to use vocabulary strategies to build confidence and knowledge in my students. My students in both the regular classroom and Math Intervention class felt more confident and used the strategies to do homework and prepare for tests. This is very significant for these students. To see them learn and use a strategy they feel works for them is a change. I have found in past years that many of these students give up early in second semester. They find that the material gets too difficult and they struggle to find things that work for them.

I will continue to use graphic organizers to help students understand and organize their thoughts and understanding. The graphic organizers provided a great tool for students to take notes. Previous years my math students found it difficult deciding what notes they needed to take and what would be helpful to them on homework or tests. Throughout my research students placed the graphic organizers in their math folders and notebooks and referenced them. This not only gave support with homework and tests, but helped in organization as a math student.

My research supports continuing to have students discuss and show their understanding and prior knowledge throughout the lessons. It was great to see students take pride in what they had learned in prior classes. As stated by student A, “I felt good when I remember something from last year and could help in class” (Student Interview, April 2008). This was key in building the confidence of my students in the area of math.

Overall the strategies I used did benefit my students. I will continue to use these strategies and continue to look for more that will help the achievement and confidence of my students. As stated by student C when asked what suggestions she had for teaching vocabulary next year, ”I think you should do what you did this year” (Student Interview, April 2008). She was not the only student during interviews to make that suggestion. This tells me that I really should continue using vocabulary strategies to enhance my teaching and learning of my students.

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Appendix A

Pre Confidence Survey

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
I am good at math.					
I like to answer questions asked by the teacher in math class					
I am comfortable asking questions in math if I don't understand something.					
I am comfortable sharing my math ideas with the class.					
I understand the vocabulary we use in math.					
I think I learn better when I understand the vocabulary in math.					
It is easy for me to use the vocabulary in math class.					

Circle your answer.

1. Which of these best describes yourself as a math student?

Struggling Ok Good Pretty Good

2. Which of these best describes how a friend would describe you as a math student?

Struggling Ok Good Pretty Good

3. How often are you asked to explain your answer using math vocabulary?

Never Less than ½ the time More than ½ the time Always

4. How easy is it for you to use math vocabulary to explain you answer?

Very Hard Hard Ok Easy

Appendix B

Post Confidence Survey Name_____

	Strongly Agree	Agree	Disagree	Strongly Disagree
I am good at math.				
I like to answer questions asked by the teacher in math class				
I am comfortable asking questions in math if I don't understand something.				
I am comfortable sharing my math ideas with the class.				
I understand the vocabulary we use in math.				
I think I learn better when I understand the vocabulary in math.				
It is easy for me to use the vocabulary in math class.				

Circle your answer.

1. Which of these best describes yourself as a math student?

Struggling Ok Good Pretty Good

2. Which of these best describes how a friend would describe you as a math student?

Struggling Ok Good Pretty Good

3. How often are you asked to explain your answer using math vocabulary?

Never Less than ½ the time More than ½ the time Always

4. How easy is it for you to use math vocabulary to explain you answer?

Very Hard Hard Ok Easy

Appendix C

Student Interview Questions NAME_____

1. What do you like best about math?

2. What do you like least about math?

3. Do you understand math vocabulary?

4. Can you give me an example of your use and understanding of a math word?

5. Do you think that it is important to know math words?

6. Do you think it is important to understand how to use math words?

7. Do you think knowing math words and how to use them helps you understand math?

8. What makes math easy or difficult for you?

9. What could teachers do to help students with in math?

10. Why is it important to know the meanings of vocabulary words you see in math?

11. Has your attitude about working math problems changed this year? Why or why not?

12. As I think about how much to focus on vocabulary in my math classes next year, what advice would you give me?

13. How do you hope your next math teacher will treat vocabulary in math class?

14. What do you think makes some word problems harder than others?

15. What makes you more willing to try some word problems than others?

16. Is there anything else I should ask you to get a better picture of your attitude toward math and vocabulary?

17. Is there anything you would like to ask me about confidence or vocabulary?

Appendix D

Student Questioner **Name**

1. What do you like best about math? Why?

2. What do you like least about math? Why?

3. Do you understand math vocabulary? Explain.

4. Can you give me an example of your use and understanding of a math word?

5. Do you think that it is important to know math words?

6. Do you think it is important to understand how to use math words? Explain.

7. Do you think knowing math words and how to use them would help you understand math? Explain.

8. What makes math easy or difficult for you?

9. What could teachers do to help students with in math?

10. Why is it important to know the meanings of vocabulary words you see in math?

11. Has your attitude about working math problems changed this year? Why or why not?

12. As I think about how much to focus on vocabulary in my math classes next year, what advice would you give me?

13. How do you hope your next math teacher will treat vocabulary in math class?

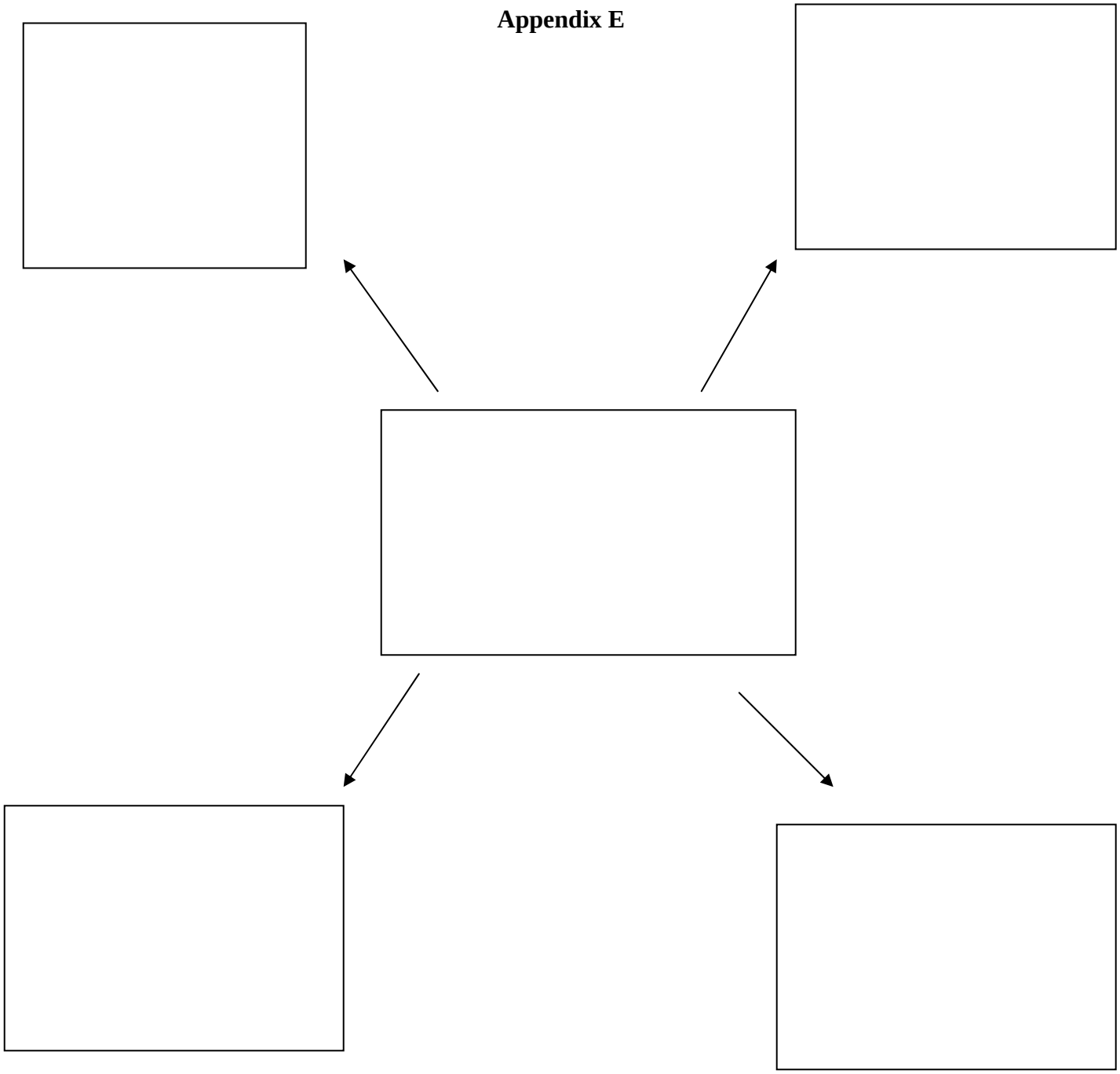
14. What do you think makes some word problems harder than others?

15. What makes you more willing to try some word problems than others?

16. Is there anything else I should ask you to get a better picture of your attitude toward math and vocabulary?

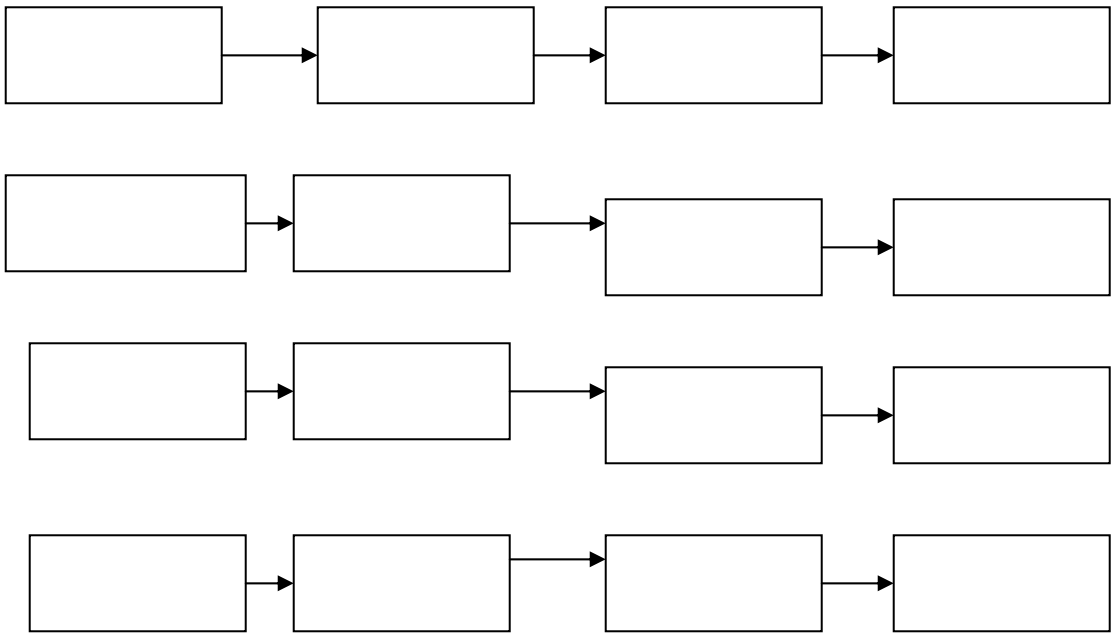
17. Is there anything you would like to ask me about confidence or vocabulary?

Appendix E



Appendix E (continued from page 20)

LESSON_____

WORD	WHAT IT LOOKS MEANS	WHAT IT LOOKS LIKE	HOW IT IS USED

LESSON_____