

Summarization in Math Class

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Abstract

This action research study of twenty students in my sixth grade mathematics classroom examines the implementation of summarization strategies. Students were taught how to summarize concepts and how to explain their thinking in different ways to the teacher and their peers. Through analysis of students' summaries of concepts from lessons that I taught, tests scores, and student journals and interviews, I discovered that summarizing mathematical concepts offers students an engaging opportunity to better understand those concepts and render that understanding more visible to the teacher. This analysis suggests that non-traditional summarization, such as verbal and written strategies, and strategies involving movement and discussions, can be useful in mathematics classrooms to improve student understanding, engagement in learning tasks, and as a form of formative assessment.

INTRODUCTION

“Did they really get what I was trying to teach them?” There have been many times when I have finished a lesson and asked myself this question. Sometimes, I am teaching at the board, and I turn around, and there are more than twenty faces staring back blankly at me. If this were a television sit-com, I would hear crickets chirping. This is a persistent struggle in my teaching. How do I know my students understand?

Usually it seems as though my lessons are going well and students are learning the material, then test day comes and my students struggle. What happened from the time students learned the material until the test? Had they not understood the material the all along? I realized that I was relying heavily on my students’ initiated questions for clarification. I thought that if my students did not understand a concept, they would let me know. But usually this turned out not to be reliable. For many reasons, students tend to shy away from asking questions when they do not know something. Maybe they do not want other students to know that they do not get something, or they assume they have a grasp on a concept when they actually do not. It is hard for me to know if my students understand what I am saying and what I am asking them to know.

When I am watching and listening to students working problems out of the book, do I really know that they understand the concept we are learning? They may have gotten the problem right or they may have gotten it wrong but it could be for different reasons and not because they did not know how to solve it or the concept involved. My students’ true understanding was not easily seen, based on working problems from the book. The struggle is compounded when it is combined with the rigorous curriculum that I teach. Our class works at a district, grade-level objective each day, and I need to know quickly that we can move on

successfully to the next day's material. I have very little time for re-teaching, and I need to know if it is necessary.

I decided that summarization might possibly be a solution to some of my problems. Rick Wormeli, a nationally certified teacher, wrote a book called *Summarization in any Subject* (2005) that includes different ways for students to summarize material in different subjects. These summaries are what I have used in my classroom. What excited me about this collection of ideas is that there are many different ways to summarize. Wormeli holds, "It can be done in writing, but also orally, dramatically, artistically, visually, physically, musically, in groups, or individually" (p. 2). My interests lie in whether summarization allows me to see what my students know through their work and discussions, while giving my students the chance to be creative and explore mathematics concepts in different ways. I am also interested in knowing whether summaries done by students can give me the quick feedback I need to follow district pacing guidelines.

I have always sensed that it would be useful to use the first part of class and the last part of class for learning new material and summarizing that material. I consider this beneficial for students because they would be thinking about mathematics as soon as they enter the room, and as they are leaving. I would like to see my students talking to their peers and me about concepts they are learning. Ideally this will result in students having a better grasp of the concept being taught, because they either learned it from me initially, they picked it up from the summarizing activity or from hearing one of their peers' explanations. Furthermore, this would enable me to tell if a student is struggling, so I can go with more practice, or I can pair him or her with a student who has a better understanding. In the ideal situation I envision, students will be able to

know the mathematics better and be better prepared for the assessments I am required to administer.

A TEACHING PROBLEM

Why might summarizing be important? Why is this worth knowing about? There seem to be a set of commonsense assumptions about summarization. For one, should teachers not assume that summarization can increase mathematical understanding in many ways? Or that it can improve students' understanding of concepts, their ability to communicate their thinking and understanding with their peers and teacher, and their retention of mathematical concepts? Does not summarization also improve the teacher's understanding of student learning, by being able to see where students are strong, and where they need more help during a class period. Does not summarization give teachers instant feedback of students' progress?

I think that many teachers are like me in that they are not sure if what they are teaching is sinking into their students' minds. I am always wondering whether students are getting it. I am hoping that summarizing the material gives me the opportunity to see what my students know that day, instead of waiting to see how they do on quizzes and tests. If this is successful, I will be able to re-teach concepts soon after the original lesson which will give students a better chance of understanding.

Sometimes it is difficult for me to know whether students understand what I am teaching. Students may not understand a concept, but do not ask questions because they are worried about what their peers may think and they do not want to look like they do not know how to do something. I am seeking to understand if summarizing in different ways can give students a creative way to communicate their thinking in which I am able to see their understanding. There is very little research about the effects of summarization besides those related to reading

comprehension. This is why it is important to me to conduct this research, to see if summarizing has the effects that I assume it does.

This problem also relates to many standards set by the National Council of Teachers of Mathematics (NCTM). The first NCTM principle that this problem relates to is equity (NCTM, 2000), Every student should not receive identical instruction but different, relevant types of learning opportunities. I hold that a variety of summarization techniques gives students who have different learning styles the opportunity to learn the content and explain their learning. Some students learn through activities involving written explanation, discussions, or visual presentations, summarization can give all of those opportunities.

The NCTM principles state that assessment should support the learning of important mathematics and furnish useful data to both teachers and students (2000). Summarization can give feedback to students by giving them a chance to monitor their own learning and learn from their classmates. It can also give me, as the teacher, data on what my students understand, and with what they may need further help.

This problem of practice also relates to the standard of communication because summarization gives students the opportunity to communicate their thinking with their peers and teacher, express their thinking with mathematical language, and evaluate their classmates thinking. Due to all of the different areas that summarization falls into and can benefit, I had to broaden my search for articles while investigating research on the topic.

WHAT THE LITERATURE HAS TO SAY

The summarization I envision in my classroom does not fall under the same type of summarizing being researched. There is much research relating to summarization in the classroom, but much of that research does not seem to look at all of the benefits that come with

implementing summarizing strategies, instead focusing on its effects on reading comprehension. However, it can be useful to summarize material in all subjects to improve understanding of the concepts being learned.

I look at summarization in my mathematics classroom and see it as a way for students to go over the material being taught that day, get a deeper understanding of that material and make it stick, communicate their knowledge in different ways, learn from their peers, and for the teacher to have a better knowledge of students truly know. Subsequently, I needed to broaden my search for research on the topic and look at ways summarization, formative assessment, communication, and memory is being researched.

Summarizing skills are essential in an academic setting due to the frequency of summary assignments, the potential for using summarizing as a study aid, and the need for these skills in more complex assignments (Kirkland and Saunders, 1991). So what exactly is summarization? Most of the summarization skills being taught and researched are in the realm of reading a passage and then summarizing that passage using certain rules.

In their study of teaching summarization skills to urban, minority high school students in hopes to improve reading comprehension, Hare and Borchardt (1984) taught the rules: delete trivia and redundancies, substitute a super ordinate for a list of terms and a list of actions, and select or invent a topic sentence (p. 63). They found that carefully delineated instruction in summarization skills positively influenced students' use of summarization rules and the quality of their summarization products (p. 75). In a broader view, Marzano, Pickering, and Pollock (2001) state that for students to effectively summarize, they must delete some information, substitute some information, and keep some information. This is related to my concerns for summarization this research project and connected to Wormeli's (2005) definition of

summarization as restating the essence of text or an experience in as few words as possible or in a new, yet efficient, manner (p. 2).

Summarization is more than just summarizing a text by writing about it in a more concise way. Borasi, Siegel, Fonzi, and Smith (1998) concluded from their research, in which they implemented transactional reading strategies in four secondary mathematics classrooms, that their studies invites students to explore the texts read through a different symbolic means-oral language, written language, visual images, and actions (p. 302). They also found these ways of talking, writing, drawing, and acting out and on mathematics-related texts can provide mathematics students with concrete ways to engage actively in making sense of the text read and, by making their tentative thinking public, to discuss their questions and interpretations with peers and teachers (p. 302). Wormeli (2005) holds that many students and teachers assume that summarization must be done in writing, either with a pencil and paper or on a keyboard. This assumption misses summarization's great dexterity.

Some problems are found with using summarization, however. Many teachers find that they do not have time to teach students to summarize and use it in their classrooms. In their research on maximizing student performance in summary writing, Kirkland and Saunders (1991) found time constraints as one of the external constraints that play in determining student success with assignments (p. 106). With hectic schedules, outside distractions, and overloaded curriculum, teachers have a hard time stopping their teaching and giving students time to summarize.

As a part of their research on support of informal assessment in mathematics in Australia, Morony and Olson (1994) conducted a teacher survey involving nearly six hundred second, fifth, ninth, and twelfth grade teachers. They state that to be able to report that a student has achieved

this outcome, a teacher will need to employ a range of assessment strategies in order to obtain the necessary information (p. 394). This is where summarization can be used. In her research on mathematics teachers as informal assessors, Watson (2000) studied 30 primary, middle, and secondary teachers' assessment strategies. Her research included identifying practices of mathematics teachers acting as informal assessors, and critically studying how two teachers developed their views of some of their students. Watson asked teachers who were trained in assessment practices "how do you find out and recognize what children know and can do in mathematics?" (p. 72). She found that teachers attempt to understand what students know through observation, speech and written work (p. 73).

Borko (1997) had teachers use running records and written summaries while students read aloud. The teachers could then use the information to assess students' comprehension and fluency and to develop instructional plans that address specific student needs (p. 233). In end-of-year interviews, Borko found that teachers knew more about what their students understood and could do in reading and mathematics than they had in previous years (p. 234).

Assessment does take time and teachers need to work to use it effectively. Torrance and Pryor (2001) used teacher researchers looking at their own classroom practices and university researchers conducting interviews and observing classrooms for their research on developing formative assessment in the classroom. One thing they found was that teachers felt assessment, even with the regular routines of the classroom, was an additional task (p. 628).

The Standards of the National Council of Teachers of Mathematics state that communication is an essential part of mathematics and mathematics education (NCTM 2000). Clarke, Waywood, and Stephens (1993) researched mathematics writing. Their study explored the implications of regular completion of student journals in mathematics at Catholic secondary

girls school. They state that classroom environments that place particular communication demands on students can facilitate the construction and sharing of mathematical meaning and promote student reflection on the nature of the mathematical meanings they are required to communicate (p. 235)

An important idea for educators to remember is to give students different ways to communicate their thinking. Watson (2000) reported some teachers would be unwilling to believe a student understood unless they had heard the student explain “in their own words” (p. 84). Others in her research preferred written work because it was safe, reliable form of evidence, however there was also wide recognition that many students had considerable difficulty in recording in writing what they could do mentally or practically (p. 84). McClaskey (1995), in her research on multiple intelligences, also states that offering students the opportunity to share their knowledge orally will often reveal they actually know more than they were able to communicate in written format (p. 56).

Teachers can also benefit from giving students different ways to communicate their understanding, hopefully in ways the students feel comfortable with. In her research on mathematics anxiety, Newstead (1998) used questionnaires with 246 fifth and sixth grade students and found that mathematical anxiety levels were lower with students in classes using an alternative approach, as opposed to a traditional approach (p. 68). For her research she described the “alternative” approach as pupils use and discuss their own strategies for solving word sums, which are used as the principal vehicle for learning and solving non-routine problems and discussing strategies in small groups are of primary importance (p. 58). Students feel comfortable when they can use different strategies and discuss problems with students. Talking,

drawing, and writing can give students the opportunity to justify their thinking, formulate questions, and summarize important insights (Whitin & Whitin, 2002, p. 205).

Communication can also help students learn from their peers. Listening to others' explanations gives students opportunities to develop their own understandings (NCTM 2000). Borasi, Siegel, Fonzi and Smith (1998) found that stopping frequently to share questions and interpretations with a partner provided these students with a constructive way to approach the reading of a text they had initially perceived to be quite difficult (p. 281). This can be applied to students communicating their thinking with mathematical problems. It is important to allow students to work together because some students might not understand a concept that the teacher explains, but they get it when they hear one of their peers explain the process.

Woodward, Monroe, and Baxter (2001) researched performance assessment and the effect it had on student achievement with seven fourth grade teachers and their students. They focused their research on students with learning disabilities. After their research they found that there was a high emphasis from the teachers in their study on using tutor scaffolding and peer mediation (e.g. verbal collaboration between students) (p. 43). They also found that this type of scaffolding is likely to be viable only when working with a small number of students and that past research from Baxter indicates that during large class discussions, students with learning disabilities tend to remain passive (Baxter et al, in press; Woodward, Monroe, & Baxter, 2001). This is something with which I hope summarizing can help. When I use verbal summarizing in class, I am seeking to understand how students who usually do not contribute to discussions react when given the opportunity to share their thinking in ways with which they are comfortable. These sessions also allow teachers to hear students describe their thinking, enable students to grapple with the perspectives of their peers, and invite the entire class to work collaboratively to

pursue the mathematical ideas introduced through the reading experiences (Borasi, Siegel, Fonzi, & Smith, 1998, p. 298).

By reading the research on these different topics, I realize more how they are interlinked. Using summarization as a form of formative assessment and communication can give teachers the opportunity to see student learning and understanding. It can also give students the chance to discover together and learn from each other. I see my research falling into the middle of what is already out there. I am planning to research the combination of summarization, formative assessment, communication and how all of these affect student learning. While most of the research on summarization is on how to summarize and teach summarization skills (e.g., Hare & Borchardt, 1984; Kirkland & Saunders, 1991), my research will be based on the process of summarizing in and for mathematics teaching. My research is focused on using strategies from Wormeli's (2005) book, and making time to summarize will affect student learning, comprehension, understanding, and retention.

Like a lot of the research, I focus on how using formative assessment in my classroom can give me an understanding of my students' knowledge and understanding. Like Torrance and Pryor (2001), I am seeking to understand whether using summarization is worth the time spent to find out what students know. I also see my research fitting in with Watson's (2000) work, looking to see if I can see what students understand through observation, speech, and written work.

As in Woodward, Monroe, and Baxter (2001), I am also seeking to understand the effects of summarization as a form of communication on students who are struggling and do not contribute much to class discussions. Does being able to communicate their thinking with their peers and hearing others explanations help students understand material and feel confident to

contribute their own thoughts? As I mentioned before, hopefully this may also allow students to pick up concepts and ideas from other students that they may have missed during direct instruction. My research can be useful because it incorporates and examines a combination of many different aspects, mainly summarization, formative assessment, and communication, and how these can be implemented effectively in my mathematics classroom to increase student learning.

MY RESEARCH'S PURPOSE

I want to know if summarization can be used successfully in the mathematics classroom. Summarization is traditionally used as a way to break down text for better understanding. I am interested in seeing if more non-traditional strategies can be used affectively in mathematics class so students have a better understanding of concepts.

I would like to know if summarizing is a way for students to communicate their thinking with their peers and whether that will increase their understanding. Many times I have felt that students learn more from their classmates explaining a concept than when I explain it. I think summaries would give students that chance to talk about mathematics with their peers. This will hopefully help a student who did not have a strong hold of a concept after direct instruction. I am also interested in seeing whether summarization can help me as a teacher to know what my students understand. I think summarizing concepts written or verbally will act as formative assessment for me, and I will be able to quickly know whether my students are getting what I am teaching that day.

My research is based on four questions:

1. What happens to student understanding as a result of the use of summarization strategies?

2. To what extent does student achievement change when summarization strategies are implemented during mathematics class?
3. What effect does the scheduling of summarizing in the mathematics class -- at the beginning, middle or end of a class period-- have on student engagement?
4. What happens to my teaching as I open the class with new material, and incorporate summarization strategies?

ACTION RESEARCH METHODS

To pursue these questions I had to make many changes in my classroom and to my teaching, a kind of natural experiment. Students were used to starting the period by going over previous homework and taking attendance. Then we would begin our lesson for the day, and end with practicing problems out of the book. This project forced me to change the schedule of the class in order to have time to present new material to the class, and be able to summarize that material. This was a difficult transition for my students and myself, but we became more comfortable with it as time went on.

With these big changes to our class, and using strategies that normally are not used in mathematics, I really wanted to know how my students felt the summarizing strategies affected their learning. I also wanted to know the effects summarization had on my teaching. I focused my data collection around these questions as I collected data through test scores, student summaries, interviews, surveys and teacher and student journals. I started collecting data during the first week of February. To begin the project my class and I discussed what I wanted my students to do during the semester, and why I felt it would be beneficial to them. We also discussed what a good summary was, and how we need to take a concept and decide what is most important about it, and be able to reword that in our own terms. I also discussed with

students how I wanted them to really try to make the information their own by using their own language and connecting the concept to their own world.

The first summary we did was called “Luck of the Draw” (Wormeli, 2005, p. 113) in which students wrote a summary of the concept being learned, and then the next day I drew one out of a hat and read it to the class. That class period the students and I discussed positives and negatives of different student summaries. This discussion was very beneficial because now the students and I knew what to look for in future summaries. Like “Luck of the Draw”, I based all of the summaries on Wormeli’s “Summarization in Any Subject.” I tried to use many different written and verbal summaries during the project and collected them from the students.

In order to see how the changes were affecting my teaching, I used an organizer (Appendix A) to record what happened during the class each day. I recorded the lesson the summary we used, specific student comments, how I felt the summary went, and any problems that I faced as a teacher. I was able to fill this out during class so I did not miss any information. I really felt these helped because I was able to record my thoughts about how I felt things were going as a teacher. One thing I reflected on was how difficult it was to find time to summarize and be able to stop my instruction, even if it is not completely finished, to give students the opportunity to summarize what they learned. I want to see whether summarization was worth doing from a teacher’s perspective. I then wrote a journal each week discussing specific lessons and summaries that happened, and used the organizers to help me remember everything. Being able to reflect on the different strategies and techniques I was using each week gave me a better understanding of my teaching and what I needed to do to insure my students were learning.

Hearing my students’ thoughts on summarizing and the changes we were making in class was very important to me. I created a list of journal questions (Appendix B) that I wanted

students to respond to, and took time every other week to have them write their own journal about their perspective on the activities being done in class. Students wrote their journals entries on February 12 and 26, March 12, and April 2 and 16, of 2008. This gave me a great idea of what they thought was important about summarization and how it helped them with their understanding. I also asked students to fill out a survey (Appendix C) about their thoughts on mathematics class this semester on April 18, 2008. At the end of the project, April 15-19, 2008, I interviewed small groups of students (Appendix D). Again, this gave students the opportunity to voice their ideas about the project and also give me suggestions for implementing summarization next year.

In order to see the affects on student achievement, I collected student scores from the tests on the concepts covered in each chapter of our textbook. I administered chapter tests on February 16, March 11, April 2 and 22, 2008. This data was difficult for me to analyze due to factors that could contribute to their achievement on tests. By the end of my project, the test scores became the least important data that I collected because to me they did not show the true effects of summarization.

At the beginning of this project I was interested in seeing how starting a class with new material would affect my students' engagement. I was hoping that they would be more engaged by starting their learning right away as opposed to having to go over homework from the previous night, taking attendance, and listening to announcements. By the end of project, my feelings changed. Through my journals I started to see that engagement was not really being affected at the beginning of the period, but it was during the time we summarized the material. I asked students to fill out an engagement survey (Appendix E) each day during the week of April

7 through 11, 2008, rating how engaged they felt they were during direct instruction, and then again during the summary to see if their engagement increased.

After collecting my data, I tried to organize it using my research questions, and other topics that I was seeing through my research, communication and formative assessment. While analyzing the data I focused on what students were saying about summarization, the changes we were making in class, and seeing if there was any correlation between their comments and their achievement.

FINDINGS ON MY SUMMARIZATION EFFORTS

I made significant changes to my teaching and my mathematics class during this project. I had grown accustomed to teaching from the textbook, having students practice problems, then assigning homework. I was used to taking care of all of the little things, like attendance and announcements, at the beginning of the period, and not worrying what time I actually began the new material. In this project, I worked hard to get started with new material right away, and also to give my students time to summarize and discuss that material.

Because of all of these changes happening, my mathematics class looked a lot different this semester. These changes started right away at the beginning of the period. A greater sense of urgency emerged when the bell rang. This proved difficult quickly when I realized that I would have to deal with the announcements being read over the intercom. I tried to get the intercom shut off in my room, but was unable to. After the announcements, many of my students started talking with their friends about many things other than mathematics, and other students with their heads on their desk still trying to wake up so early in the morning. The class eventually became comfortable with the new schedule and knew that once the announcements started they were to listen, and once the last one was read, it was time to start our lesson.

From the start of my project I was able to start teaching new material between three and five minutes after the bell rang. This was important because I wanted to see if students' engagement was affected by the direct instruction at the beginning of the period, and there needed to be time to summarize the material. Another big change that came during this direct instruction time was I noticed that I was planning and teaching a lesson with more of an emphasis on individual steps of a concept. Knowing that I wanted the students to be able to summarize and take the material that I taught them and make it their own, made me look deeper at the steps and how I would explain those to students.

I noticed significant changes after my direct instruction lesson. In the past students practiced problems from the book, asked questions, and started on their homework. This was no longer happening. Students were now thinking about concepts and discussing their understanding in different ways. On February 10 they wrote poems about the Pythagorean Theorem. On March 3 they designed graffiti on a "brick wall" that explained scale drawings to a passerby. During the summary "Partners A and B" (Wormeli, 2005, p. 127) on April 2, students worked in partners and one said everything they knew about ratios, then their partner did the same without repeating anything. Whether it was a written or a verbal summary, discussion was always involved. Students were excited to explain their thinking during these times, telling why they chose to include a certain step, or what they thought was most important for others to know.

After this first round of summary, I took care of the attendance and go over questions from previous homework. We then returned to the material from today by practicing problems and asking questions. After this was completed, we started the next round of summarizing. This was called our "ticket to leave" and usually was in the form of a sticky note that students wrote information on or solved a problem. They would then stick the note to the door as they left the

classroom. I was able to pick up the notes and check for understanding, and students left the room thinking about the topics we discussed in class. The two pieces of summarization allowed students to think about and discuss the concept, and gave me the opportunity to see what they knew.

I am organizing the presentation of my findings reflecting on my three research questions and the effects on understanding, achievement, and student engagement through data I collected from teacher and student journals, surveys, interviews and test scores.

Student understanding and the use of summarization strategies

I found that by using summarization strategies, I am giving my students multiple opportunities to gain a better understanding of the concepts I taught during mathematics class. The purpose of summarizing is for students to understand the material on a deeper level and make the mathematics knowledge their own. Students were given that opportunity each time we summarized a lesson. For the students' journal on February 26, I asked students to respond to the question "Do you feel that summarization affects your understanding of the material, and in what ways?" Samantha¹ answered by writing, "I feel that summarizing does help. It really helps me dig into my brain and remember what I learned and put it down in writing without repeating what you [the teacher] just said." This student indicates that she is able to use summarization to make the information their own, which will hopefully offer them the opportunity to take away a new, deeper understanding of the concept. Around 40% of the students gave similar responses, discussing putting what they learned in their own words.

I asked the same question during our final interviews, given April 14 -18, 2008, and received many similar responses. From the interviews, I noticed that students were realizing the

¹ All names are pseudonyms.

importance of including summarization into our daily class period. This conversation came from the interview on April 15 when I asked the group to compare this semester and last semester:

Mark: We don't have as much time to work on homework this semester.

Ashley: Yeah but if you summarize the right way you shouldn't need as much time because it will be easier.

Jack: Even if we had more time for homework, we might not have the information right so it wouldn't matter.

Misty: And if we don't have it right, we have to ask you on every problem, and then we go home we won't understand.

As I listened to this conversation, I noticed how the students who responded about homework understood the benefits of summarization and how they could offset the issue of having time for homework. Furthermore the students in this group implied that they knew the importance of their understanding of the material when they leave the classroom and not having to rely on my help.

In another journal assignment, on April 2, 2008, I asked students "Why is summarization important? What are some benefits of summarizing?" Ashley wrote, "A benefit is you can check your understanding, if you know how to do it or not. Because if you're summarizing and you can not think of how to summarize a step you know you need the teacher to explain it again." I see this is an example of a student taking control of her learning and knowing whether she understands a concept by summarizing it. Misty responded similarly, penning, "Summarization is important because when you're summarizing you can see what you really get, and what you do not really get. You can use the way other people summarized the lesson to help you with what you really do not get or know." Thirty-five percent of the class responded in similar fashion. In the survey, 14 out of the 20 students agreed that summarizing material after we learn it helps

them understand the material better, meaning 70% of the class thought on some level that summarization had a positive effect on their understanding.

During summarization, students were able to explain the concept in different, more non-traditional ways. I did not limit students to practicing problems out of the book. This was a way to increase their understanding of concepts by thinking about them in different contexts. During our lesson on the Pythagorean Theorem, I asked students to summarize what they learned by creating a poem explaining the way we could solve for the hypotenuse of a right triangle. The students worked in partners and I moved around the room listening to their discussions. I wrote in my journal that week about one group:

I went to two students who were almost done with their poem and looked at it. One verse said “you take a and b and times it by 2.” I said to them, “This is a great poem, but I think there’s something not quite right about this.” They looked it over, and then one student said, “Oh, times itself, not by 2.” He was referring to “a squared plus b squared.” They changed the poem. (March 22, 2008)

These students have a better understanding of the Pythagorean Theorem, because of this summary. Would they have figured out their mistake by working problems in the book? Maybe, but the poem was a way to think about a mathematics concept creatively and it led to their discussion and finding their mistake.

Another way summarization shapes students’ understanding is the many different opportunities it offers opportunities to revisit and think about the topics that we have learned. During a daily lesson, the class typically discusses the new material at the beginning of class. The students then summarize that material. I use the middle of class for checking homework, taking attendance, and any other administrative things we need to do. After this the class returns

to the day's material, and then summarize again at the end of class. In their journals for February 26, 2008, I asked students to respond to the question, "Does summarizing at the end of class before you leave affect your learning and how?"

Many students wrote that summarizing at the end of the class does affect their learning. Brooke penned, "I think summarizing at the end of class does affect my learning because I leave class thinking about the topic we learned and then usually I think about it the whole day and clarify it in my head." To me this is great; students thinking about mathematics after they leave class! I do not think it would happen if they learned the concept and then practiced out of the book. In the survey I asked students fill out, 15 of the 20 students surveyed agreed on some level that it is important to them to summarize the material we learned before I leave class.

A change in my teaching became apparent during this process. I am no longer relying on the students to understand concepts solely on my teaching and giving examples at the board. I was able to give students other opportunities to understand, and I gave myself more opportunities to see understanding.

I found that some students will not raise their hands and ask questions even if they do not understand something, usually because they are timid or do not want other students to know that they do not know how to do something. In a journal entry on March 12, 2008, Jeff wrote, "Some kids are shy and do not like asking questions when they do not understand things in class out loud." I know that it is difficult for some students to stand up in front of the whole group and admit they are not sure of something. Summarization gave students the opportunity to work in partners and smaller groups, and they were able to discuss concepts in different ways and also picking up concepts from their peers.

Some students seem to benefit from hearing their classmates explain something instead of hearing it from me. During our final interviews on April 18, I asked a small group if they felt they learned better from the teacher or their classmates. Jeff responded, “My classmates since their minds are the same as ours, they put it in our form which more easier to understand, and they bring other ways to do it.” All six students in that group agreed with him. In a different interview group, Angel replied, “If you said something, and then a student said something, someone might understand it better from the student.” In the survey students completed, I asked the students to respond to the statement “I learn mathematics concepts better by listening to my classmates explain it,” and only one of the twenty students disagreed. Students need the opportunity to communicate their thinking with their peers, summarization can give them this opportunity. This can also give students a chance to understand a concept that they did not before by listening to their peers’ explanations. Responding to the question “Why is summarization important?” from the journal on April 2, Misty answered, “You can use the way other people summarized the lesson to help you with what you really do not get or know.” Thirty-five percent of the class responded in similar fashion to that question.

Summarization benefits both student and teacher by giving the students the opportunity to understand concepts and the teacher the opportunity to see that understanding quickly. Through this research project I found that summarization can be a useful form of formative assessment. When students are summarizing, their understanding becomes more visible to me as the teacher. I had a better grasp of what my students know and what they do not know. In my journal on February 9, I noted that I had not been using the phrase, “Does that make sense?” while I am teaching, as if I were not confident whether my students were understanding the concepts I was teaching. Because of this lack of confidence, I used to say this all the time. One specific example

of this was on April 3, when the class did a summary called “Line Up” (Wormeli, 2005, p. 108). During this summary each student had a card with either a number or a radical expression, like the square root of 81, on it. Students were put into small groups and had line up from least to greatest based on the number on their card. While they did this, I moved around the room listening to their conversations. In one small group there was a student who thought that nine squared was the same as nine multiplied by two. Another student suggested the first student should line up in a different spot, they discussed it and agreed. From this encounter, I was able to tell that the student needed some extra assistance and I would need to discuss exponents again with him. Using summarization I was able to get instant feedback of what my students understood, and what they would still need help with.

Student Achievement and Summarization Strategies

I have come to the conclusion that student achievement depends on many factors, including how they summarize the material in class and use those summaries on their homework and tests. I realized early on in the research process that summarization could be valuable to students when they are taking their test, but it depends on the student.

It is difficult to say that student achievement was affected by summarization. I conclude on some level it was, but their achievement also depended on other factors. The material this semester may have been easier or more difficult for some students. Some students may have understood the concept completely, but made simple mistakes that resulted in a lower grade. Some students may just perform better on tests than others.

Along with those factors, the way students approached summarization and how they used those summaries also affected their performances on tests.. I saw throughout the project that the students who are performing well on tests, were the same students who seemed to give maximum

effort when it came to summarization. In my journal on March 17, I wrote, “There are always a handful of students who do not really get into the summarizing. I do not know if they think it is boring, or hard, or just another thing they have to do. Some of these students also always seem to score lower on their tests and need to re-take parts. These students also had these habits last semester, but I was hoping that the summaries would help them, but I do not think they will unless the students put more effort into them.” Honestly, those results did not surprise me, but I thought that I would investigate them a little further.

Out of the twenty students in my class, twelve students ended up with a ninety percent or greater on tests covering the material from each chapter. In the journal on March 12, I asked students to respond to the question “When you take a test, do any of the summaries we have done in class help you?” Of the twelve students who are receiving an A, almost 70% of them agreed on some level with Beth who answered, “On tests the summaries help because I sometimes remember the material better. Sometimes if we do pictures I can really remember the material from those pictures.” On the other hand, there were three students who averaged less than eighty percent on tests, two out of those three did not feel that the summaries helped them on the tests.

My hope was that students would be working on their test and would go back to their summaries and think, “Oh that’s right we made a comic strip about this,” or, “I remember the steps of this from our Partner A and B talk.” This did not happen with every student; in fact, the results were pretty mixed. When I interviewed a small group of students on April 19, 2008 I asked whether the group thought about the summaries or the practice from the book when they were taking the test. Ricky responded, “More the summaries for me, because I thought about my poem during the test.” Ashley agreed, “Once you do something fun it stays in your head, they

help me on my test because if they are fun summaries I will remember them.” However during the survey given on April 19, to the statement, “I remember the summaries we do in class when I take a test,” nine students disagreed with the statement, while ten agreed.

Schedule Changes of Mathematics Class, Summarizing, and Student Engagement

My original thought for my research was that I was wondering if my students would be more engaged and focused right away at the beginning of the period. I wondered if that would then effect what they took from the class as important information. To answer this, I concluded it was important to start teaching new material at the beginning of class to see if the students were engaged, and also to give us time to summarize the lesson both in the middle of class and at the end.

I found that starting the period with new material was sometimes difficult to do because of outside factors and the students’ engagement level. I noted in my journal on February 5, that it was impossible to truly start teaching at the beginning of the period. “I can not get the announcements turned off, so basically we are sitting and listening, waiting for them to end before we can start. Also it has been snowing this week, which means there have been buses that have been late, which carry about one fourth of my students.” Due to the announcements and other things that could not be controlled, like the buses, I found that having mathematics at the beginning of the day has its disadvantages. Another one of those disadvantages is that some students were not quite awake yet, which obviously affected their engagement.

In their journals for February 12, I asked students to respond to the question, “Does starting right away with new material affect how you understand concepts and how you learn them?” Forty percent of the class agreed with Sally who said, “Well, starting new material right after announcements is hard. Right in the morning is a time our brains are fuzzy.” I saw that

many of my students felt tired and not ready to learn first thing in the morning. However it was beneficial to start with new material because it did give the class a chance to summarize the concepts, and during that time students could compensate for the lack of engagement earlier. It was beneficial because even if something was missed during that initial instruction due to students' brains being "fuzzy", there was still an opportunity for them to pick it up later during the summarization time.

Even though the engagement levels were sometimes low during the direct instruction, I saw levels of engagement rise when we got to the summaries. This increase in engagement was especially evident during summaries that included movement.

In one of my journal entries, on February 19 I discussed one summary exercise used in class called "Summary Ball" (Wormeli, 2005, p. 158).

In this summary students stood up and we threw a beach ball around the room. When students caught the ball they had to give a statement about the concept we learned that no other student had already said. This summary really worked well because it got students up and moving, and because they could not repeat anyone else, they had to focus on what all of their classmates were saying. Students seemed really engaged. They seemed to have a lot of fun with it.

Another example of high levels of engagement was on March 3, when the class discussed angles. I used two different summaries one that I took from Wormeli's (2005) book during that lesson, "Word Splash" (p. 188) and followed by one I called "Splat." During the first part, I made a bunch of cards out of construction paper with terms and definitions related to angles, such as acute or ninety degrees. As I was walking to the board, I tripped and spilled all of the cards, a suggestion Wormeli gave in his book. I asked the students to tape them to the board in

an order that made sense. This led to a good discussion because one student put the cards “acute” “less than” and “90 degrees” in order. The class said that he was right, but other cards could be used as well. The student at the board did not see that, but they discussed it and he realized that he also could have used cards to say “acute, less than, right angle”, or “acute, less than, obtuse angle.” At the end of class the cards were back on the board in a random order, and I asked two students to stand at the board with their backs turned to it, holding fly swatters. I then gave them a question and they had to turn around and swat the term or definition that went with the question. Whoever did this first stayed at the board and a new opponent came up for the next question. While the class was doing this, two comments by students stood out. One said “This is fun,” and another said, “All of our summaries should be like this.”

Although all of the summaries I used in class were beneficial in many ways, it was obvious that students enjoyed the summaries that involved movement, and activities like drawing, poetry, games, and music, which makes sense. Another aspect of summarization that is useful is that it can be used with students’ multiple intelligences in mind. In a journal on April 2, I asked students what summary they would choose between a summary like “Line Up”, which involves movement and communication, or “3-2-1” (Wormeli, 2005, p. 39), which is an individual written summary. Steve said, “Between the two, I would rather do line up because it’s like a hands on activity. We actually get to get up and move around.” Eighty percent of the students agreed with Steve and chose the summary with movement.

With the schedule changes, I found that it was important to start the class with new material and summarize during the middle and end of the class because students were engaged at the time when we discussed the concepts we learned and as they were leaving the classroom.

Summarization and My Teaching

Through this research project, I found that I was focusing more during my planning of lessons, in particular the planning of the individual concepts of a lesson in order for students to summarize. For students to summarize effectively, they need to know what is important about the concept, and what they can dismiss. For them to do this I need to make sure I present everything they need to know in order for them to make that decision. During this project I have been planning my lessons with this in mind. In my journal entry on March 12 journals I stated, “It seems that I am really studying the “mini lessons” within a regular lesson in order to make sure that my students can effectively summarize.”

As I plan for my lesson, I am also thinking about what summary I should use that day. This was sometimes a difficult process. In another teacher journal on March 18, I said “One thing that has been difficult for me lately is finding a summary that I can incorporate in mathematics. We did a lesson on square roots and I was racking my brain trying to decide on a summary that would be worthwhile for the students without them just re-telling the information that I taught them.” Since I am taking a strategy that is traditionally used with reading text, at times it was difficult to find one that would work with mathematics concepts. It was important for me to have my students stay away from just re-telling what I said, because that would not help them understand the concept.

Even with these difficulties, I found that summarization was a worthwhile experience for my students and myself. In their final journal on April 16, I asked students, “Do you think you will use summarization in other classes (mathematics and other subjects) next year?” Samantha responded,

I think I will use summarization in other classes because it helps me get my thoughts to the subject/topic and think about it. If I do not understand it, summarizing helps with thinking of the steps or which formula goes with what. Overall, it just really helps me to focus, and that's good in every class, not just mathematics.

I was happy to see that seventy eight percent of the class agreed and said they would use summarization next year because summarization is a skill they can use in any subject throughout their schooling.

CONCLUSION

These findings from my research project say that summarization can be used successfully in many ways in the mathematics classroom. Summarization can increase understanding of concepts by students by giving them opportunities to see and think about the material in different contexts and discuss them with their peers, and also makes that understanding visible to teachers.

If students are struggling with a concept, their peers' explanations may be what they need to help them understand it and those explanations can come through summarizing. In their study, Borasi, Siegel, Fonzi and Smith (1998) found that stopping frequently to share questions and interpretations with a partner provided these students with a constructive way to approach the reading of a text they had initially perceived to be quite difficult (p. 281). My research supports this claim, and also takes it a step further. I conclude that summarization can be used to give students the opportunity to learn from each other, and my discussions with students through journals and interviews have found that some students do learn more from their peers' explanations than their teachers. This is information that would be valuable for teachers of all subjects so they can give students the opportunity to discuss concepts with the other students as much as possible.

The increase in communication in different ways due to summarization also gives students a chance to express their thinking in a more comfortable way. In her research Newstead found that mathematical anxiety levels were lower with students using an alternative approach that used discussion. Though I did find in my research that many students felt comfortable with verbal summaries, there were also students who would rather use a written summary. What worked best was to use a variety of summaries to give the best possibility that my students would feel comfortable sharing in the classroom. Learning these different types of strategies can help students using strategies in the future because they can choose strategies that work for them.

When Watson (2000) conducted her research on teachers acting as informal assessors, she found teachers attempt to understand what students know through observation, speech and written work. My research strongly supports the thoughts of those teachers, because as I used summarization in variety of ways to assess student knowledge, it was through me watching students summarize, listening to their conversations, and viewing their written summaries. Summarization can take many different forms, which means teachers are able to keep their assessments fresh and still get a strong grasp on student understanding.

Teachers can use summarization in their mathematics classes as a way for their students to show what they understand and to discuss that knowledge with the class. Using these strategies, teachers will be able to incorporate some creative ways for their class to think about mathematical concepts. Kirkland and Saunders (1991) found that time constraints was a problem for teachers implementing these types of strategies. Although at times in my research it was difficult for me to find time for everything that I wanted to do, I found that the benefits from summarization were worth the planning and time commitment.

I discovered most through the research project that with summarization that was done in class, the most important part was the process, not the final product. In his book Wormeli (2005) states, "... real learning doesn't occur while you are doing the thing itself. Learning comes in the debriefing afterward, when the instructor helps the members of the group process what they have accomplished" (p. 5). Through this project, I found that this discussion can come during the summary and after it. Many times it did not matter what type of summary the class was doing, whether we were writing poems, creating comic strips, or throwing the summary ball around the room, it was the thinking that was involved and discussions that came with it that were the most beneficial to me and my students.

IMPLICATIONS

As a result of this study, I found that summarization is a valuable practice that can be used productively in a mathematics class. I would like to continue to use these strategies while teaching mathematics and am excited to see the results it brings when using them for an entire year.

By using summarization at the beginning of the school year, my hope is that students will become more comfortable with the process and successful using strategies that they normally would not use in mathematics class. As summarizing becomes more of our regular classroom routine, students will develop a better understanding of what information should be summarized, hopefully giving them a better understanding of the mathematical concepts. By becoming more skilled at the summarization process, students will hopefully also apply these skills to other subjects.

Next year I project that I will be able to see whether there is an effect on student achievement on tests by starting the process earlier. I plan to let students take summaries home

with them so that they will be able to study from them while preparing for their tests. This will give students the chance to continue thinking about a concept in their own way, which will help them make the information their own. My hope is that when students take a test, their mind will go back to the summary we did in class, and that will increase their achievement.

I plan to continue using the summarization strategies as a form of formative assessment for my students. Using these strategies in class, I get a quick understanding of what my students know and what they still need more instruction on.

Finally I plan to continue using summarization as a way to get my students talking with each other. I am going to try to take the focus of my classroom away from myself, and put it more on my students. Their ability to communicate their thinking will increase their success in my mathematics class and their other classes. Summarization will contribute to this process.

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APPENDIX A

Teacher Journal Prompt

Date of Journal _____

Brief description of lesson/lessons for this journal:

Focus on these prompts and attach journal

How are students using the summaries in class?

What is the quality of their summaries?

Do some types of summaries (written, verbal, etc) seem most effective?

How does summarization effect student understanding/retention?

After direct instruction, how does the whole class seem to understand material? How do they show that?

After listening to and discussing student summaries, how do students seem to understand the material?

Do students seem to understand the main concepts of the lesson?

Does the change in schedule seem to effect student understanding?

How are students communicating concepts?

How are students verbally communicating concepts? Writing?

How does summarization seem to effect student comprehension?

Am I seeing any change in student comprehension?

Does the change in schedule seem to effect student engagement?

What obstacles do I face in presenting the day's material at the beginning of class?

How are students handling moving from instruction to summary and back?

Does summarization at the end of class seem to benefit students? Middle of the class?

Has it been difficult to be sure to summarize at the end of class, especially when I'm not through the material?

APPENDIX A

Daily Record Sheet (use for remembering daily information, communication, etc. for weekly teacher journal)

Date _____

Summary Strategy Used:

Overall effectiveness of summary:

Specific student communication/summary/responses:

Schedule Notes (what is working, not working, etc.):

APPENDIX B

Student Journal Prompts

Journal 1 (2-12-08)

How do you feel Mathematics class is going so far?

Do you like learning new material at the beginning of class?

Do you feel learning new material at the beginning of class helps you learn? If so, how? If not, why?

During class when do you feel you are most focused? Why do you think that is?

What topics that we have discussed have been easy for you? Difficult?

Do you feel you have been learning best from the teacher or from your fellow students summaries? What are some examples?

Do you feel you have been understanding and remembering mathematic concepts better lately? If so, how? If not, why?

Do you feel you have been participating in class more lately (raising your hand, working problems on the board, helping classmates, etc.)? What are some examples?

Journal 2 (2-26-08)

Do you feel that summarizing affects your understanding of material? In what ways?

In what ways does summarizing affect you when you take a test?

Does starting right away in class with new material (after announcements) affect how you understand concepts and how you learn them? Explain?

Does summarizing at the end of class before you leave affect your learning? How?

Which helps you more, written or verbal summaries? Why?

Journal 3 (3-12-08)

How does summarizing material affect your understanding of the material? In what ways?

When you take a test, do any of the summaries we've done in class help you? How?

Do you think that it's worth it to have time to summarize during class, even if it means there's less time for homework? WHY?

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How does summarizing help with material that you think is easy? How does summarizing help you with material that you think is hard?

What is a specific summary that has helped you the most? Why and how did it help you?

Journal 4 (4-2-08)

Why is summarization important? What are some benefits of summarizing?

If you had to choose between a summary like “Line Up” and a summary like “3-2-1” which would you rather do?

WHY?

What could I do to make summarization more valuable? How could they be more helpful to you?

When you compare mathematics class last semester and this semester, what is different? How do you feel these changes have affected your learning?

Journal 5 (4-16-08)

We are now almost done with our project; do you think you will use summarization in other classes (math and other subjects) this year or next year?

If you took your summaries, like poems, comic strips, or 3-2-1 home with you, would they help you prepare for your test? Would they help you with your homework?

If I continue to use summarizing in my math class next year, what should I do differently? The same?

Last semester after our lesson we would practice problems and work out of the book, this semester we worked on a summary involving the concept, compare your engagement as a student during those times.

APPENDIX C

Math Survey

Student # _____

Please circle the number that relates to your personal opinion about the way our math class is going so far this year. Please be completely honest.

Never or No	Not Really	Not sure	Sometimes	Always or Yes
1	2	3	4	5

1. Summarizing material after we learn it helps me understand the material better.

1	2	3	4	5
---	---	---	---	---

2. When I do not understand something after we learn it in class, summarizing helps me learn it.

1	2	3	4	5
---	---	---	---	---

3. I learn math concepts better by listening to my classmates explain it.

1	2	3	4	5
---	---	---	---	---

4. It helps me to understand a concept when I can explain it in my own words.

1	2	3	4	5
---	---	---	---	---

5. I remember the summaries we do in class when I take a test.

1	2	3	4	5
---	---	---	---	---

6. I am doing better in math class since we started summarizing.

1	2	3	4	5
---	---	---	---	---

7. Discussing our summaries in class helps me.

1 2 3 4 5

8. I am focused and ready to learn when we begin discussing new material in class.

1 2 3 4 5

9. I am focused and engaged during our summaries

1 2 3 4 5

10. It's important to me to summarize the material we learned before I leave the class.

1 2 3 4 5

11. I could take the summarization strategies we have learned in math and use them in other subjects.

1 2 3 4 5

12. Summaries help me with my homework

1 2 3 4 5

13. Summaries help me on my tests

1 2 3 4 5

14. Summarizing makes math class more fun.

1 2 3 4 5

15. I enjoy doing things in math class that we normally would not do, like poems and comics.

1 2 3 4 5

APPENDIX D

Student Interview Questions

How do you feel about math class this semester? Is there anything you really liked? Anything you didn't like?

Why do you think I have changed our class schedule and asked students to summarize daily?

What effects do you feel using summarization strategies have on your learning?

How do you feel you have understood the material we have been covering this semester? Please explain.

Does it help you to learn mathematics by summarizing the information after learning it? Please explain.

Do you feel you learn more from listening to the teacher explain concepts or listening to your classmates explain concepts? Please explain.

When during the class period do you feel like you are the most focused? Why do you think that is?

How comfortable are you in explaining what you have learned? Would you rather do that in writing or verbally? Please explain.

What has helped you the most this year in math? What has helped you the least? Why do you think that is?

Did you like going over new material at the beginning of class? What are some pros and cons of starting the class with new material?

What have you learned this year that you feel comfortable using in the future? Give examples.

Do you feel like you could explain most concepts we've learned this semester to others who haven't learned it? Please give a specific example.

Do you feel like you could take some of the summarization skills you've learned and incorporate them in other subjects? Please give a specific example.

As I think about planning my math classes for next year, what advice would you give me about using summarizing in class? What advice would you give me about the daily schedule in math?