

SUNY COLLEGE AT BROCKPORT

MATHEMATICS JOURNALS

IN A TIME OF FLUX

By

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Abstract

The purpose of this study is to evaluate the relationship between learning style and level of engagement in math journal writing. After students completed a learning style assessment, they composed a series of 6 journal entries. Each entry was scored “Engaged” or “Not Engaged.” There is no statistically significant relationship between a student’s learning style and level of engagement. Thus, using a learning style intake assessment to qualify students for a journal writing program may not be appropriate. A teacher should examine the research literature for personally relevant examples and find a colleague at his or her school to facilitate the process of updating classroom practice before engaging in a major change.

Chapter 1—Statement of Problem

Purpose

- To evaluate the relationship between learning style and level of engagement in math journal writing.

Introduction

As a mathematics teacher in a reading program, I am interested in exploring uses of the reading and writing process with students in content-focused classrooms. The Board of Regents has changed the format of the high school Regents examinations in mathematics. Students are required to explain the procedure by which they arrived at solutions. I feel that examining the use of mathematics journals is a particularly relevant topic.

With new state assessments stressing process in addition to product—coupled with a mandate to prepare all students for a Regents diploma—I believe that it is necessary to teach my students in a variety of ways. No longer is the lecture-drill-practice-repeat model of mathematics instruction sufficient for students to be successful in mathematics.

In addition, I am sensitive to the unique perspective 14- and 15-year-old students bring to the classroom. At this age, children are typically resistant to change and prefer classroom routines and teaching styles with which they are familiar.

Because I must address the needs of students with a wide range of abilities, it is vital that I differentiate my instruction. Journal writing is one major form of differentiation. In addition, the journal may become a place for students to respond to their mathematics learning affectively. Affective elements of learning are rarely emphasized in a fast-paced Regents classroom.

Further study on how individual differences—such as personality, learning and teaching styles, mathematical background, or gender—may influence students' and teachers' decisions and behavior with respect to journal writing would thus be valuable and may further help individual teachers decide whether and how to employ this strategy in their classes. (Borasi & Rose, p. 364)

A review of the literature reveals an underlying assumption that journal writing increases the level of mathematical understanding of students. However, there are concerns that not all students benefit equally from this procedure.

Need for the Study

Judging from personal experience, it is unlikely that a math teacher with 125 students can respond weekly to every student's journal with interest and enthusiasm. It is my goal to identify if there is a correlation between a student's learning style and the benefit he or she receives from using a math journal. This information could be used to develop an intake assessment to identify which students would most likely benefit from regular, engaged dialog with the teacher in a math journal. The teacher could then use this information to decide how to utilize journals with his or her classes.

Chapter 2—Review of the Literature

Historical Foundations

Since 1989, when the National Council of the Teachers of Mathematics (NCTM) published its *Curriculum and Standards* document, American mathematics education has gone through comprehensive systemic reform. Leaders of American mathematics education expect graduating high school seniors to be able to reason logically, apply theorems to real life applications, and transfer mathematical ways of thinking to other academic and social spheres.

Edna M. Waller, an elementary teacher in Mississippi, expresses her desire to reach these new goals and describes the experience of many other educators:

I have been working to implement more of an application approach to the mathematics curriculum for my students...Even though they were mastering the basic skills, they did not seem to understand the practical application of mathematics. Modern business and industry leaders have also voiced a concern that graduates of the public school system are not adept at practical, everyday mathematical problem solving. (Stone, 1999, p. 55)

Higher levels of thinking, and not just “skill and drill,” are expected outcomes of instruction in today’s math classroom.

A Nation at Risk, published by the National Commission on Excellence in Education in 1983, painted a bleak picture of the status of public education in the United States.

If an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war. As it stands, we have allowed this to happen to ourselves... We have, in effect, been committing an act of unthinking, unilateral educational disarmament. (p. 5)

In response to this heavy criticism, educators felt it necessary to pursue alternative approaches to teaching. The “whole language” approach to teaching language arts was part of the response to this negative evaluation of education in the early and middle 1980s. Similarly, mathematics teachers were forced to reevaluate the effectiveness of their programs. The NCTM responded with constructivist pedagogy.

According to Glasersfeld (1995), constructivism

starts from the assumption that knowing, no matter how it be defined, is in the heads of persons, and that the thinking subject has no alternative but to construct what he or she knows on the basis of his or her own experience... [A]ll kinds of experience are essentially subjective. (p. 1)

This philosophy shifts focus from the mind of the teacher to the mind of the student. It is impossible to learn something as a passive recipient because knowledge is not a description of abstract truth. Rather, education requires a student to respond actively to what he or she is studying.

The constructivist point of view contradicts an underlying assumption of the philosophy of mathematics from the previous 2000 years. In his overview of the history and problems of philosophy, Stumpf (1989) writes that

Plato put mathematics into the center of his curriculum, arguing that the best preparation for those who will yield political power is the

disinterested pursuit of truth or scientific knowledge. Here the mind is trained to cut through opinion and emotion and by hard thinking to confront the facts of reality and to base judgments on knowledge. (p. 50)

Historically, mathematics has been seen as an abstract reality worthy of study because of its close relationship to truth. The Platonic view of mathematics implies that the discipline can be studied without the construction of new meanings. Rather, mathematics has an external existence independent of the subjective experiences of individuals.

The idea that math has an independent, Platonic existence was severely challenged by the work of Kurt Godel, a 20th century German logician most famous for his Incompleteness Theorem of 1931.

When Godel published [his theorem,] it was as though an arithmetician had proven that $2 + 2 = 5$.
What is the truth value of the following sentence? **This Sentence is false.**
The result is paradoxical. The sentence can be neither true nor false. Godel showed that...every axiomatic system will have at least one statement within it that can be proven neither true nor false. Since no deductive system can assign a truth value to every claim within the system, complete knowledge [through mathematics is impossible].
(Mitchell, 1996, p. 14)

A great deal of tension has developed among mathematics educators who were trained under a Platonic philosophy thousands of years old and asked to adjust their teaching to a new, constructivist approach. Neither teachers nor mathematicians integrated Godel's work to pedagogy before the NCTM published its *Curriculum and Standards* in 1989.

Constructivism has its roots in the writings of John Dewey.

As director of the Laboratory School for children at the University of Chicago, he experimented with a more permissive and creative atmosphere for learning, setting aside the more traditional and formal method of learning by listening and encouraging instead the pupil's initiative and individual involvement in projects. (Stumpf, 1989, p. 422)

Dewey believed that the constructivist philosophy more closely reflected reality than the Platonic view of truth, including mathematical truth.

Piaget heavily influenced the popularity of the constructivist philosophy as well, demonstrating that children gradually develop the ability to reason abstractly. One important question to be explored by educators is whether or not Piaget's theory implies that an underlying concrete foundation is necessary before students can understand abstract concepts, particularly mathematical concepts. Teachers who subscribe to a constructivist perspective assume that this is the case.

Mathematics Education in New York State

A new Regents exam, called Math A, will be required of all New York State students graduating in June 2004 or later. The only alternative will be a special education diploma. No more local diplomas will be offered unless the Board of Regents elects to allow a variance for students scoring under 65 on this required assessment.

The Math A exam, similar in format to the Math 4 and Math 8 grade level exams already in place, will require students to answer both traditional short-answer and constructivist extended-response test items. Examples of each type of

question, as well as a copy of the Math A Core Curriculum, are included in Appendix A.

In 1996, the NYS Education Department published its *Learning Standards for Mathematics, Science, and Technology*, outlining the new philosophy of teaching and assessment that is being implemented today. In their introduction to the document, the Regents write that

[a] classroom typically includes students with a wide range of abilities who may pursue multiple pathways to learn effectively, participate meaningfully, and work towards attaining the curricular standards. Students with diverse learning needs may need accommodations or adaptations of instructional strategies and materials to enhance their learning and/or adjust for their learning capabilities. (p. 1)

Thus, the expectation has been placed upon secondary teachers of mathematics to prepare all students for Regents-level exams, and no longer just students preparing for college or other advanced education. Tracking children into various levels is no longer considered an acceptable option for teachers and administrators. Requiring all students to pursue a Regents diploma has resulted in a significant change in instruction style and level of content covered in a typical Regents course. In addition, schools have eliminated courses such as business and consumer math.

In 1991, the State Education Department published *A New Compact for Learning: A Partnership to Improve Educational Results in New York State*. This

document outlined the rights and responsibilities of major stakeholders in the process of educational change.

At the state level, the Board of Regents will make appropriate changes in policy and regulation and propose statutory changes for consideration by the legislature. The State Education Department will work with all parties to bring about the needed changes... The full promise of the Compact will take many years to realize. But the work can begin at once—and, indeed, it has begun in many places. (p. 19)

Today's students and teachers are experiencing the results of the work described in the *Compact for Learning*. The new state assessments are a result of the goals outlined in this influential document.

The Problem of Educational Change

More students in the primary grades have been taught mathematics with a constructivist approach than today's high school students. It is likely that elementary students will thrive under differentiated teaching and learning techniques espoused by the NCTM, Board of Regents, and other organizations.

However, there is a core of students now in grades 6 through 9 who received their earliest mathematical training under the old, Platonic approach. They learned mathematics as an abstract series of rules and theorems. Changes in education involve a time of "implementation dip," and my main concern is for the students who will be taking the Math A exam in the next four years.

Teachers of math have told their students that there is one answer and one accepted procedure for solving most math problems. Educational leaders

responsible for legislation and construction of new state assessments expect teachers to adopt a constructivist approach. They must lead students to guided understanding of mathematical procedures and algorithms, and to analyze and interpret real-life situations not immediately connected to a given mathematical procedure. The skills and habits of mind required to be successful on these new assessments are very different than the ones that today's 9th grade math students have brought with them to my classroom.

Tyak and Cuban (1995) warn that

[s]etting high goals is an essential stage in reform, but raising expectations to a level likely to be achieved only by "schools that are light years beyond those of today" can quickly lead to discouragement or disillusionment. (p. 132)

It is vital that both teachers and students have the opportunity to adjust their work toward higher and philosophically different standards than those expected in the past. This paper will serve as part of my adjustment to the new Math A standards. The success of my students depends in large part upon their not experiencing "discouragement or disillusionment."

Additional Comments

Tension has developed between some of the writing activities encouraged by the NCTM and the test items included on the new Math A exam constructed for high school sophomores in New York. For instance, Moses, Bjork, and Goldenberg (1990) suggest that math teachers should encourage students to

explore questions that have more than one possible answer. However, other authors, including Greene and Schulman (1996), find journal writing helpful for understanding the thinking processes of students encountered with a traditional one-solution problem requiring several steps to complete.

The Board of Regents in New York state will implement a series of two required state exams, Math A and Math B, based upon a state core curriculum document, which in turn has been inspired by the NCTM standards documents. Consequently, it is necessary that I adjust and improve my instruction to help my students meet these different and more difficult standards.

Summary of the Uses and Theory of Mathematics Journals

Until recently, writing to express process and feelings was an activity exclusively explored in language arts and English classes. However, constructivist thought emphasizes the importance of both cognitive and affective processes involved in learning new concepts. Thus, journal writing is becoming used more frequently in other academic areas, including mathematics.

Of particular concern in my study is introducing journals to students who are not used to this form of expression in math class. Developmentally, 9th grade students tend to prefer stable, familiar routines, so I will have to be very clear and consistent in my implementation of any journal writing program.

At the vanguard of the movement to teach mathematics from a constructivist perspective were Borasi and Rose (1989), who outlined many of the

potential benefits of using journals. In a general mathematics class for non-major college students, these authors found that journal entries focused upon five major areas of interest: feelings, concepts, process, structure of mathematics, and structure of the course. As a result of analyzing students' writing, the teachers were able to respond more effectively to students' misconceptions and concerns. The students were able to explore and examine personal feelings and ideas about math in ways that they had never been able to do before. A key for the teacher is to emphasize the importance of thinking on paper and not just reporting accurate results.

David L. White and Katie Dunn (in Connolly & Vilardi, 1989), outline novice teachers' use of journals in a professional training program. They make the following recommendations:

1. Writing tasks ought to be standing and consistent, once a day or once a week.
2. Journals should be part of a reading/writing cycle. Instructors should respond to each entry or block of entries.
3. Instructors should emphasize the most relevant content. They ought to avoid responding to irrelevant or tangential content.
4. Respond to entries with a push to generalize: Ask Why is this so? How do you know? What does all this add up to? What does it mean?

White and Dunn go on to explain that “[m]uch of what we were able to accomplish in the journals writing was an outgrowth of the audience teachers perceived for their journals.” (p. 105) It is vital, no matter the age of the students,

that a teacher create an atmosphere of dialogue in students' journals. Teachers should provoke thought in their students' minds, not fear.

DiPillo, Sovchik, and Moss (1997) recommend using journals in middle school math classes for four reasons: exploring new concepts, thinking about what is happening in the classroom, reflecting upon personal thoughts and feelings, and other miscellaneous prompts. Students reported that they were better able to remember information for tests after having written about that information in their journals.

Rose (in Connolly & Vilardi, 1989), summarizes many of the concerns I had as I prepared for this study.

One of the greatest concerns to mathematics teachers about journals are [*sic*] the *procedural* questions. Again, various approaches are possible, depending on context and need. The journals can be collected or not, collected randomly or routinely, collected frequently or infrequently, responded to or not responded to, and graded or not graded. The combinations of factors producing the greatest success for me is to collect the journals randomly, every couple of weeks, reading and responding back in a day and giving credit for keeping up with frequency and volume of writing. For teachers who have many students in multiple classes, the collection of journals can be staggered and only short responses need be given. Students appreciate the fact that teachers respond individually more than to the volume of that response. (p. 26)

In a formal research study of 75 college students, Harchelroad and Rheinheimer (1993) found that for students who scored above a 350 on the math portion of their SAT exam, using a journal significantly improved their performance in a general math review course. However, for students scoring

below 350 on the math portion of their SAT, journals had no significant effect on their course grade. This result suggests that journals tend to aid students with richer background knowledge more than students entering class with very weak skills and understanding.

There has been an increase in the use of math journals in recent years. I am not, however, willing to spend a significant portion of my time using journals in my mathematics classroom if their use does not lead to a measurable benefit for my students.

There are few studies that explore the process of implementing math journals for the first time. Also, as math teachers have gone through the process of changing their practice to include the use of math journals, few have written about their feelings and struggles in a way that I find authentic, honest, and relevant to my practice. These are issues that math teachers must deal with to implement math journals in their classrooms effectively.

Chapter 3—Design

Purpose

- To evaluate the relationship between learning style and level of engagement in math journal writing.

Goals

1. I will explore possible applications of journal-writing as a tool of transition for students trained in a Platonic model of mathematics who are being tested in a style which is more constructivist in format.
2. I will examine my own teaching style and feelings related to this significant change in mathematics education. I was taught under the Platonic model, and must now adapt to a more constructivist model.

Research Questions

1. (Quantitative, student-focused) What correlation is there between learning style and level of engagement while writing in a mathematics journal?
2. (Qualitative, student-focused) In what ways will students' understanding of Math A Regents concepts improve through the process of writing in a mathematics journal?
3. (Qualitative, teacher-focused) How will I respond to the transition from a Platonic to a constructivist model of mathematics education?

Methodology

Subjects. Ninety-five students in a junior high school in a suburban upstate New York school district began in this study. Twenty-seven of these students were involved in a program which takes two years to complete and extends the amount of class time they will receive to prepare for the Math A exam.

About 35% of the students scored a 1 or 2 on the four-point Grade 8 Math exam. This means that they had not yet achieved a level of mathematical proficiency considered acceptable to receive a Regents diploma. Three of the students were deaf and receive interpretation services in class. None of the students is in an accelerated program; every student is in a course consistent with his or her grade level.

Some students transferred out of my classes, and others did not complete a learning style inventory, so only 82 students are included in the final analysis. Take note, in Appendix D, that five students scored equally on two learning styles. Therefore, 87 sets of data appear in the analysis.

Materials/Instruments. Each student completed the Excel Learning-Style Inventory. The entire inventory is reprinted in Appendix B.

Each student used a spiral bound, single subject notebook for responding to journal prompts.

I kept a personal journal in which I recorded my thoughts and feelings related to using journals in my classes.

Procedures. Every student completed a learning style inventory at the beginning of the study.

Students wrote entries in their journal once per week. A variety of prompts were used. The formal study period extended from February through April. Most entries were expected to be at least 100 words in length. Weekly prompts are listed in Appendix C. Because I lost two days of instruction during week 5 of this study, I did not require a regular journal entry. Completed prompts for weeks 1-6 were worth 10 points each. The final, 200-word essay was worth 40 points. A perfect journal score was 100 points. This made the combined mark for the journal equivalent to the value of a traditional end-of-unit exam. The grade sheet and journal prompts, as well as introductory materials, are printed in Appendix C.

I read and responded to each journal entry. In a private grade book, I scored each entry Engaged or Not Engaged. An Engaged entry demonstrated relevant and original thoughts related to that week's prompt. A Not Engaged entry met the minimum requirements to receive credit but did not, in my opinion, demonstrate relevant and original thoughts related to that week's prompt. All late entries were scored Not Engaged.

After week 6, I sent home progress reports to all students. Their scores were based upon traditional coursework and journals. Journals accounted for about 25% of students' third quarter progress report marks. At this time, I recorded the number of missing journal entries. This is the number I used to analyze completion rate of journal entries. Low progress report scores provided students external motivation to make up missing entries, so completion rates after week 6 were skewed upward. I did not include the final journal entry in the statistical analysis of students' completion and engagement rates.

I wrote in my own journal throughout the entire study period, recording my thoughts, feelings, and reactions to the study.

Analysis of Data

I used the learning style inventory to categorize students into preferred learning style. If students scored equally on two learning styles, I included their results twice, separately under each learning style. My goal was to develop a profile that describes a typical student who likes using a math journal, as well as a typical student who dislikes using a math journal. In addition, I hypothesized that learning style may be positively correlated to engagement rates; if this is so, the learning style inventory could be used to identify which students will most benefit from using a journal.

I analyzed my own journal entries to see what stages of growth I experienced going through the process of changing my teaching style. My goal

was to create a summary flowchart of my thoughts, feelings, and struggles.

Perhaps teaching colleagues who face the same set of instructional changes that I am experiencing will find this self-analysis helpful as they encounter educational change.

Chapter 4—Results of the Study

Research Question #1: What is the correlation between learning style and level of engagement while writing in a mathematics journal?

After I read each journal entry, I scored it on a single scale: engaged or not engaged. In addition, I recorded all incomplete entries. Then I tallied these results by each student's learning style. Those students identified with two preferred learning styles I included in the analysis two times, once under each learning style.

These results are outlined in the following graph:

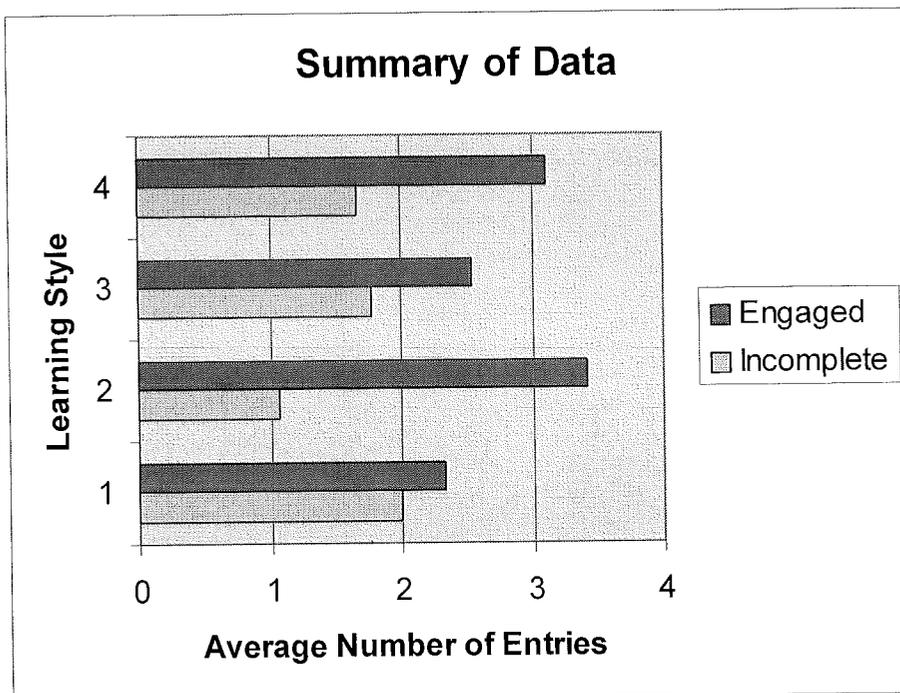


Figure 1.

The learning style inventory is reproduced in Appendix B. The following table, Figure 2, summarizes the four learning styles measured by this instrument:

SUMMARY OF LEARNING STYLES	<i>PERCEIVE CONCRETELY</i>	<i>PERCEIVE ABSTRACTLY</i>
<i>PROCESS REFLECTIVELY</i>	TYPE ONE	TYPE TWO
<i>PROCESS ACTIVELY</i>	TYPE FOUR	TYPE THREE

Figure 2.

It is important to note that learning style two describes those students best suited to traditional teaching and learning. This is the group of students with the highest rates of completion and engagement in this study. Although the results outlined in Figure 1 are not statistically significant, it appears that the category of students best served by mathematics journals are the same students who are most comfortable with traditional instructional techniques.

Further analysis indicates that when comparing learning style to number of incomplete journal entries, the distribution is not normal, using an alpha level of 0.10. According to the D'Agostini Test, $n = 87$, $T = 2001$, $D = 0.2707$, $P = 0.011$. Thus a Kruskal-Wallis Test, with H_C adjusted by a factor of 1.096, is appropriate for comparing the mean number of incomplete entries to learning style. In summary: $n_2 = 27$, $R_2/n_2 = 37.9$, $n_3 = 22$, $R_3/n_3 = 48.3$, $n_4 = 20$, $R_4/n_4 = 41.6$, $n_1 = 18$, $R_1/n_1 = 50.6$, $N = 87$, $H_C = 3.98$, $p = 0.26$. The results of this test are not significant, using an alpha level of 0.05.

A similar procedure is appropriate for comparing the mean number of engaged entries to learning style. According to the D'Agostini Test, $n = 87$, $T = 2112$, $D = 0.2857$, $P = 0.094$. Using an alpha level of 0.10, these data are not normally distributed. Thus, a Kruskal-Wallis Test is appropriate. With H_C adjusted by a factor of 1.035, $n_2 = 27$, $R_2/n_2 = 52.6$, $n_3 = 22$, $R_3/n_3 = 39.2$, $n_4 = 20$, $R_4/n_4 = 44.1$, $n_1 = 18$, $R_1/n_1 = 36.8$, $N = 87$, $H_C = 5.52$, $p = 0.14$. Using an alpha level of 0.05, there is no statistically significant relationship between learning style and mean number of engaged entries.

Research Question #2: In what ways will students' understanding of Math A Regents concepts improve through the process of writing in a mathematics journal?

Jennifer, a type three learner, posed the following question in her journal: "If I owned a [business] what calculations and what would it [e]ntail to keep the [business] going? Would I really need math?"

She replied to her own question:

I think math would be a large part in owning and keeping up a bussiness. Some examples would be keeping books (on money). In and out coming money, paying employees, keeping stock and having time.

First of all in owning a business you would need to keep books (or records) of the money that is being spent. That way you can budget your money wisely. You would need math like addition to add up all the money that is being used up...

It was unusual for students to identify a personal connection between advanced Math A concepts and their own experiences. Beyond addition,

subtraction, multiplication, and division, Jennifer and her classmates had difficulties applying math to daily life. Perhaps it is not reasonable to expect high school freshmen to achieve this level of personal application.

Jared, a type four learner, exemplified the feelings of students who disliked using a math journal in the following response:

I found this journal to be of quite great annoyance. Although this is the only [journal entry] that I have done it is still taking my time from making video games. I need that time to practice my future career....This would be a great idea for an English class but not for math, sorry, I don't think so.

In general, a typical student who did not benefit from a math journal was identified by the Excel Learning-Style inventory as a category one or four learner. He or she indicated that it did not seem right to have to do so much writing in a math class. English was the proper place for this type of reflection.

I was expecting this reaction from some of my students. It is important to note that my attitude toward the implementation of journals might have influenced these negative reactions.

Not all students agreed with Jared, however. A great number of them reported enjoying the experience. Allison, a type two learner and one of the deaf students, writes:

I liked using this math journal because it is a lot of fun to write (more than doing math homework! Just kidding.) It was good because I don't get many chances to write in my own journal.... It makes you stop and think about other things which is very important to do because we often don't

have time to, or we forget and need to be reminded. I would definitely rate this experience a 4.75 out of 1 [to] 5. Thank you.

In general, students who completed the most journal entries and were most often engaged were identified learning types two and four. Some students who had trouble on the traditional work I assigned enjoyed the math journal as a break from the routine and an opportunity to raise their grades.

A majority of students of all learning styles did not find my journal prompts relevant to their math learning, however. In retrospect, I believe that my questions should have been more specifically related to the course content. Had I selected problems directly from previous Math A exams, such as the extended response items listed in Appendix A, students might have found the experience more meaningful. The prompts that I constructed were too philosophical for my stated goal to help students learn Math A concepts more deeply.

Despite the lack of congruence to my stated objective, this project was successful in other ways. I developed an ongoing dialog with many of my students. We were able to share ideas with one another in a way that is usually not possible in a math classroom. The one-on-one interaction I experienced with my students is something that I will remember well.

Research Question #3: How will I respond to the transition from a Platonic to a constructivist model of mathematics education?

Before this study, I was not interested in adjusting my teaching style. I was content with a traditional classroom. It would have been easier to stick with the status quo. However, I recognized that there might be value in trying a different approach to my instruction, so I agreed to research applications of math journals to my own classroom.

There were numerous articles advising teachers with younger children and with adult students. For several months, however, I was unable to find anything in the literature related to the use of journals with high school students. I felt as though the research did not relate to my situation.

After much searching, however, I found an article describing a ninth grade teacher who used math journals. It seemed as though I was reading about my own class. I began the process of implementing math journals in my own class.

I found that it was a struggle to balance my own ideas about math journals with what the research suggested. This tension became easier to handle when I realized that I was creating a false dichotomy. It was not necessary to pick one approach or the other. Rather, I could integrate both perspectives simultaneously.

Researchers suggested a minimum of 100 words per entry and a personal response to each entry (Borasi & Rose, 1989). These ideas were very effective when I began assigning journal entries.

I chose to write in my own journal and pursue conversations with my colleagues. My journal was a valuable resource. I used it as a place to record

feelings of success and of failure. However, because I was the first math teacher in my district to implement a math journal program in my classroom, I could not find colleagues with whom to discuss my ideas and progress.

The following chart outlines the results of my self-analysis:

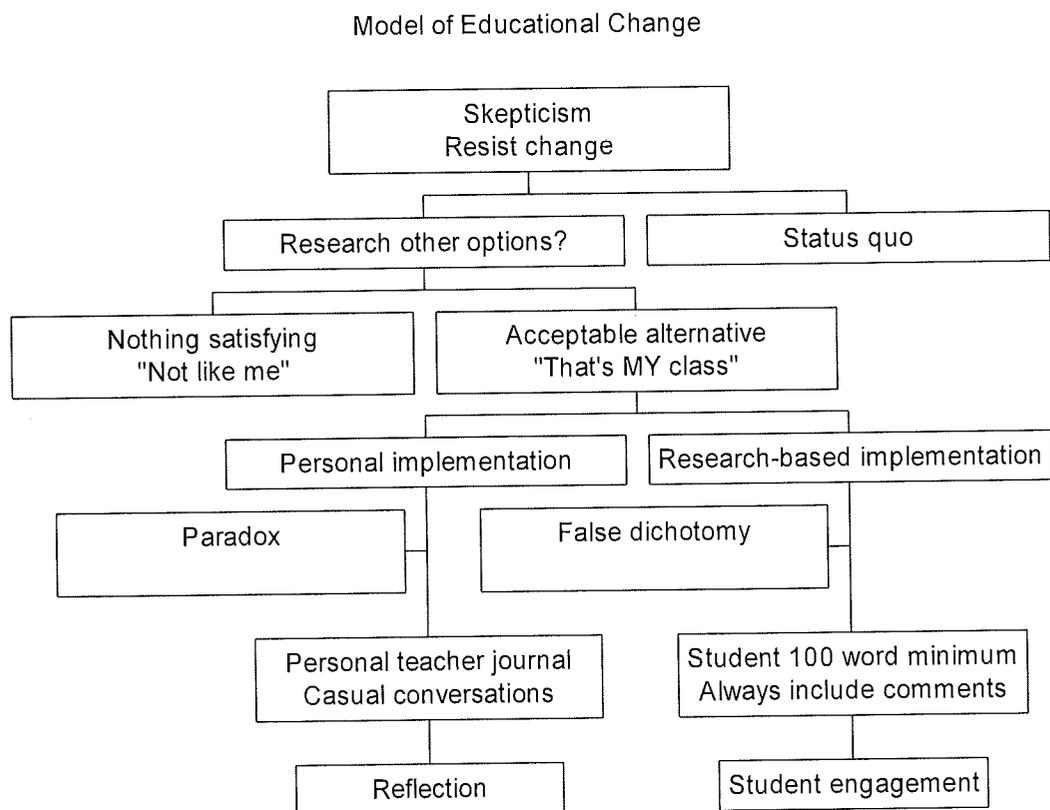


Figure 3.

It is common for people to feel a sense of resistance when changing routines that seem to be working already. This is especially true of teachers who are held accountable to their students' final exam results at the end of the school year.

My initial response was to avoid the use of math journals. It took me months of research before I located the information I found necessary to feel comfortable implementing journals in my own classroom. When I felt a personal connection to a published researcher, my attitude toward the use of journals improved significantly. I was able to deal with my concerns more effectively. Thus I was ready to develop an implementation plan based upon a healthy balance among theory, research, and personal experience.

It is important to note that my personal resistance to the concept of math journals may have affected my students' performance. Perhaps another teacher would have better success implementing journals with their classes. There may also be a learning style inventory better suited to serve as a math journal pretest than the one I selected.

Chapter 5—Conclusion and Implications

Conclusion

The learning style inventory used in this study was meant to be a guide for teachers and students, but was not intended to be a predictor of classroom performance. A lack of statistically significant results indicates that the Excel Learning-Style Inventory is not appropriate as an intake assessment for the purpose of identifying students most likely to engage in journal writing.

Implications for the Classroom

The most difficult part of constructing this study was creating appropriate journal prompts. I recommend that a teacher using journals for the first time adapt commercial journal prompts, rather than creating entries from scratch.

Because I was the first math teacher in my district to implement a math journal requirement in my course, I felt alone at times. It is wise, when embarking on a new type of instruction, to team up with at least one other colleague interested in beginning a similar program.

When exploring new teaching techniques, it is important to understand the concepts and ideas behind the instruction. However, it is unlikely that a teacher will implement new ideas in his or her classroom until he or she feels a personal connection. A teacher should seek these connections in conversations with colleagues and in researching the literature. My own personal connection was

with a published author, not with any coworkers. Both systems of support would have been better.

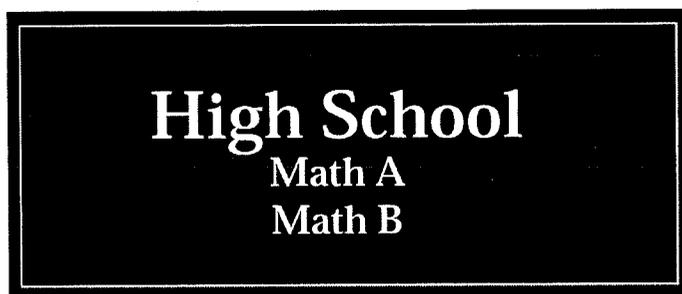
Implications for Further Research

This study illustrated the inability of one inventory to serve as a pretest for the use of math journals. Other researchers could explore the use of alternative learning style assessments as intake exams for implementing a journal program.

However, I think that the best measure of engagement is a direct one. If a teacher records each student's level of engagement for a few weeks, he or she could use this data to decide who is best suited to continue using the math journals. This direct measure would eliminate the potential of overlooking students who might benefit from a mathematics journal program because of a faulty intake inventory.

I believe that further study may indicate that learning style two students, those children best suited to traditional mathematics instruction, are the same students most likely to be engaged in journal writing. This poses a troubling question. If the students best served by traditional instruction are the same students best served by math journals, is it worthwhile to use journals? A study comparing student achievement in classes with journals to student achievement in classes without journals would be appropriate. If journals do not improve students' academic performance, then their use must be questioned.

Appendix A: Math A Core Curriculum and Sample Test Items



Manipulatives

Algebra tiles
Dice
Geometric models
 tessellation tiles

Mirrors or mirrors
Spinners
Geoboards
Conic section models

Volume demonstration kits
Measuring tools
Compasses
PentaBlocks

Calculator

Calculators will be *required* for use on Math A and B assessments. Scientific calculators are required for the Math A assessments examinations. Graphing calculators that do not allow for symbolic manipulation will be required for the Math B assessment examination and will be permitted (*not required*) for the Math A Regents examination starting in June 2000.

The Math A exam may include any given topic listed in the Core Curriculum with any performance indicator. The exam includes most of the topics in the present Course I and a selection of topics from Course II. Programs other than Course I and II could be used as long as all the performance indicators and topics in the curriculum are part of the program. Examples of assessment items for Math A have been provided for most performance indicators. The items were selected from the 1997 pilot test and 1998 Test Sampler. Suggestions for classroom activities are substituted for any performance indicator that was not included in the sample test.

The Math B exam may include any given topic listed in the Core Curriculum with any performance indicator. Programs other than Course II and III could be used as long as the performance indicators and topics mentioned are part of the program. Since there is no Math B exam at this time, no assessment items have been included for Math B. Suggestions for possible classroom activities or problems are given instead to provide clarification of most performance indicators.

Key Idea 1 Mathematical Reasoning

Students use mathematical reasoning to analyze mathematical situations, make conjectures, gather evidence, and construct an argument.

PERFORMANCE INDICATORS	INCLUDES	EXAMPLES
<p>Construct valid arguments.</p>	<ul style="list-style-type: none"> • Truth value of compound sentences (conjunction, disjunction, conditional, related conditionals such as converse, inverse, and contrapositive, and biconditional). • Truth value of simple sentences (closed sentences, open sentences with replacement set and solution set, negations). 	<p>See Assessment Example 1A.</p>
<p>Follow and judge the validity of arguments.</p>	<ul style="list-style-type: none"> • Truth value of compound sentences. 	<p>See Assessment Example 1B.</p>

Key Idea 2 Number and Numeration

M

ath A

Students use number sense and numeration to develop an understanding of the multiple uses of numbers in the real world, the use of numbers to communicate mathematically, and the use of numbers in the development of mathematical ideas.

PERFORMANCE INDICATORS	INCLUDES	EXAMPLES
Understand and use rational and irrational numbers.	<ul style="list-style-type: none"> Real numbers including irrational numbers such as non-repeating decimals, irrational roots, and pi. 	See Assessment Example 2A.
Recognize the order of real numbers.	<ul style="list-style-type: none"> Rational approximations of irrational numbers. 	See Assessment Example 2B.
Apply the properties of real numbers to various subsets of numbers.	<ul style="list-style-type: none"> Properties of real numbers including closure, commutative, associative, and distributive properties, and inverse and identity elements. 	See Classroom Idea 2C.

Students use mathematical operations and relationships among them to understand mathematics.

PERFORMANCE INDICATORS	INCLUDES	EXAMPLES
<p>Use addition, subtraction, multiplication, division, and exponentiation with real numbers and algebraic expressions.</p>	<ul style="list-style-type: none"> • Signed numbers. • Use of variables: order of operations and evaluating algebraic expressions and formulas. • Addition and subtraction of polynomials: combining like terms and fractions with like denominators. • Multiplication of polynomials: powers, products of monomials and binomials, equivalent fractions with unlike denominators, and multiplication of fractions. • Simplification of algebraic expressions. • Division of polynomials by monomials. • Operations with radicals: simplification, multiplication and division, and addition and subtraction. • Scientific notation. • Simplification of fractions. • Division of fractions. • Prime factorization. • Factoring: common monomials, binomial factors of trinomials. • Difference of two squares. 	<p>See Assessment Example 3A.</p>
<p>Use integral exponents on integers and algebraic expressions.</p>	<ul style="list-style-type: none"> • Powers: positive, zero, and negative exponents. 	<p>See Assessment Example 3B.</p>
<p>Recognize and identify symmetry and transformations on figures.</p>	<ul style="list-style-type: none"> • Intuitive notions of line reflection, translation, rotation, and dilation. • Line and point symmetry. 	<p>See Assessment Example 3C.</p>
<p>Use field properties to justify mathematical procedures.</p>	<ul style="list-style-type: none"> • Distributive and associative field properties as related to the solution of quadratic equations. • Distributive field property as related to factoring. 	<p>See Classroom Idea 3D.</p>

Key Idea 4

Modeling/Multiple Representation

Students use mathematical modeling/multiple representation to provide a means of representing, interpreting, communicating, and connecting mathematical information and relationships.

PERFORMANCE INDICATORS	INCLUDES	EXAMPLES
<p>represent problem situations symbolically using algebraic expressions, sentences, tree diagrams, geometric figures, and graphs.</p>	<ul style="list-style-type: none"> • Use of variables/Algebraic representations. • Inequalities. • Formulas and literal equations. • Undefined terms: <i>point</i>, <i>line</i>, and <i>plane</i>. • Parallel and intersecting lines and perpendicular lines. • Angles: degree measure, right, acute, obtuse, straight, supplementary, complementary, vertical, alternate interior and exteriors, and corresponding. • Simple closed curves: polygons and circles. • Sum of interior and exterior angles of a polygon. • Study of triangles: classifications of scalene, isosceles, equilateral, acute, obtuse, and right; triangular inequality; sum of the measures of angles of a triangle; exterior angle of a triangle, base angles of an isosceles triangle. • Study of quadrilaterals: classification and properties of parallelograms, rectangles, rhombi, squares, and trapezoids. • Study of solids: classification of prism, rectangular solid, pyramid, right circular cylinder, cone, and sphere. • Sample spaces: list of ordered pairs of n-tuples, tree diagrams. 	<p>See Assessment Example 4A.</p>
<p>justify the procedures for basic geometric constructions.</p>	<ul style="list-style-type: none"> • Basic constructions: copy line and angle, bisect line segment and angle, perpendicular lines and parallel lines. • Comparison of triangles: congruence and similarity. 	<p>See Classroom Idea 4B.</p>
<p>describe transformations in the coordinate plane.</p>	<ul style="list-style-type: none"> • Reflection in a line and in a point. • Translations. • Dilations. 	<p>See Assessment Example 4C.</p>

Continued

PERFORMANCE INDICATORS	INCLUDES	EXAMPLES
<p>Develop and apply the concept of basic loci to compound loci.</p>	<ul style="list-style-type: none"> • Locus. • At a fixed distance from a point. • At a fixed distance from a line. • Equidistant from two points. • Equidistant from two parallel lines. • Equidistant from two intersecting lines. • Compound locus. 	<p>See Assessment Example 4D.</p>
<p>Model real-world problems with systems of equations and inequalities.</p>	<ul style="list-style-type: none"> • Systems of linear equations and inequalities. 	<p>See Assessment Example 4E.</p>

Key Idea 5 Measurement

M^{ath} A

Students use measurement in both metric and English measure to provide a major link between the abstractions of mathematics and the real world in order to describe and compare objects and data.

PERFORMANCE INDICATORS	INCLUDES	EXAMPLES
Apply formulas to find measures such as length, area, volume, weight, time, and angle in real-world contexts.	<ul style="list-style-type: none"> Perimeter of polygons and circumference of circles. Area of polygons and circles. Volume of solids. Pythagorean theorem. 	See Assessment Example 5A.
Choose and apply appropriate units and tools in measurement situations.	<ul style="list-style-type: none"> Converting to equivalent measurements within metric and English measurement systems. Direct and indirect measure. 	See Classroom Idea 5B.
Use dimensional analysis techniques.	<ul style="list-style-type: none"> Dimensional analysis. 	See Assessment Example 5C.
Use statistical methods including the measures of central tendency to describe and compare data.	<ul style="list-style-type: none"> Collecting and organizing data: sampling, tally, chart, frequency table, circle graphs, broken line graphs, frequency histogram, box and whisker plots, scatter plots, stem and leaf plots, and cumulative frequency histogram. Measures of central tendency: mean, median, mode. Quartiles and percentiles. 	See Assessment Example 5D.
Use trigonometry as a method to measure directly.	<ul style="list-style-type: none"> Right triangle trigonometry. 	See Assessment Example 5E.
Apply proportions to scale drawings and direct variation.	<ul style="list-style-type: none"> Ratio. Proportion. Scale drawings. Percent. Similar figures. Similar polygons: ratio of perimeters and areas. Direct variation. 	See Assessment Example 5F.
Calculate absolute value, distance between two points, and the slope of a line to the coordinate plane.	<ul style="list-style-type: none"> Absolute value and length of a line segment. Midpoint of a segment. Equation of a line: point-slope and slope intercept form. Comparison of parallel and perpendicular lines. 	See Assessment Example 5G.

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PERFORMANCE INDICATORS	INCLUDES	EXAMPLES
<p>Explain the role of error in measurement and its consequence on subsequent calculations.</p>	<ul style="list-style-type: none"> • Error of measurement and its consequences on calculation of perimeter of polygons and circumference of circles. • Area of polygons and circles. • Volume of solids. • Percent of error in measurements. 	<p>See Classroom Idea 5H.</p>
<p>Use geometric relationships in relevant measurement problems involving geometric concepts.</p>	<ul style="list-style-type: none"> • Similar polygons: ratio of perimeters and areas. • Similar figures. • Comparison of volumes of similar solids. 	<p>See Assessment Example 5I.</p>

Key Idea 6 Uncertainty

M^{ath} A

Students use ideas of uncertainty to illustrate that mathematics involves more than factness when dealing with everyday situations.

PERFORMANCE INDICATORS	INCLUDES	EXAMPLES
<p>Judge the reasonableness of results obtained from applications in algebra, geometry, trigonometry, probability, and statistics.</p>	<ul style="list-style-type: none"> Theoretical versus empirical probability. 	<p>See Classroom Idea 6A.</p>
<p>Use experimental and theoretical probability to represent and solve problems involving uncertainty.</p>	<ul style="list-style-type: none"> Single and compound events. Problems involving <i>and</i> and <i>or</i>. Probability of the complement of an event. 	<p>See Assessment Example 6B.</p>
<p>Use the concept of random variable in computing probabilities.</p>	<ul style="list-style-type: none"> Mutually exclusive and independent events. Counting principle. Sample space. Probability distribution. Probability of the complement of an event. 	<p>See Assessment Example 6C.</p>
<p>Determine probabilities, using permutations and combinations.</p>	<ul style="list-style-type: none"> Factorial notation. Permutations: nPr and nPr. Combinations: nCr and nCr. 	<p>See Assessment Example 6D.</p>

Students use patterns and functions to develop mathematical power, appreciate the true beauty of mathematics, and construct generalizations that describe patterns simply and efficiently.

PERFORMANCE INDICATORS	INCLUDES	EXAMPLES
<p>represent and analyze functions, using verbal descriptions, tables, equations, and graphs.</p>	<ul style="list-style-type: none"> • Techniques for solving equations and inequalities. • Techniques for solving factorable quadratic equations. • Graphs of linear relations: slope and intercept. • Graphs of conics: circle and parabola. • Graphic solution of systems of linear equations, inequalities, and quadratic-linear pair. • Algebraic solution of systems of linear equations, inequalities, and quadratic-linear pair by substitution method and addition-subtraction method. 	<p>See Assessment Example 7A.</p>
<p>Apply linear and quadratic functions in solution of problems.</p>	<ul style="list-style-type: none"> • Graphic and algebraic solutions of linear and quadratic functions in the solution of problems. 	<p>See Assessment Example 7B.</p>
<p>Translate among the verbal descriptions, tables, equations, and graphic forms of functions.</p>	<ul style="list-style-type: none"> • Translate linear and quadratic functions, systems of equations, inequalities and quadratic linear pairs between representations that are verbal descriptions, tables, equations, or graphs. 	<p>See Assessment Example 7C.</p>
<p>Model real-world situations with the appropriate function.</p>	<ul style="list-style-type: none"> • Determine and model real-life situations with appropriate functions. 	<p>See Assessment Example 7D.</p>
<p>Apply axiomatic structure to algebra.</p>	<ul style="list-style-type: none"> • Solve linear equations with integral, fraction, or decimal coefficients. • Solve linear inequalities. • Solve factorable quadratic equations. • Solve systems of linear equations, inequalities, and quadratic-linear pair. 	<p>See Assessment Example 7E.</p>

ASSESSMENT EXAMPLES

Math A

EXAMPLES FOR

Math A



chool of 320 students, 85 students are in the band, 200 students are on sports teams, and 60 students participate in activities. How many students are involved in either band or sports?

how how you arrived at your answer.



ary and Tom are classmates, then they go to the same school."
h statement below is logically equivalent?

- f Mary and Tom do not go to the same school, then they are not classmates.
- f Mary and Tom are not classmates, then they do not go to the same school.
- f Mary and Tom go to the same school, then they are classmates.
- f Mary and Tom go to the same school, then they are not classmates.



thing store offers a 50% discount at the end of each week that an item remains unsold. Patrick wants to buy a shirt e store and he says, "I've got a great idea! I'll wait two weeks, have 100% off, and get it for free!" Explain to your d Patrick why he is incorrect, and find the correct percent of discount on the original price of a shirt.



or what value t is $\frac{1}{\sqrt{t}} < \sqrt{t} < t$ true?

EXAMPLES FOR

Math A



ash bought d dollars worth of stock. During the first year, the value of the stock tripled. The next year, the value of stock decreased by \$1,200.

Part A

an expression in terms of d to represent the value of the stock after two years.

Part B

initial investment is \$1,000, determine its value at the end of 2 years.



154 is expressed in the form 1.54×10^n , n is equal to

- C. 3
- D. -3



gon $RSTUV$ has coordinates $R(1,4)$, $S(5,0)$, $T(3,-4)$, $U(-1,-4)$, and $V(-3,0)$.

On graph paper, plot pentagon $RSTUV$.

Draw the line of symmetry of pentagon $RSTUV$.

Write the coordinates of a point on the line of symmetry.

ASSESSMENT EXAMPLES

EXAMPLES FOR

Math A

Math A



A 10-foot ladder is placed against the side of a building as shown in Figure 1 below. The bottom of the ladder is 8 feet from the base of the building. In order to increase the reach of the ladder against the building, it is moved 4 feet closer to the base of the building as shown in Figure 2.

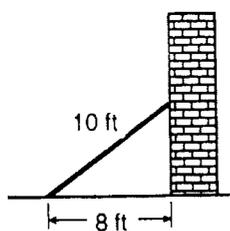


Figure 1

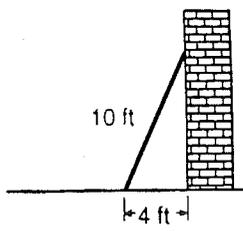


Figure 2

How many feet farther up the building does the ladder now reach? Show how you arrived at your answer.



A quadrilateral was constructed by using two rectangles $ABDC$ and $A'B'D'C'$. Rectangle $A'B'D'C'$ is the result of a translation of rectangle $ABDC$. The table of translations is shown below.

Find the coordinates of points B and D .

Rectangle $ABDC$	Rectangle $A'B'D'C'$
$A (2,4)$	$A' (3,1)$
B	$B' (-5,1)$
$C (2,-1)$	$C' (3,-4)$
$D (-6,-1)$	D'



The distance between points P and Q is 8 units. How many points are equidistant from P and Q and also 3 units from P ?

- C. 0
D. 4



Carlos purchased 12 pens and 14 notebooks for \$20. Carlos bought 7 pens and 4 notebooks for \$7.50. Find the price of one pen and the price of one notebook, algebraically.

EXAMPLES FOR

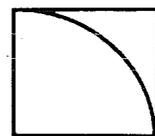
Math A



own plans to carpet part of her living room floor. The living room floor is a square 20 feet by 20 feet. She wants to a quarter-circle as shown below.

o the *nearest square foot*, what part of the floor will remain uncarpeted.

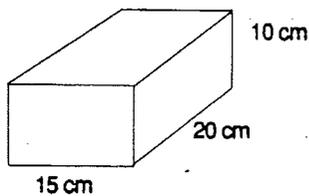
ow **how you arrived at your answer**.



20'



ight a generator that will run for 2 hours on a liter of gas. The gas tank on the generator is a rectangular prism dimensions 20 centimeters by 15 centimeters by 10 centimeters as shown below.



If Jed fills the tank with gas, how long will the generator run?
Show how you arrived at your answer.



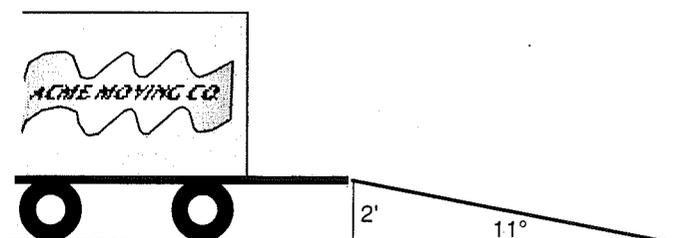
first 5 biology tests, Bob received the following scores: 72, 86, 92, 63, and 77. What test score must Bob earn on h test so that his average (mean) for all six tests will be 80% ?

Show how you arrived at your answer.



lgate of a truck is 2 feet above the ground. The of a ramp used for loading the truck is 11° , as

o the *nearest tenth of a foot*, the length of the ramp.



ASSESSMENT EXAMPLES

EXAMPLES FOR

Math A

Math A

has two square garden plots. The ratio of the lengths of the sides of the two squares is 2:3. What is the ratio of their

- 3
2
9
4



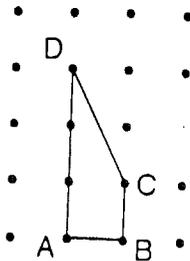
is the distance between points A (7,3) and B (5,-1)?

(1) $\sqrt{10}$
(2) $\sqrt{12}$

(3) $\sqrt{14}$
(4) $\sqrt{20}$



figure shown below, each dot is one unit from an adjacent horizontal or vertical dot.



he number of square units in the area of quadrilateral ABCD.
ow how you arrived at your answer.

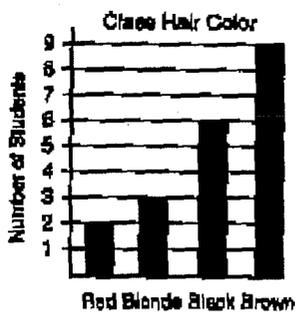
**EXAMPLES FOR
Math A**



playing a game in which he rolls two regular six-sided dice.
What is the probability that he will roll two doubles in a row?



A graph below shows the hair colors of all the students in a class.



What is the probability that a student chosen at random from this class has black hair?



Erica cannot remember the correct order of the four digits in her ID number. She does remember that the ID number contains the digits 1, 2, 5, and 9. What is the probability that the first three digits of Erica's ID number will all be odd numbers?

- 1
- 3
- 2
- 1

ASSESSMENT EXAMPLES

Math A

EXAMPLES FOR
Math A

of the following tables represents a linear relationship between the two variables x and y ?

1)

x	1	2	3	4
y	2	4	8	16

(2)

x	1	2	3	4
y	4	2	2	4

(3)

x	2	4	6	8
y	2	3	4	5

(4)

x	1	3	5	7
y	1	9	25	49



an equation to represent the price (P) of mailing a letter that weighs a certain number of ounces (x) if the cost is \$0.23 for the first ounce and \$0.23 for each additional ounce. Show how that equation would be used to determine the cost of mailing a 4-ounce letter.



Two video rental clubs offer two different rental fee plans:

Club A charges \$12 for membership and \$2 for each rented video.

Club B has a \$3 membership fee and charges \$3 for each rented video.

The graph drawn below represents the total cost of renting videos from Club A.

Part A

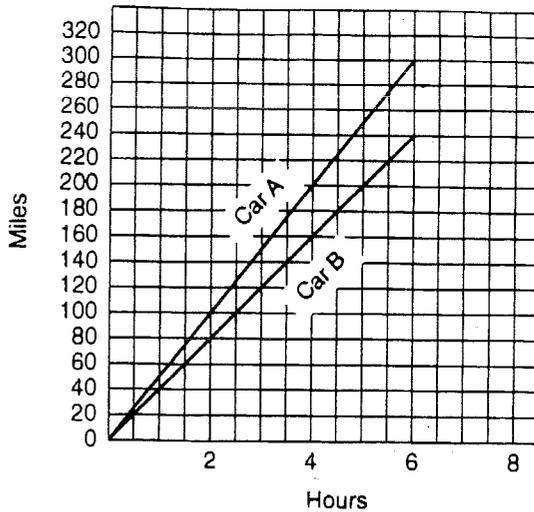
On the same set of xy -axes, draw a line to represent the total cost of renting videos from Club B.

Part B

At what number of video rentals is it less expensive to belong to club A? Explain how you arrived at your answer.

EXAMPLES FOR
Math A

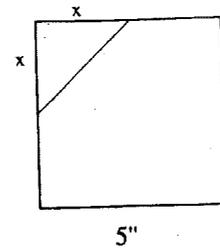
The graph below represents the distances traveled by car A and car B in 6 hours.



Which car is going faster and by how much? Explain how you arrived at your answer.

A student is cut off a 5-inch by 5-inch square piece of paper. The cut is x inches from the top-left corner as shown below.

Part A
Write an equation, in terms of x , that represents the area, A , of the paper after the corner is removed.



Part B
What value of x will result in an area that is $7/8$ of the area of the original square piece of paper? Show how you arrived at your answer.

CLASSROOM IDEAS

EXAMPLES FOR

Math A

Math A

Following ideas for lessons and activities are provided to illustrate examples of each performance indicator. It is not intended that you use these specific ideas in their classrooms; rather, they should feel free to use them or adapt them if they so desire. Some of these ideas incorporate topics in science and technology. In those instances the appropriate standard will be identified. Some classroom ideas exemplify more than one performance indicator. Additional relevant performance indicators are given in brackets at the end of the description of the classroom idea.



- Have students make multiplication and addition charts for a 12-hour clock, using only the numbers 1-12.
- Have students determine if the system is closed under addition and multiplication. If not, they should give a counterexample.
- Have students determine if multiplication and addition are commutative under the system, and if not, give a counterexample.
- Have students determine if there is an identity element for addition and multiplication, and if so, what are they?
- Have students determine if addition and multiplication are associative under the system, and if not, give a counterexample.
- Do each element have an additive and multiplicative inverse?
- Determine if multiplication is distributive over addition (if not give a counterexample) and if addition is distributive over multiplication (if not, give a counterexample). [Also 3D.]



Apply the field properties used in solving the equation $2(x - 5) + 3 = x + 7$.



Explain why the basic construction of bisecting a line segment is valid.

EXAMPLES FOR

Math A



Watching a TV detective show, you see a crook running out of a bank carrying an attaché case. You deduce from conversation of the two stars in the show that the robber has stolen \$1 million in small bills. Could this happen? Why not?

1. An average attaché case is a rectangular prism (18" x 5" x 13").
2. You might want to decide the smallest denomination of bill that will work.

[Also 5A.]



An odometer is a device that measures how far a bicycle (or a car) travels. Sometimes an odometer is not adjusted accurately and gives readings which are consistently too high or too low.

Paul did an experiment to check his bicycle odometer. He cycled 10 laps around a race track. One lap of the track is 1.25 kilometers long. When he started, his odometer read 1945.68 and after the 10 laps his odometer read 1949.88. Determine how far Paul really traveled with what his odometer read.

Make a table that shows numbers of laps in multiples of 10 up to 60 laps, the distance Paul really travels, and the distance the odometer would say he traveled.

Graph to show how the distance shown by the odometer is related to the real distance traveled.

Write a rule or formula that Paul can use to change his incorrect odometer readings into accurate distances he has gone since the start of his ride.

An odometer measures how far a bicycle travels by counting the number of times the wheel turns around. It then multiplies this number by the circumference of the wheel. To do this right, the odometer has to be set for the right wheel circumference. If it is set for the wrong circumference, its readings are consistently too high or too low. Before Paul's experiment he estimated that his wheel circumference was 210 cm. Then he set his odometer for this circumference. Use the results of his experiment to find a more accurate estimate for the circumference.



A bag contains 20 slips of paper. Five of the slips are marked with a "X," seven are marked with a "Y," and the rest are blank. The slips are well mixed. Determine the probability that a blank slip will be drawn without looking in the bag on one draw. Have students determine the probability theoretically and then have each conduct the experiment with the bag and see how close the empirical probability was to the theoretical probability. Combine data from all students to see if a larger number of trials will result in an empirical probability that more closely resembles the theoretical probability. [Also 6B.]

Appendix B: Student Survey of Learning Style

TYPE ONE LEARNERS

Perceive information concretely and process it reflectively. They integrate experience with the self. They learn by listening and sharing ideas. Are imaginative thinkers who believe in their own experience. They excel in viewing direct experience from many perspectives. They value insight thinking. They work for harmony. They need to be personally involved, seek commitment. Are interested in people and culture. They are thoughtful people who enjoy observing other people. They absorb reality; they seem to take in the atmosphere almost like osmosis.

They seek meaning and clarity.

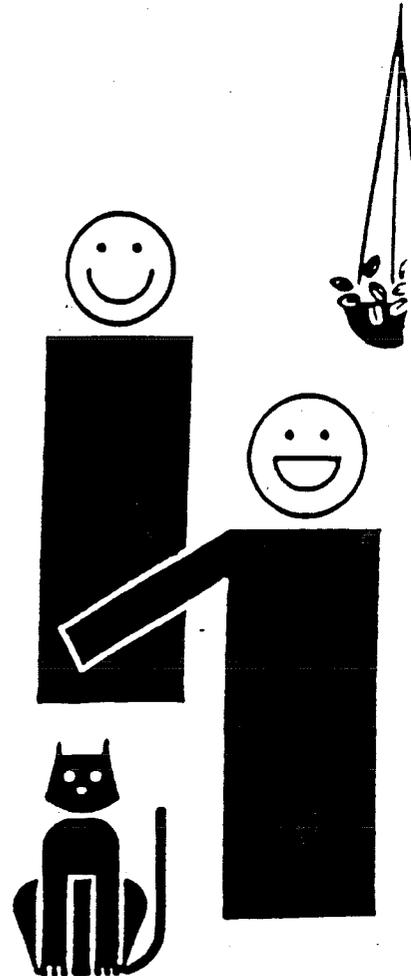
As leaders they:

- thrive on taking the time to develop good ideas,
- tackle problems by reflecting alone and then brainstorming with staff,
- lead by their heart, involving other people in decision making
- exercise authority with trust and participation,
- work for organizational solidarity
- need staff who are supportive and share their sense of mission.

As teachers they:

- are interested in facilitating individual growth,
- try to help people become more self aware,
- believe curricula should enhance one's ability to be authentic,
- see knowledge as enhancing personal insights,
- encourage authenticity in people,
- like discussions, group work, and realistic feedback about feelings,
- are caring people who seek to engage their students in cooperative efforts,
- are aware of social forces that affect human development,
- are able to focus on meaningful goals,
- tend to become fearful under pressure and sometimes lack daring.

STRENGTH: Innovation and Ideas
 FUNCTION BY: Value clarification
 GOALS: To be involved in important issues
 and to bring harmony
 FAVORITE QUESTION: WHY?



TYPE TWO LEARNERS

Perceive information abstractly and process it reflectively. They form theory and concepts by integrating their observations into what is known. They seek continuity. They need to know what the experts think. They learn by thinking through ideas. They value sequential thinking. Need details. They critique information and collect data. They are thorough and industrious. They will reexamine the facts if situations perplex them. They enjoy traditional classrooms. Schools are made for them. They are more interested in ideas than in people. They prefer to maximize certainty, and they are uncomfortable with subjective judgments.

They seek goal attainment and personal effectiveness.

As leaders they:

- thrive on assimilating disparate facts into coherent theories.
- tackle problems with rationality and logic.
- lead by principles and procedures.
- exercise authority with assertive persuasion, by knowing the facts.
- work to enhance their organization as embodiment of tradition and prestige.
- need staff who are well organized, have things down on paper, and follow through on agreed decisions.

As teachers they:

- are interested in transmitting knowledge.
- try to be as accurate and knowledgeable as possible.
- believe curricula should further understanding of significant information and should be presented systematically.
- see knowledge as deepening comprehension.
- encourage outstanding students.
- like facts and details, organizational and sequential thinking.
- are traditional teachers who seek to imbue a love of precise knowledge.
- believe in the rational use of authority.
- tend to discourage creativity by a dominating attitude.

STRENGTH: Creating concepts and models
FUNCTION BY: Thinking things through
GOALS: Intellectual recognition
FAVORITE QUESTION: WHAT?



TYPE THREE LEARNERS

Perceive information abstractly and process it actively. Integrate theory and practice. Learn by testing theories and applying common sense. They are pragmatists, they believe if something works, use it. They are down-to-earth problem solvers, who resent being given answers. They do not stand on ceremony, but get right to the point. They have a limited tolerance for fuzzy ideas. They value strategic thinking. They are skills-oriented. They experiment and tinker with things. They need to know how things work. They edit reality, cut right to the heart of things. Sometimes they seem bossy and impersonal.

They seek utility and results.

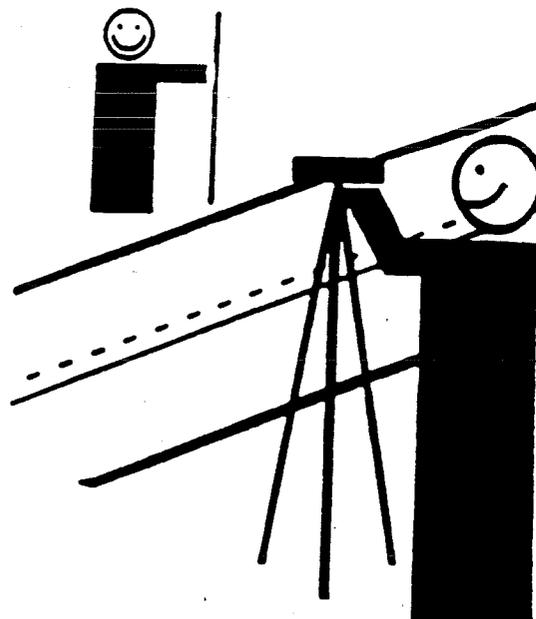
As leaders they:

- thrive on plans and time lines.
- tackle problems by making unilateral decisions.
- lead by personal forcefulness, inspiring quality.
- exercise authority by reward/punishment. (the fewer the rules, the better, but enforce them).
- work hard to make their organization productive and solvent.
- need staff who are task-oriented and move quickly.

As teachers they:

- are interested in productivity and competence.
- try to give students the skills they will need in life.
- believe curricula should be geared to competencies and economic usefulness.
- see knowledge as enabling students to be capable of making their own way.
- encourage practical applications.
- like technical skills and hands-on activities.
- believe the best way is determined scientifically.
- use measured rewards.
- tend to be inflexible and self-contained.
- lack team-work skills.

STRENGTH: Practical application of ideas
FUNCTION BY: Factual data garnered from kinesthetic, hands-on experience
GOALS: To bring their view of the present into line with future security
FAVORITE QUESTION: HOW DOES THIS WORK?



TYPE FOUR LEARNERS

Perceive information concretely and process it actively. Integrate experience and application. Learn by trial and error. Are believers in self-discovery. Are enthusiastic about new things. Are adaptable, even relish change. They excel when flexibility is needed. Often reach accurate conclusions in the absence of logical justification. Are risk takers. Are at ease with people. They enrich reality by taking what is and adding to it. Sometimes seen as manipulative and pushy.

They seek to influence.

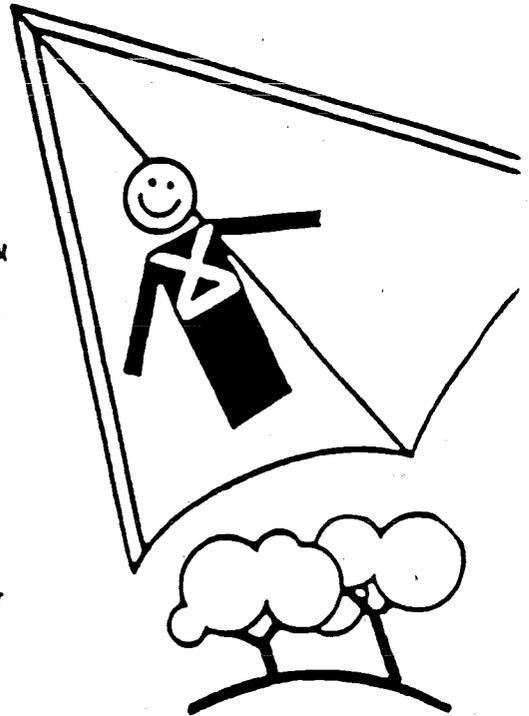
As leaders they:

- thrive on crisis and challenge.
- tackle problems by looking for patterns, scanning possibilities.
- lead by energizing people.
- exercise authority by holding up visions of what might be.
- work hard to enhance their organization's reputation as a front runner.
- need staff who can follow-up and implement details.

As teachers they:

- are interested in enabling student self-discovery.
- try to help people act on their own visions.
- believe curricula should be geared to learners' interests and inclinations.
- see knowledge as necessary for improving the larger society.
- encourage experiential learning.
- like variety in instructional methods.
- are dramatic teachers who seek to energize their students.
- attempt to create new forms, to simulate life.
- are able to draw new boundaries
- tend to rashness and manipulation.

STRENGTH:	Action, getting things done
FUNCTION BY:	Acting and testing experience
GOALS:	To bring action to ideas
FAVORITE QUESTION:	IF?



Earning something - Try to recall some recent situations where you had to do something new, perhaps in your job or at school. Then, using the spaces provided rank a "4" for the sentence ending that describes how you learn best, down to a "1" for the sentence ending that seems least like the way you would learn. Be sure to rank all the endings for each sentence unit. Please do not make tie decisions for any of the situations.

When I learn	_____ I like to deal with my feelings	_____ I like to watch & listen	_____ I like to think about ideas	_____ I like to be doing things
learn best when	_____ I trust my hunches & feelings	_____ I listen & watch carefully	_____ I rely on logical thinking	_____ I work hard to get things done
When I am learning	_____ I have strong feelings & reactions	_____ I am quiet & reserved	_____ I tend to reason things out	_____ I am responsible about things
learn by	_____ feeling	_____ watching	_____ thinking	_____ doing
When I learn	_____ I am open to new experiences	_____ I look at all sides of issues	_____ I like to analyze things, break them down into parts	_____ I like to try things out
When I am learning	_____ I am an intuitive person	_____ I am an observing person	_____ I am a logical person	_____ I am an active person
learn best from	_____ personal relationships	_____ observations	_____ rational theories	_____ a chance to try out and practice
When I learn	_____ I feel personally involved in things	_____ I take my time before acting	_____ I like ideas & theories	_____ I like to see results from my work
learn best when	_____ I rely on my feelings	_____ I rely on my observations	_____ I rely on my ideas	_____ I can try things out for myself
When I am learning	_____ I am an accepting person	_____ I am a reserved person	_____ I am a rational person	_____ I am a responsible person
When I learn	_____ I get involved	_____ I like to observe	_____ I evaluate things	_____ I like to be active
learn best when	_____ I am receptive & open-minded	_____ I am careful	_____ I analyze ideas	_____ I am practical

column totals (add each critically)

_____ **COLUMN 1**

_____ **COLUMN 2**

_____ **COLUMN 3**

_____ **COLUMN 4**

x = column 4 minus column 2 _____

y = column 3 minus column 1 _____

Learning-Style Inventory Notes

Directions for taking the Learning-Style Inventory

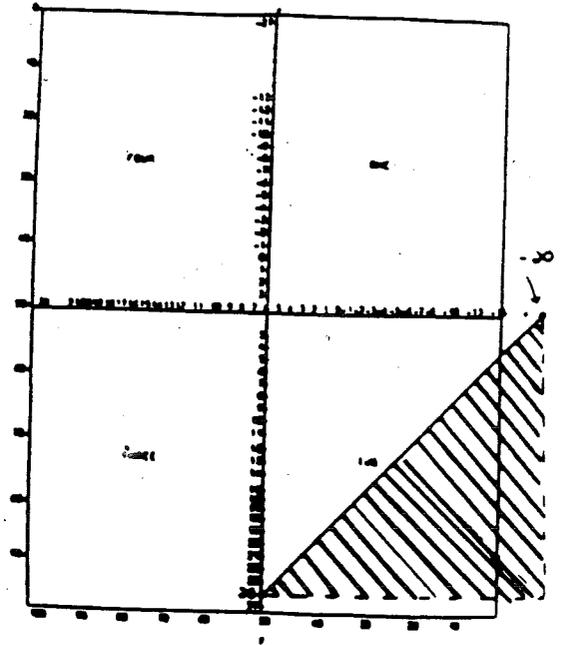
1. Take the Learning-Style Inventory in a quiet, relaxed location.
2. Read the directions carefully at the top of the Inventory.
3. After you have completed the Inventory (which follows these notes), add the numbers in all of the columns vertically and write the result below each one.
4. Calculate an x and y value by following the formula at the bottom right hand corner of the Inventory. Do not be concerned if you calculate a negative value for one or both of the coordinates.

Directions for graphing your results

1. Plot the x and y values that you calculated on the graph following the Learning-Style Inventory with dots.
2. Join the dots to create a straight line.
3. Extend each plotted point so that you create a triangle in the quadrant in which your line dominates more.

For example:

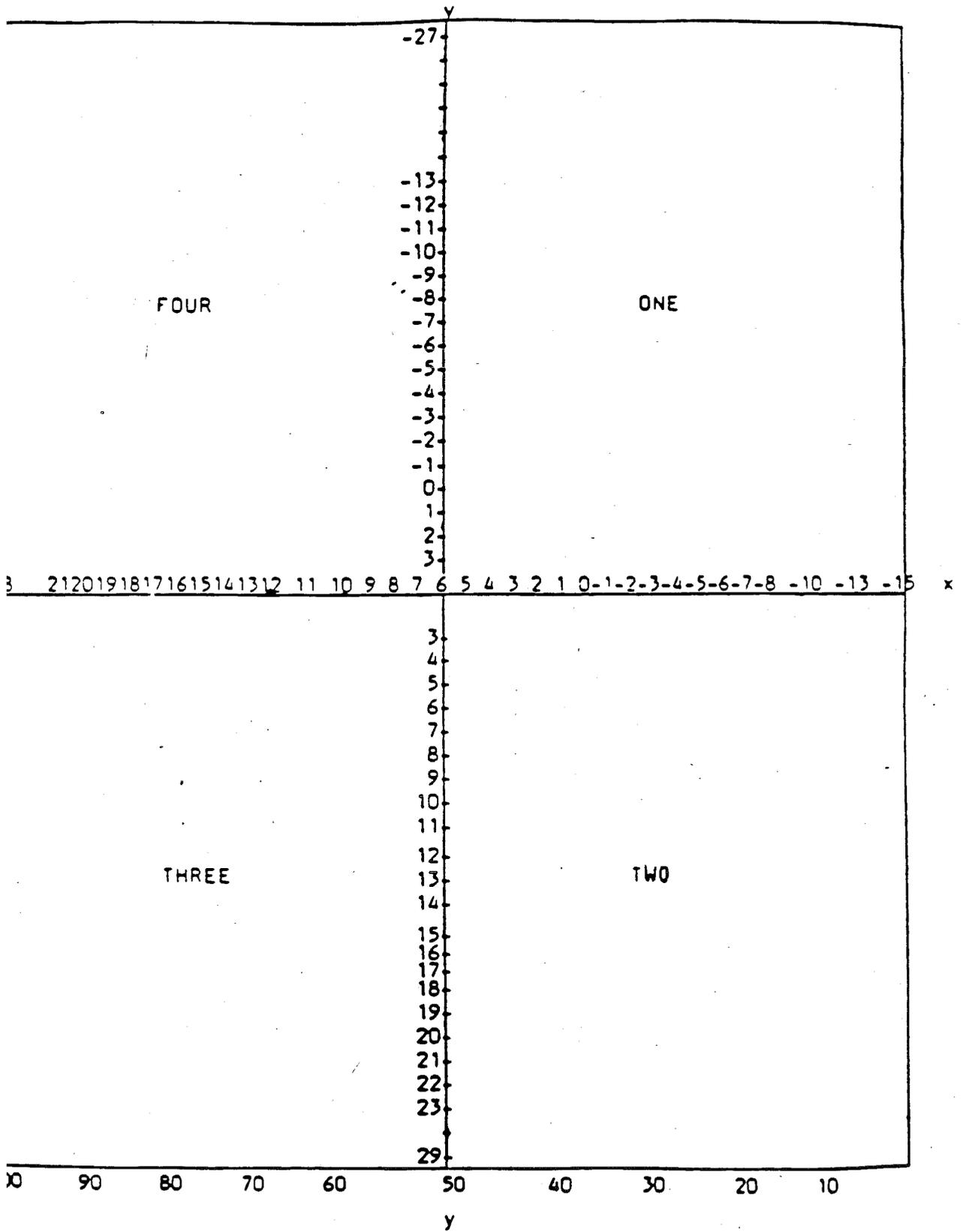
If the result from $x = \text{column 4 minus column 2}$ is -20 and
 $y = \text{column 3 minus column 1}$ is 28 then
 the graph would look as follows:



Interpreting graphed results

See sheets numbered 5-8 and *THE 4MAT® LEARNING TYPE DESCRIPTIONS* for an explanation of your Learning-Style Inventory results.





Appendix C: Grade Sheet, Supplemental Material, Journal Prompts

Week of [Date]	Minimum 100 Word Entry? (10 Points / Week)	Bonus
1/29	Yes No	
2/5	Yes No	
2/12	Yes No	
2/26	Yes No	
3/5	Yes No	
3/12	Yes No	
3/19	Yes No	
3/26	Yes No	
4/2	Yes No	
4/9	Yes No	

3rd Ten Weeks Journal Grade Equals One 100 Point Test

Added Bonus: _____

_____ / 100 Points

Mathematics Journals

Rationale: The New York Board of Regents has implemented a Core Curriculum that reflects a new philosophy of mathematics. Finding the right answer is not enough, because students and adults naturally want to know the answers to “Why” questions. Why is the sky blue? Why does $2 + 2 = 4$? Why do leaves turn colors in the fall?

When you enter the world of work, your boss will expect you to communicate clearly with coworkers and customers. It will not be acceptable to answer the question “Why?” with “Because I told you so.” Thus, we will begin to explore “Why?” questions in mathematics class through the use of a single-subject, spiral-bound notebook.

Grading: Every student will be required to compose at least one essay, 100-word minimum, each week, related to some mathematics topic we cover in class. I will provide you with class time and topic ideas to complete this requirement.

Once per week, I will collect your journals and respond to your entries. If you choose to write additional 100-word minimum entries, I will assign you bonus credit for use on your next quiz or test.

Format: Each entry must be dated. Grammar and spelling will not be graded, but proper use of the English language will benefit the expression of your ideas. I will share entries that I have written to help you develop your own math journal style.

Goal: It is my desire to help you think clearly and justify your decisions logically. Essays, more than mathematical symbols, force a student or teacher to answer “Why?” If you develop the ability to answer “why” in math class, then your math journal has served its purpose.

Journal Question for Week #1:

Imagine that you are a contractor in charge of bringing a mega-mall with 250 stores to Webster.

Respond to the following prompts:

1. What mathematics is necessary to create this mall?
2. Is arithmetic enough to address all of the issues involved in bringing this mega-mall to Webster, or is more advanced math (such as geometry or algebra) necessary?

Remember:

- 100 word minimum
 - proper grammar and spelling is encouraged
 - charts and graphs are acceptable, but not required
 - deadline: next Monday
-

Journal Question(s) for Week #2

CHOICE 1

AJ Davis asked an interesting question in Period 7 this week.

“Why should we learn some of this stuff if we’ll never use it again?”

Respond to the following prompts:

1. Should high school students study concepts in math, English, social studies or science that they will not use in their jobs?
2. Why do you feel this way?

CHOICE 2

Respond to the following prompts:

1. In what situations might you use square roots?
2. What practical applications are there for the Pythagorean Theorem?
3. Have you ever used a form of the Pythagorean Theorem in your life experiences?

Remember:

- 100 word minimum
- proper grammar and spelling is encouraged
- deadline: _____

Journal Question for Week #3: Respond to Jonathan McGarvey's presentation "When am I ever going to use this?"

Journal Question for Week #4

CHOICE 1

What is your opinion of the amount of money people make? Do you think there should be a limit to how much money people can make? Should people in some professions be required to make more money than people in other professions?

This is an economic and moral decision in addition to a mathematical one.

CHOICE 2

The TI 83 Plus calculator can graph lines. It can also graph more complex functions.

Do you think that students should be required to learn to do by hand things which can be more quickly accomplished with technology? Why do you feel this way?

Remember:

- 100 word minimum
 - proper grammar and spelling are encouraged
 - deadline: _____
-

Journal Question for Week #5: Create a "Cheat Sheet" for your Unit 9 Graphing test.

Journal Question for Week #6

Here are a couple of quotes for you to consider:

CHOICE 1

"I find this law at work: When I want to do good, evil is right there with me."

~ Paul of Tarsus (1st Century A.D.)

CHOICE 2

"Conscience is the perfect interpreter of life."

~ Karl Barth, Swiss theologian (1886-1966)

CHOICE 3

Select your own favorite quotation.

Choose JUST 1 quote and respond to the following questions:

1. What do you think the quote means?
2. Do you agree or disagree with the quote?
3. How would you explain this quote to a youngster in 4th or 5th grade so that he or she could understand it?
4. Why did you pick this quote?

Remember:

- 100 word minimum
- proper grammar and spelling are encouraged
- deadline: _____

Journal Questions for Weeks #7-10 (worth 40 points)

Please answer each of the following questions completely:

1. What did you find helpful, useful, and educational about this math journal? Why?
2. What did you NOT find helpful, useful, and educational about this math journal? Why not?
3. Did you like using a math journal? Why or why not?
4. Would you recommend that I repeat this experience with next year's math classes? Why or why not?
5. Please rate this experience from 1 to 5 (1=not at all positive, 3=neither negative nor positive, 5=very positive)

Remember:

- ** 200 word minimum
- proper grammar and spelling are encouraged
- deadline: _____

Appendix D: Data

Summary of Data, Listed by Student

Student ID	Learning Style	# Incomplete	# Engaged
2.01	2	2	3
2.02	3	0	4
2.03	4	5	0
2.04	2	0	3
2.05	2	2	2
2.06	2	0	4
2.07	3	3	2
2.08	4	1	4
2.09	1	5	0
2.10	4	0	5
2.11	1	0	4
3.01	1	3	2
3.02	2	0	4
3.03	2	2	3
3.04	3	4	1
3.05	4	5	0
3.06	1	4	1
3.07	4	0	3
3.08	2	2	2
3.09	4	5	0
3.10	2	0	5
3.11	4	0	5
3.12	1	2	2
3.12	2	2	2
3.13	2	0	5
5.01	2	4	1
5.02	1	5	0
5.03	1	0	4
5.03	4	0	4
5.04	1	1	3
5.05	1	0	5
5.05	2	0	5
5.06	1	0	4
5.07	2	1	3
5.07	3	1	3
5.08	2	0	4
5.09	3	0	2
5.10	2	0	4

5.11	1	1	2
5.12	3	1	4
5.13	4	2	2
5.14	3	0	5
5.15	2	0	5
5.16	4	0	3
5.17	1	0	5
6.01	3	3	1
6.02	2	0	4
6.03	4	0	5
6.04	3	1	1
6.05	4	4	1
6.06	1	5	0
6.07	4	5	0
6.08	1	5	0
6.09	2	3	2
6.10	1	1	1
6.11	1	2	3
6.12	4	0	3
6.13	2	0	5
6.14	3	2	2
6.15	3	5	0
6.16	2	0	4
6.17	3	5	0
6.18	2	5	0
6.19	4	1	4
6.20	2	0	4
6.21	4	0	5
6.22	3	4	1
7.01	2	2	2
7.02	2	0	5
7.03	3	0	5
7.04	3	3	2
7.05	2	3	2
7.05	3	3	2
7.06	3	1	4
7.07	3	0	4
7.08	3	0	3
7.09	1	1	4
7.09	2	1	4
7.10	4	1	4
7.11	2	0	5
7.12	3	1	2
7.13	1	1	2
7.13	4	1	2
7.14	3	2	3

7.15	3	0	5
7.16	4	0	3
7.17	4	0	3

Student ID: Class #.Individual #

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