(Highlights of study directly related to Muggins Math printed in bold print.)
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The role of playing games in developing algebraic reasoning, spatial sense, and problem-solving.

Introduction and Literature Review

Purpose and Relevance

Using games in the classroom to facilitate learning has been common practice among teachers for many years. Blum and Yocum (1996) supported instructional game-playing in the classroom because it provided an exciting and motivating strategy for students to practice skills already learned. They suggested that there are several benefits from using instructional games in the classroom. Games are naturally motivating and fun, games facilitate individualization of assessment and instruction, and games make the abstract concrete.

As a teaching tool games helped students become better problem solvers because playing games gave them a chance to work out problems and develop strategies for solving problems in a non-threatening environment. (Klein & Freitag, 1991; Olson & Platt, 1992 as cited in Blum & Yocum, 1996). Playing games provided opportunities for students to invent and test various strategies and procedures for solving problems. Kamii, Lewis and Livingston (1993) stated, "When children invent their own problem-solving strategies, they do not have to give up their own thinking, their understanding of [the concept] is strengthened and they develop better number sense" (p. 201). This also afforded students time to test their theories and strategies along with providing practice in multi-step problem-solving. "Playing games offers repeated use of ... strategies and invaluable practice of skills already learned. Practice becomes more effective because students become active participants in their own learning" (Ernest, 1986; Rakes & Kutzman, 1982; Wesson et al., 1988 as cited in Klein & Freitag, p. 303).

Playing games in the classroom provided a forum for students to have discourse with peers (Beigel, 1997; Wakefield, 1997). They discussed options, strategies and solutions and gained insight and understanding from each other as well. Wakefield further proposed that the social interaction during the playing of games not only helped student understanding, but played a large role in the game etiquette of following rules and fair play (1997).

Most studies in the field of using instructional games in the classroom focus on students with special needs as their subjects. Blum and Yocom mentioned three such studies that yielded positive results (1996). Beattie and Algozzine (1982) found that students with mild disabilities who practiced math facts and played instructional math games were on-task about 20% more than their peers and also received higher grades. Delquadri, Greenwood, Stretton and Hall (1983) found that by using an instructional spelling game, learning-disabled students were able to decrease their spelling errors equal to the level of their non-disabled peers. Mackay and Watson (1989) were able to show improvement of communication skills with severely learning-disabled students by using instructional games.

There were no studies found in which non-disabled students were used as subjects. This study looked at such groups.

Questions

The purpose of this study was to test the hypothesis that playing math-related games played a role in developing students' ability to solve problems involving algebraic reasoning and spatial sense.

Researchers chose the following from the NCTM Curriculum and Evaluation Standards for School Mathematics (1989), "spatial sense is an intuitive feel for one's surroundings and the objects in them" to define spatial sense (p. 49). Having spatial sense means understanding the relationships of objects, the sizes and shapes of figures and objects, and the direction, orientation and perspectives of objects (Liedtke, 1995). Based on these definitions, the following are examples of the use of spatial sense. Students with spatial sense are able to manipulate patterns and shapes or objects both physically and mentally in order to show an understanding of the properties of that pattern, shape, or object. Some examples of the games used and their nature follow. Playing the game Rush Hour[R] which involves manipulating cars and trucks to create a path for removing a particular car, required the use of spatial sense. The playing area consists of a limited number of spaces from which no vehicles may be removed. A similar game played by students was Stormy Seas[R]. Students also played Connect Four[R], a game where students used a vertical game board to attempt to line up four checkers in a row, either vertically, horizontally, or diagonally before their opponent succeeded in the same task. This game required students to manipulate the checkers physically in making moves, and mentally in planning strategies to create the desired pattern in order to win the game. Students also needed to do multi-step problem-solving to strategize about how to win each of the above games.

Based on readings related to algebraic reasoning and their expertise, the researchers defined algebraic reasoning as the ability to develop relationships, some abstract, between numbers and patterns and to describe, represent, and model these relationships. An example of algebraic reasoning is in playing the game Muggins[R]. Participants roll three dice, for example 4, 3, and 5. Using each number once, players must generate a number between 1 and 36. Players use any combination of the four operations in order to come up with a number. For example, 3 X 4 + 5 can be used to generate the number 17.

Methods

Two fifth grade classes from the same school were involved in this study. Both classes consisted of upper middle-class students who scored above the 30th percentile in math on the Stanford Achievement Test in April 2000. The control group was a class of 26 students who were taught by a teacher with 39 years of teaching experience. The experimental group was a class consisting of 24 students whose teacher had 14 years of teaching experience. Both teachers used the same traditional text. The curriculum taught by both teachers throughout the school year was the same: addition, subtraction, multiplication and division of whole numbers, decimals and fractions, as well as a unit in geometry. The experimental group teacher also used Mad Minute daily. The Mad Minute is a timed drill in which students attempt to complete thirty to sixty basic facts in one minute. Success in completion and accuracy advance the student to the next level of problems. A problem situation was also posed for five minutes at the beginning of class every other day in this class.

The experimental class was divided into six groups of the students' choosing. **The groups rotated through each of six stations twice a week, spending about 30 minutes at each station. Most stations consisted of specific commercial games that require students to utilize algebraic reasoning and/or spatial sense, based on the definitions and examples previously stated.** One station was devoted to shareware games from the Internet. These games also required students to utilize algebraic reasoning, spatial sense, or problem-solving. A complete list of the games used is included at the end of the article. The teacher gave instructions about how to play each game. **These games and Internet sites were also available for students to use during their free time throughout the course of this study. This provided students with approximately 100 minutes of optional game-playing time per week, in addition to the required 60 minutes, for a possible total of 160 minutes per week.** After a few weeks of play, some stations were combined because individually the games didn't hold the students' interest for the allotted time of play. Students helped decide which games were paired.

Ms. Lach used a pretest/posttest model with items generated from assessments used by the school district and from Test Ready Plus[TM], a Quick-Study Program published by Curriculum Associates (1994). Sample test items are shown in Figure 1.

[FIGURE 1 OMITTED]

Issues of validity were addressed in the following ways. Researchers selected items that required students to use algebraic reasoning to develop relationships between numbers and patterns and to describe, represent, and model those relationships. Other items chosen were those requiring students to use spatial sense to show their understanding of the relationships of objects, the size and shapes of objects, and the direction, orientation and perspectives of objects. Independently, the researchers chose and sorted all of the items into categories of algebraic reasoning and spatial sense based on the definitions. The distribution of the test items can be found in Table 1.

Reliability of this measurement tool was addressed by administering the test to a group of fifth grade students who were not involved in the study. Students took the test twice, three weeks apart, and the students' scores were unchanged.

The researchers administered the pretest to both classes the first week of school and the same test was given as a posttest at the end of this study 12 weeks later. A rubric was used for scoring the pretests and posttests. The rubric scoring level was 0 to 4 and differentiated between those problems requiring an explanation and those that require an answer only, as shown in Table 2.

The regular math instruction that took place in Ms. Lach's room was more traditional in terms of skill development. The teacher modeled the skill, provided opportunities for guided practice, and then had the students do independent practice.

Findings

A one-tailed t-test compared the overall average pretest scores of the control group and the experimental group to determine whether the groups were different. With a probability level of 0.2756, there was no significant difference between the two groups. A one-tailed t-test tested the null hypothesis that there was no difference between the control group's pretest and posttest results ($p<0.2496$), and no difference between the experimental group's pretest and posttest results ($p<0.01$) as shown in Table 3. **From the pretest to the posttest, the control group showed no significant difference. However, the difference with the experimental group was highly significant. This information supports the hypothesis that playing math games improved the students' abilities in solving problems involving spatial sense and algebraic reasoning.**

An item analysis of the comparison of the mean pretest score to the mean posttest score of the experimental group was performed, as shown in Table 4. This indicated that responses to items 1, 5, 6, 7, 9, 10, 11, and 12 were significantly different from the pretest to posttest, and that items 2, 3, 4, and 8 were not. In studying the item analysis of the control group, it was found that two items showed a significant difference between the pretest and the posttest. They were item 12, with a p-level of

0.01913, and item 7, with a p-level of 0.02287.

Other findings related to this study, but that were not included as part of the design are stated here. Student enthusiasm for the game-playing was very high at the outset and continued to be high for a variety of the games included in the study, as observed by the teacher and as shown in their desire to continue playing. The teacher also saw a high level of engagement during the games as compared to other times in class. Some students had difficulty with some of the games because they proved to be challenging. This was exhibited by students who became frustrated by frequent losses. Strategies were developed to enable the students to remain involved with the games for longer periods of time, and students were able to work through multi-step problems. Others struggled with social issues such as not feeling successful in front of their peers. This manifested itself when a parent contacted the teacher about how the parent might do more with her child at home in order for him to become more successful against his peers. Another socially connected finding was that students learned to play fairly, to help each other, and to communicate their understanding. Students were focused on who went first and who might be cheating at the beginning of the study. As the study continued, going first became less of an issue and students spent more time explaining their reasoning and thinking rather than being confrontational. It was also found that game-playing extended beyond the classroom and into the home. Several families contacted the teacher about the names of games and about where they could purchase games in order to play them at home.

Discussion

While the benefits of using games in the classroom seemed obvious, the researchers had no statistical evidence of their benefit prior to the study. The posttest numbers between the two groups indicate that the groups had very different levels of success in problem-solving with algebraic reasoning and spatial sense after the 12 week period. There were a few items that students did not score differently on in either group. Those items were 2, 3, 4, and 8. Students scored well on items 2, 3, and 8 before and after the implementation of the use of games. Items 2 and 3 were area and perimeter problems. Item 8 was a number sentence problem. Clearly, the students understood the problems at the outset. Item 4 was a grid that had a pattern established in the first two rows. The pattern was a doubling one. The third row contained the numbers 7 and 14. Rather than doubling to get 28, the majority of the students just added seven to 14 to get 21. The majority of the students had the same wrong answer after the implementation of the use of games because they only looked at one row to generate the next number in the pattern.

While the study did not quantitatively measure the following aspects of student learning, the teacher noticed several changes among students throughout the study. Student enthusiasm was very high with regard to playing games. The students knew they were being studied, which might have been a factor in some of the enthusiasm.

Among student responses several were insightful. One student said that he only liked games that made him think. Another student said she wanted to play the "fun" games and still another said that he only plays games on the computer now that he's older. Another student said she wasn't very good at math games, but that she would help out anyway. After a few weeks, some students exhibited frustration. They needed support in developing strategies that others had figured out. In one particular instance, the teacher worked with the student and parent in order to help the student be more successful.

Some additional benefits of using games beyond those already reported in this study follow. Students learned new games, some of which were purchased by families for use at home. Students developed greater confidence in mathematics as a result of being successful at playing games. Students also learned how to strategize and how to solve multi-step

problems, as well as how to communicate about their strategies. An example of this was in playing Muggins[R]. In order to get more points, students needed to place marbles in a row, on successive turns. Thus, placing a first marble in a good position would increase the likelihood of being able to place successive marbles next to it. This required them to look ahead to future turns and to do multi-step problem-solving in their play. The teacher saw evidence of students developing the ability to place marbles in better strategic positions as they gained more experience with the game. Students also learned to play fairly with each other and learned how to help each other as well as ask peers for help.

Although the data supports the hypothesis, there are points to consider in reading these results. For example, were there other factors that contributed to the success of this study? Perhaps the use of the Problem of the Day, which provided problem-solving practice, was a contributing factor to the positive outcome of this study. Would different games yield different results? Would using computer software programs specific to algebraic reasoning and spatial sense affect the results differently? If the study took place over a longer period of time, would the results be different? What would we learn about student understanding if other assessments were done?

The results of the study support what was thought by many teachers for years. Playing games provides an avenue for students to develop algebraic reasoning, spatial sense, and problem-solving. Additional findings were that students were more motivated and more involved when learning took place through game-playing. Students were challenged to think about strategizing and multi-step problem-solving. They were also motivated to discuss their thinking with peers in order to improve the game-playing for all involved. These results along with those above are incentives for further exploration of the learning that takes place when students play games in mathematics.

Games used in study:

Connect Four [Game]. (1990). Milton Bradley Company. Guess Who? [Game]. (1996). Milton Bradley Company. Izzi [Game]. (1992). Binary Arts Corporation. Mastermind [Game]. (1998). New York: Pressmen Toy Corporation. **Muggins [Game]. (1990). Old Fashioned Crafts.** Rush Hour [Game]. (1996). Binary Arts Corporation. Stormy Seas [Game]. (1998). Binary Arts Corporation. Tangramables. (1987). Highland Park: Learning Resources. 24 [Game]. (1998). Suntex International Incorporation.

Table 1. Test Item Distribution

Item #	1	2	3	4	5	6	7	8	9	10	11	12
Algebraic Reasoning	X			X	X	X		X				X
Spatial Sense		X	X				X		X	X	X	

Table 2. Scoring Rubric

SCORE LEVEL	PROBLEMS REQUIRING AN EXPLANATION	PROBLEMS REQUIRING AN ANSWER WITH NO EXPLANATION

4	Provides correct answer; explanation is correct and thorough, showing complete understanding	Correct answer given
3	Answer may be correct or incorrect, but explanation shows some understanding	N/A
2	Incorrect answer; explanation shows little or no understanding	N/A
1	Answer may be correct or incorrect, but no explanation was given	Incorrect answer given,
0	Problem not attempted	Problem not attempted

Table 3. Pretest/Posttest Results

	X Pretest	X Posttest	P-level
Control group	24.36	25.20	0.2496
Experimental Group	23.13	32.65	0.000029**
P-level	0.2756	0.00093**	

** P<.01.

Table 4. Item Analysis of Experimental Group

Item#	Type	X Pretest	X Posttest	p-value
1	AR	2.0434	2.8761	0.0116*
2	SS	3.1739	3.3043	0.3651
3	SS	3.8695	3.7391	0.2876
4	AR	2.6956	2.4347	0.2876
5	AR	1.7826	2.8695	0.0139*
6	AR	0.4782	1.7826	0.0004**
7	SS	0.8260	1.9565	0.0003**
8	AR	2.3913	2.7391	0.1678
9	SS	1.9130	2.9565	0.0012**
10	SS	1.7826	3.3913	0.0000**
11	SS	1.3913	2.1304	0.0019**
12	AR	0.7826	2.5652	0.0001**

Note. AR = algebraic reasoning; SS = spatial sense
*p<.05. **p<.01.

REFERENCES

Beattie, J., & Algozzine, B. (1982). Improving basic academic skills for educable mentally retarded adolescents. Education and Training of the Mentally Retarded, 17(3), 255-58.

Beigel, A.R. (1997). The role of talking in learning. Education, 117(3), 445-51.

Blum, H.T. & Yocum, D.J. (1996). A fun alternative: using instructional games to foster student learning. Teaching Exceptional Children, 29(2), 60-63.

Delquadri, J.C.; Greenwood, C.R.; Stretton, K.; & Hall, R.V. (1983). The peer tutoring spelling game: a classroom procedure for increasing opportunity to respond and spelling performance. Education and Treatment of Children 6(3), 224-39.

Kamii, C.; Lewis, B.A.; Livingston, S.J. (1993). Primary arithmetic: children inventing their own procedures. Arithmetic Teacher, 41(4), 200-03.

Klein, J.D. & Freitag, E. (1991) Effects of using an instructional game on motivation and performance. Journal of Educational Research, 84(5), 303-08.

Liedtke, W.W. (1995) Developing spatial abilities in the early grades. Teaching Children Mathematics, 2(1), 12-18.

Mackay, M. & Watson, J. (1989) Games for promoting communication. British Journal of Special Education, 16(2), 58-61.

National Council for Teachers of Mathematics. (1989). Curriculum and Evaluation Standards for School Mathematics. 49.

Test Ready Plus. (1994). MA: Curriculum Associates, Inc.

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Wakefield, A.P. (1997). Supporting math thinking. Phi Delta Kqppan, 79(3), 233-36.

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Muggins Math: Tools for Student Success
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A Learner-Centered Intervention

Sunman-Dearborn's Learner-Centered Programs and Muggins Math formed a partnership in 2003 with the expressed purpose of improving student learning in mathematics. The games and manipulatives promised to be best practice materials that give students a new way of looking at math. The founder of Muggins, Alan Schuler, struggled as a young student with traditional math instruction. Later in life as a 7th grade Math teacher, he said, " I had a special place in my heart for kids who have difficulties understanding operations and concepts. Muggins Math materials are especially developed for children like me" (personal communication, January 17, 2006).

It was decided to set up two pilot sites in the Sunman-Dearborn Community Schools District in order to begin a 5-year program evaluation cycle. Bright Elementary teachers and two teachers at Sunman-Dearborn Intermediate School received 2 days of training in the use of Muggins games and manipulatives. On-going support was also given as needed during the training period in 2003. During the 2004-2005 school year, the materials were implemented in all of the pilot classrooms. They were used during regular class periods for whole class and small group instruction, tutoring sessions, centers, Muggins periods, before school, game days, and tournaments. The games and manipulatives were used for instruction, remediation, and enrichment.

During the same time as the Muggins Project was underway, we were engaged in collecting learning styles data from all of our students in Grade 3 (approximately 300 students each year). The purpose of the data collection was to provide teachers with meaningful student data to guide instruction. Students completed Kaleidoscope Profiles developed by Performance Learning Systems and group data was compiled. The hope was that teachers would use the information for classroom planning. As Sizer and Sizer (1999) said, "The teacher is able to take each student on his or her own merits, to convey, not generic hope, not one-size-fits-all confidence, but the specific version which can only come from the students own facts and from knowing each child well" (Tomlinson, 2005, p 88).

A Match for Preferred Learning Styles

After 4 years of data collection, the learning styles data revealed that a large number of third grade students had common profiles. Kinesthetic was the preferred sensory style (see Figure 1). The preferred perceptual/organizational learning style was concrete/global (see Figure 2). Sensing Perceiver was the preferred temperament style (see Figure 3). According to the activities described by Performance Learning Systems (2003) that fit these types of learners, Muggins Math was a perfect match! .

In order to further investigate the impact of Muggins Math on student performance, focus groups of students representing each year of the study were interviewed. Students from Grades 3 through 6 were selected based on their learning profiles obtained from their Kaleidoscope Profiles. Each student in the focus group had a combined learning profile of kinesthetic, concrete/global, and sensing perceiver.

Focus group participants came from Bright Elementary School and the pilot classrooms at Sunman-Dearborn Intermediate School. Students were asked questions designed to give insight into their learning style connections to Muggins Math. On the first day of interviews, Audrey Roth, a fifth grade student, attributed her success in math to Muggins. She said, "I never liked math because I didn't understand it. Mrs. Koth tutored me every day for two weeks after school using Muggins giving me a better way to learn math. I moved from a D in first grade to a B+ in 5th grade because of Muggins " (personal communication, January, 13, 2006).

Student testimonials supported the importance of kinesthetic activity in their learning processes (see Figure 4). Nathan Voltz, a fifth grader said, "Sometimes when I have to go really fast, I think back to Muggins and make it work." (personal communication, January 13, 2006). Further, Marzano (2001) said, "The very act of generating a concrete representation establishes an 'image' of the knowledge in students' minds." (p.78) Jared Pierce, 6th grade student, compared the Muggins' manipulatives to "…mnemonic devices in order to re-member math facts better" (personal communication, January 13, 2006).

All students interviewed agreed that the concrete learners need to experience another way of looking at things by touching objects (see Figure 5). By doing this, they learn better than just working on paper. As Nathan Voltz said, "You mess with it so long that it finally all comes together"(personal communication, January 13, 2006). In reference to models, Anderson (1990) said, "Fortunately, the process of generating nonlinguistic representations engages students in elaborative thinking" (Marzano, 2001, p. 74). Jacob Zengerling, a fourth grade student, said, "On paper you just do certain problems. With Muggins, you have to think of a combination of problems in order to make the right moves" (personal communication, January 16, 2006).

The opportunity to make choices is important to global learners (see Figure 6). All of the sixth grade students pointed out the importance of being able to make choices while playing Muggins. Jared Pierce added "I like to trick my opponents and show my friends alternative moves" (personal communication, January 13, 2006). Trial and error also plays into the excitement of learning with Muggins. Ryan Madden, a fourth grade student said, "Right when you lay it

"Kinesthetic Learners prefer:
- Hands-on activities
- Manipulatives
- Physical movement while working"

(Performance Learning Systems, 2003).

Figure 4

"Concrete Learners prefer:
- Hands-materials
- Demonstrations
- Models
- Objects to touch and Manipulate"

(Performance Learning Systems, 2003).

Figure 5

"Global Learners prefer:
- Choices
- Trial and error discovery
- Inductive reasoning
- Group work"

(Performance Learning Systems, 2003).

Figure 6

down, you know whether it was a good move or bad move" (personal communication, January, 2006).

Sensing Perceivers like to be actively engaged in their learning (see Figure 7). Competition appeared to be important especially with the intermediate students. The sixth grade students agreed that outwitting their Opponents and getting better each time with the math facts were outcomes from playing Muggins games. Immediate feedback came with making good or bad moves. According to Marzano (2001), immediate corrective feedback positively impacts student learning (p. 96).

"Sensing Perceiving learners prefer:

- Doing hands-on activities
- Being practical- learning by doing
- Competing and performing
- Experiencing variety and uniqueness
- Receiving immediate feedback for actions"

(Performance Learning Systems, 2003).

Figure 7

A Motivational Tool for Learning

What motivated our focus group of students to learn? According to Marzano (2005), "If academic content is embedded in a game or game like activity, students tend to be engaged in the task and consequently learn the embedded content even if they are not interested in the content per se" (p. 96). This has proven to be the case for all of our focus group of students working with Muggins' games and manipulatives. Students testified that they're learning and having fun doing it. Derek Roth, a third grade student, said, "I love addition and subtraction now. Muggins helps me learn a different way. The regular way is boring!" Further, Drapeau (2004) stressed that, "It's a good idea to frequently engage your students in more active learning experiences, and game formats are a motivational way of just doing that" (p. 56).

Student Mathematical Power

Zemelman, Daniels, and Hyde (1998) stressed that "The goal of teaching mathematics is to help all students develop mathematical power." (p.89.) Muggins enabled our students to improve their math skills and basic understandings of mathematical operations. Our sixth grade students agreed that Muggins games helped them to think at higher levels and much faster in order to beat their opponents. Students at all grade levels attributed their growing confidence in mathematics to the games and manipulatives.

Interpreting Effect Size…
Growth
An effect size of:
.2 or greater, but less than .3 shows growth that is quite good.
.1 or greater, but less than .2 shows growth that is good enough to mention.
Less than .1 but greater than -.1 shows growth that is not enough to mention (Stock, 2006).

Figure 8

Increased Student Achievement

During the Muggins Math implementation year 2004-2005, Bright Elementary students in Grade 3 showed significant gains in Number Sense and Algebra and Functions on the state ISTEP+ test. Group mean scores for 105 students in terms of

References

Drapeau, P., (2004). *Differentiated Instruction: Making It Work.* New York: Teaching Resources.

Marzano, R.J., Pickering, D. J, & Pollock, J.E., (2001). *Classroom Instruction that Works.* Virginia: Association for Supervision and Development.

Marzano, R. J., Waters, T, & McNulty. B.A., (2005). *School Leadership that Works.* Virginia: Association for Supervision and Curriculum Development.

Performance Learning Systems. (2003). Sensory Learning Styles Activities.

Stock, M.J., (2006, February). Data analysis and assessment. Handout given to participants at a North Central Association workshop.

Tomlinson, C. A. (2005) Traveling the road to differentiation in staff development. The Journal of the National Staff Development Council, 26, 8-12.

Tomlinson, C. A., (2003). *Fulfilling the Promise of the Differentiated Classroom.* Virginia: Association for Supervision and Curriculum Development.

Zemelman, S., Daniels, H., & Hyde, A. (1998). *Best Practice: New Standards for Teaching and Learning in America's Schools.* New Hampshire: Heinemann.

Author's note: For more information about Muggins Math manipulatives and games visit www.mugginsmath.com. Debbie Price created the Learning Styles graphs.

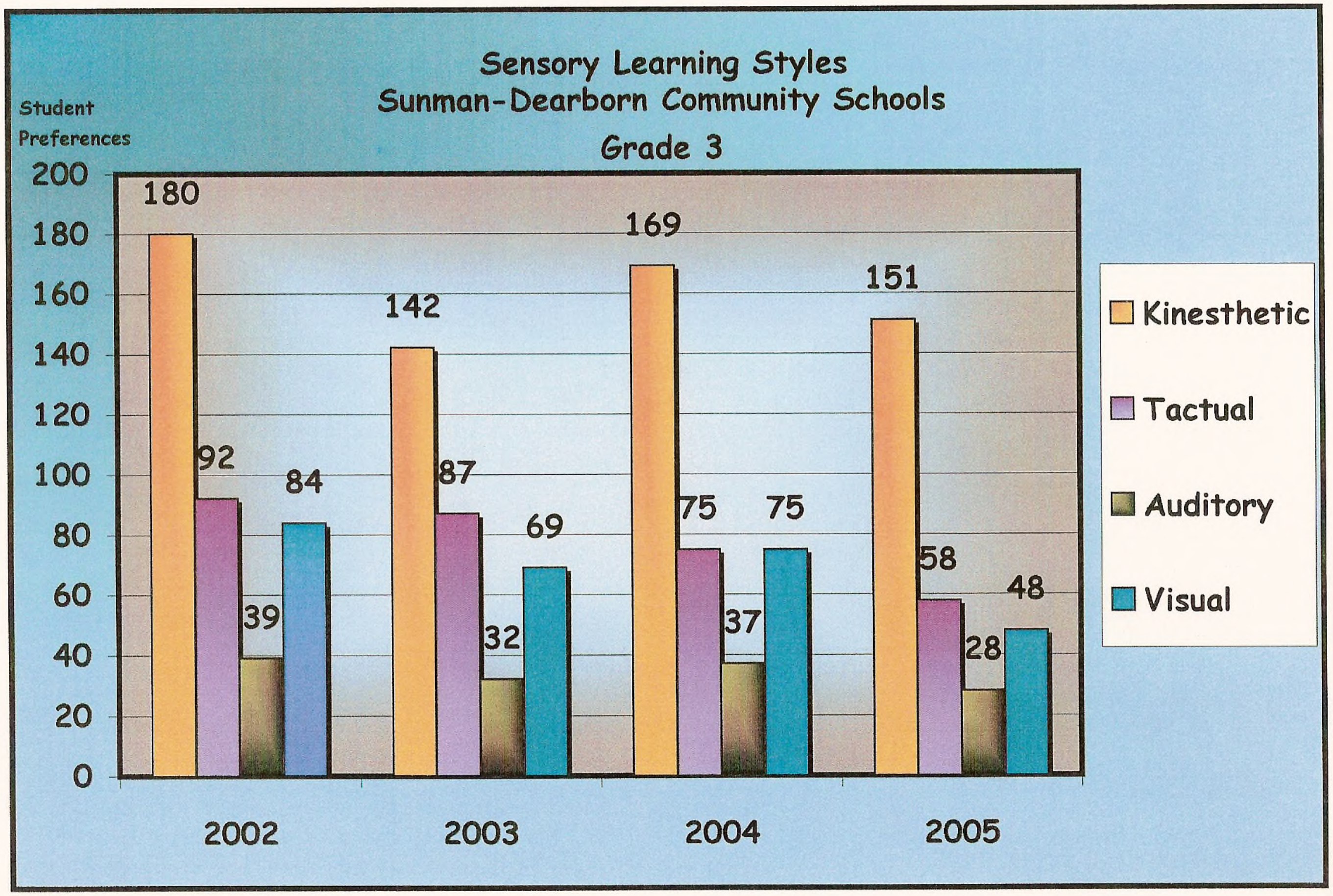

Sensory Learning Styles
Sunman-Dearborn Community Schools
Grade 3
Student Preferences
200
180
160
140
120
100
80
60
40
20
0
180
92
39
84
142
87
32
69
169
75
37
75
151
58
28
48
2002
2003
2004
2005
Kinesthetic
Tactual
Auditory
Visual

Figure 1

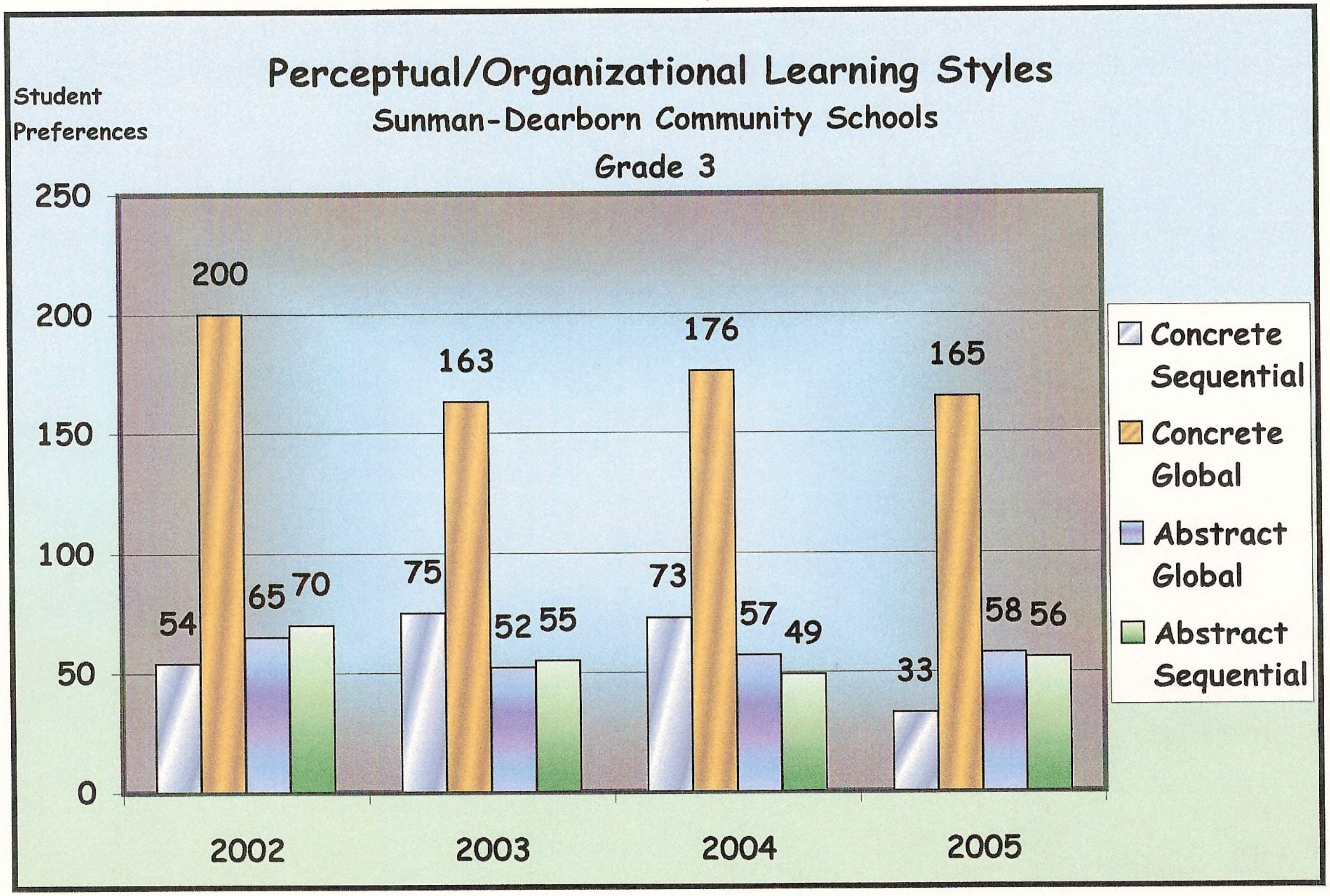
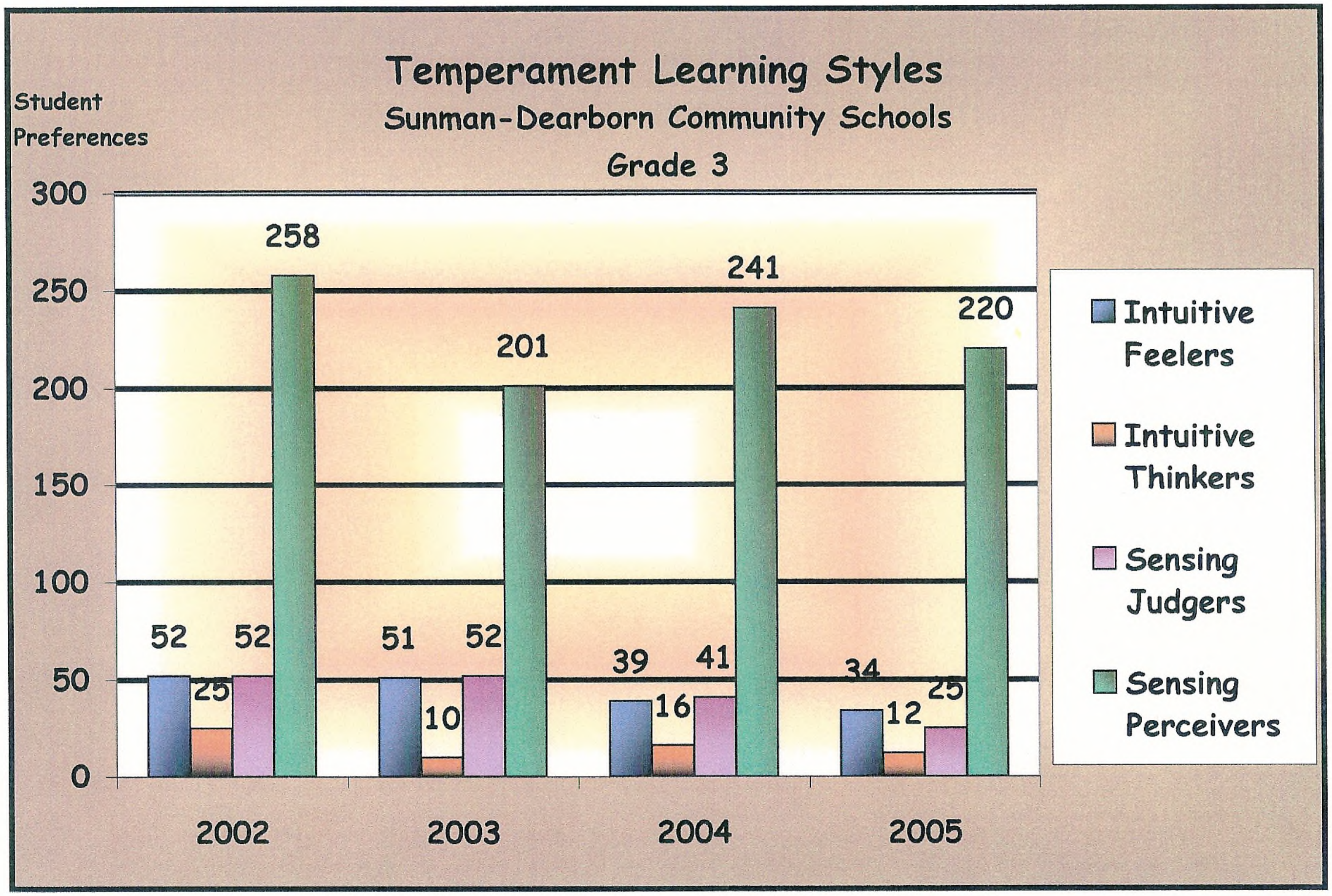

Perceptual/Organizational Learning Styles
Sunman-Dearborn Community Schools
Grade 3
Student Preferences
250
200
150
100
50
0
200
54
65
70
163
75
52
55
176
73
57
49
165
33
58
56
2002
2003
2004
2005
Concrete Sequential
Concrete Global
Abstract Global
Abstract Sequential

Figure 2



Temperament Learning Styles
Sunman-Dearborn Community Schools
Grade 3
Student Preferences
300
250
200
150
100
50
0
52
25
52
258
51
10
52
201
39
16
41
241
34
12
25
220
2002
2003
2004
2005
Intuitive Feelers
Intuitive Thinkers
Sensing Judgers
Sensing Perceivers

Figure 3