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The Middle Grade Teachers' Beliefs about Teaching Problem Solving

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This study pilot tested a researcher-designed instrument based on National Council of Teachers of Mathematics' problem solving standard and middle school teachers' beliefs about teaching problem solving. One hundred twenty four teachers' responses were analyzed. The instrument was validated and found to be reliable. The study found that females and males have significantly different beliefs about teaching problem solving. Age of the teacher did not appear to affect the teaching of problem solving.

Key Words : Teachers' beliefs, Teaching problem solving, NCTM standards, Teaching experience, Cronbach alpha, t-test.

I. Introduction

In the field of education it has become increasingly more important to stress higher order thinking. Educators at every level, of every philosophical persuasion, and from diverse backgrounds all agree that it is important to teach their students to think, although they may differ about the way in which this goal is to be accomplished (Greenfield, 1987). The skills that students obtain when using higher order thinking carry over into everyday situations.

Problem solving in a mathematical setting is a prime example of higher order thinking. Problem solving has been a primary goal of all mathematics instruction and an integral part of mathematics activities since the National Council of Teachers of Mathematics (NCTM, 1989) stated that problem solving should be the central focus of the mathematics curriculum. For many, teaching thinking is equivalent to teaching problem solving. Schoenfeld (1983) recommends that the primary responsibility of mathematics teachers is to teach their students to think, question, and probe.

In spite of the importance of problem solving, Drum (1984) claims that teaching problem solving is not encouraged in teacher education programs or in their in-service

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sessions. From the study, Drum found that teachers who teach problem solving in their classrooms tend to be older in age. Despite the existence of positive teacher opinions regarding the importance of teaching problem solving, few of them emphasize problem solving in their classrooms.

Teachers' beliefs about teaching profoundly and subtly influence their behavior (Bush, Lamb, & Alsina, 1990; Kesler, 1985; Koehler & Grouws, 1992; Silver, 1985). Researchers (Clark & Peterson, 1986) suggest a model for teacher beliefs indicating that teachers' behaviors are greatly influenced by their thought processes. Their beliefs about student behavior and their beliefs about teaching and learning affect their actions, which, in turn, affect student behavior and achievement. The research suggests that an important relationship exists between teachers' beliefs and teachers' behavior. With this background in mind, a wide acceptance of the NCTM standards depends on teachers' beliefs. These beliefs are often associated with their demographic backgrounds in age, gender, years of teaching and membership in professional development groups. Investigating the relationship between teachers' beliefs about teaching problem solving in relationship to their demographic backgrounds is meaningful for helping those who wish to design and incorporate qualitative case studies in professional development programs (Merseth, 1996). The result can be used to emphasize some program in professional development program, and to consider what age teachers have to be more considered to be educated about standards and how often teachers have to be educated. When teachers' beliefs are not match with standards, teachers have to reconsider their beliefs about their problem solving teaching.

II. Literature review

1. Problem Solving Terminology

In daily life and in the workplace, being able to solve problems is a definite advantage. Problem solving has been considered by many mathematics educators and researchers (Goldin, 1982; Mayer, 1982; Schoenfeld, 1982, 1985). While definitions of problem solving abound, in this study, the definition of problem solving was adopted from NCTM standards (2000). Basically, problem solving is described as engaging in a task for which the solution method is not known in advance. NCTM further clarifies in the problem solving standard that instructional programs should enable all students to

- build new mathematical knowledge through problem solving;
- solve problems that arise in mathematics and in other contexts;
- apply and adapt a variety of appropriate strategies to solve problems;
- monitor and reflect on the process of mathematical problem solving. (NCTM, 2000, p. 52)

2. Teachers' Beliefs and Behavior

A number of studies in mathematics education have indicated that teachers' beliefs about teaching influence their practices in the classroom and their practices influence students' achievement (Bush, Lamb, & Alsina, 1990; Kesler, 1985; Koehler & Grouws, 1992; Silver, 1985; Thompson, 1984). Furthermore, research has shown that an important relationship exists between teachers' beliefs and their behavior. Thompson (1984) found that teachers' conceptions are not related in a simple way to their instructional decisions and behavior. However, their conceptions appear to play a signigicant role in affecting their instructional decisions and behavior. Also, Kesler (1985) found that teacher's conceptions of teaching and mathematics are related to their instructional behavior.

With the idea that teachers' instructional behavior is influenced by their beliefs about teaching mathematics, researchers investigated the relationship between teachers' beliefs about problem solving and their classroom behaviors. Anderson (1998) studied teachers' problem solving beliefs and practices in K-6 mathematics classrooms with 174 classroom teachers using a researcher-designed questionnaire, interviews, and classroom observations. Gathered from open-ended questions, teachers' beliefs were found to be diverse with some teachers reporting using many of the teaching strategies that literature claimed as promoting effective learning in mathematics. Ford (1994) found a relationship between teachers' beliefs about mathematics and their teaching and students' learning. According to Ford, teachers' beliefs are important to the practice of teaching problem solving, and their beliefs affect the quality of instruction related to mathematical problem solving. Also, Zambo (1994) studied teachers' beliefs and practices in teaching mathematics problem solving. Based on 29 elementary school districts in Arizona, 744 kindergarten through eighth grade teachers agreed with NCTM's recommendations about mathematics problem solving.

However, with all these research studies, the instruments were not based on the more recent NCTM standards (2000). In order to further assess the relationship of teachers' beliefs about problem solving to their practices, an instrument needs to be developed based on the new standards.

3. Correlation Between Teachers' Beliefs and Demographic Backgrounds

Zambo and Hong (1996) examined Korean and American teachers' beliefs about mathematics problem solving. Korean teachers' and American teachers' beliefs differed because of systematic and cultural differences. Thus, teachers' demographic backgrounds appeared to make a difference in their beliefs about problem solving.

Li (1999) identified gender differences in teachers' beliefs about mathematics in his qualitative research. Male and female teachers differed in their beliefs about the importance of mathematics.

While many techniques for teaching problem solving exist, a relationship between teachers' beliefs about teaching problem solving may be related to their demographic background according to Drum's study (1984). Drum studied teachers' opinions and practices regarding the teaching of problem solving skills. He found significant differences in beliefs for teaching problem solving that correlated with differences in age, gender, years of teaching, and membership in professional development groups. The older the teachers, the more they tended to teach problem solving. Female teachers seemed to place more of an emphasis on teaching problem solving than males. The greater the number of years of teaching experience, the more the teacher tends to teach problem solving. Teachers belonging to professional associations tended to teach problem solving more often.

From this research, the question about the correlation between teachers' beliefs about teaching problem solving and their demographic backgrounds emerged. Therefore, a survey of teachers' demographic backgrounds was designed similar to that of Drum's study (1984) to accompany the proposed beliefs instrument; the backgrounds for consideration included the affect of culture, gender, years of teaching, and membership of professional development groups.

4. Teachers' Beliefs and NCTM Standards

As a response to significant concerns about the mathematics education in America, NCTM developed and revised its national reform recommendations in mathematics education in 1989 in its new standards (2000). Both documents presented NCTM's vision of how mathematics should be taught and evaluated in grade K-12. A key feature in both of these sets of standards has been a focus on problem solving. Essentially, teachers are expected to teach problem solving in a manner described by NCTM's recommendations. But, as researchers suggest, teachers' beliefs can affect their behavior in the classroom. In essence then, a wide acceptance of NCTM's problem solving standard depends on teachers' beliefs about problem solving. If teachers are to implement the tenants in the problem solving standard and if their beliefs direct their actions in the classroom, an investigation of whether their beliefs are consistent with NCTM's standard for teaching problem solving is an important step.

Zollman and Mason (1992) developed a Standards' Beliefs Instrument (SBI) to assess teachers' beliefs about the NCTM 1989 Standards. Items for the SBI were randomly chosen from several levels as representative of the 1989 Standards using three criteria - intuitively not obvious, clearly stated in a positive or negative manner, and a single sentence with a central idea. The instrument was pilot- tested and revised with the aid of 15 teachers familiar with the Standards. The final instrument with 16 items was tested for construct validity using a panel of 17 expert mathematics educators.

Since the instrument was based on the 1989 Standards, the items were not directly representative of the 2000 Standards. In order to assess whether teachers' beliefs are consistent with NCTM's current problem solving standards, a new instrument needs to be developed. However, the items from the SBI instrument provided a guideline for the development of a new instrument based on the 2000 NCTM standards.

III. Research design

The purpose of this study was to design an instrument based on the NCTM's 2000 Standards and also investigate middle school (grades 6-8) teachers' beliefs about teaching problem solving. The middle grades were selected because those grades are typically focused on teaching problem solving along with other mathematics content. This study relied on the following guiding questions:

1) Does the new instrument adequately investigate teachers' beliefs about teaching problem solving?
2) What is the correlation between teachers' beliefs about teaching problem solving and their demographic backgrounds?
3) Are teachers' beliefs consistent with NCTM's instructional problem solving standards in the 2000 version?

1. Instrument Development

The questionnaire for this study was based on the NCTM 2000 Standards with some items included from the previous instrument (where the items were deemed to be consistent with the 2000 Standards). To assure the clarity of the items, the questionnaire was distributed to pre-service mathematics teachers. The instrument was revised based on the responses.

The final questionnaire contained five subscales with the following descriptions:

A. Student's learning through problem solving (4items): Through problem solving, students can experience the power and utility of mathematics. Students can learn about, and deepen their understanding of, mathematical concepts. Also they build new mathematical knowledge through problem solving. Problem solving promotes students' mathematical learning.

B. Student's communication (2items): In classrooms where students are challenged to think and reason about mathematics, communication is an essential feature as students express the results of their thinking orally and in writing. Students communicate their mathematical thinking coherently and clearly to peers, teachers, and others.

C. Teacher's misconception about teaching problem solving (8items): From Zambo (1994) study, negatively stated items about teachers' beliefs about problem solving were included. Teachers sometimes have beliefs about teaching problem solving that are not in concert with ideas expressed in the standards.

D. Using technology (3items): Many researchers emphasized that technologies are useful for problem solving in grade 6 through 8. Technologies include computers, scientific or graphing calculators, and Internet connections.

E. Teacher's role (5items): Teacher's role in developing problem solving in grade 6 through 8 is crucial. They have to choose interesting problems that incorporate important mathematical ideas from the curriculum. The 2000 NCTM Standards for grade 6 through 8 identified many of the roles of teachers.

The initial set of items consisted of 22 positively and negatively worded items for which the coding was inverted so that in the analysis all the items were scored in the same direction. Because the number of items in the different subscales was mixed, a codebook was created. For the purpose of this study, the questionnaire used a Likert-type, 5-point response scale from strongly agree (5) to strongly disagree (1) to gauge the teachers' beliefs about teaching problem solving. One open-ended question was added to identify these teachers' concept of problem solving. Additional items addressed demographic data about the teachers.

The survey was reviewed for content and construct validity by two expert mathematics educators. To avoid item ambiguity, the instrument was reviewed by five pre-service teachers and five doctorate students. The final survey questionnaire is provided in the Appendix.

2. Participant Selection

Middle school mathematics teachers were randomly selected to participate in the project. Potential respondents were identified from teacher lists found on numerous school websites in Oregon, USA. Among the 87 Oregon middle schools, 168 middle school mathematics teachers were identified. From this pool, 150 mathematics teachers were randomly selected to respond to the survey questionnaire by mail. A total of 127 teachers (42 male, 85 female) responded to the survey.

3. Data Collection

A single mailing contained a cover letter, the survey questionnaire, and a return envelope. Data collection took place during the fifth and seventh weeks of spring term. The survey took approximately 30 minutes to complete. Follow up or reminder messages were not sent to non-respondents. A total of 127 surveys were returned to the researcher.

4. Data Analysis

Teachers' responses to the items were analyzed for reliability. The internal consistency of each subscale was calculated using Cronbach alpha. The scale for each item in the questionnaire was numerically categorized. The correlation between teachers' beliefs and their demographic backgrounds was analyzed using the simple t-test. The t-test for significant differences was performed to determine whether there is a significant difference between the variables of age, gender, years of teaching experience in mathematics, degree status, and membership in professional development organizations. Also, mean scores were used to check whether teachers' beliefs were consistent with NCTM's instructional problem solving standard.

IV. Results

One hundred twenty seven middle school teachers responded to the survey. Three teachers' responses were dropped due to incomplete responses. The 124 teachers' responses were analyzed using a reliability procedure for inter-item correlation and the internal consistency reliability (Cronbach's alpha) for each scale after a given item was removed. The delineation of the items continued until an internal reliability (Cronbach's alpha) higher than 0.75 (considered acceptable) was achieved or the delineation was conducted until only two items remained, "student's communication" and "using technology," resulting in Cronbach's alphas still below 0.75. Otherwise, for each of the scales, inter-item statistics indicated improvement with deletion of items.

There are 9 tables that consist of two parts. Each tables represent Inter-item correlation matrix in student learning; Inter-item correlation matrix in teacher's misconception; inter-item correlation matrix in using technology; Inter-item correlation matrix in teacher's role; Means, standard deviation, number of items, and reliabilities; Middle school teachers' beliefs about teaching problem solving items; Comparison of 'teacher misconception' by gender; and Comparison of students' learning with teachers' age. The first part (table 1 to table 7) is the procedure of item selection and checking reliability and validity. The second part (table 8 and table 9) is the correlation of teachers' beliefs and their demographic background.

The inter-item correlation matrix for the four items on student learning, described in Table 1, shows that two items (interest 17 and major 13) had a low correlation with other items. Factor analysis identified these items as not being related to the other items. Upon reflection on these items, they were viewed as not related to student learning. Actually item 13 (problem solving should be the major emphasis of mathematics instruction) and 17 (problems in middle grades should engage students' interest) were not related to student learning. They were different questions. After they were simply deleted, the reliability Cronbach's alpha was .830. After all, two items, 1 (problem solving promotes mathematical learning) and 2 (well-chosen problems can be valuable in developing students' understanding of important mathematical ideas), were selected in 'Student Learning' scale (A). This method was used with other scales.

Table 1. Inter-Item Correlation Matrix in Student Learning

	promote1	wellcho2	major13	interest17
promote1	1.000			
wellcho2	.747	1.000		
major13	.009	.072	1.000	
interest17	.336	.258	-.028	1.000

Table 2 shows that two items, explain3 (students should explain how they solved a problem) and defend5 (students should be asked to defend their reasoning and answers in problem solving) were correlated at Cronbachs' alpha .725. Student's communication is the one of important strategies in problem solving. Through communication, students learn more to contemplate the concept being communicated. NCTM clearly explains what students need to communicate in problem solving. Students should explain their solution strategies and defend their reasoning and answers in problem solving. Although Cronbach's alpha was below .75, it was considered acceptable and the two items were considered necessary in identifying teachers' beliefs about teaching problem solving in student's communication.

Table 2. Inter-Item Correlation Matrix in Student's Communication

	explain3	Defend5
explain3	1.000	
defend5	.589	1.000

In Table 3, items right9 (students need to be given the right answer to all of the problems they work) and hearing10 (hearing different ways to solve the same problem confuses students) were lowly correlated with other items. They were deleted. Also to increase Cronbach's alpha item howto6 (it is better to tell students how to solve problems than to let them discover how to solve the problems on their own) was deleted too. After deletion of three items, the Cronbach's alpha was .781 which was considered acceptable. With this change, the subscale of 'teacher's misconception' contained only two items (bestway 7 and correct 8).

As shown in Table 4, the item called calculat14 (calculators are an important tool for solving "messy," complex problems) was lowly correlated with the other items. Actually the item asked about technology but the inter-item correlation showed low correlation. Using a calculator, not a graphing calculator, may have a different meaning for the middle school mathematics teachers. Item calculat14 was deleted too. Although item calculate14 was deleted, Cronbach's alpha remained lower than .75 (.674) with two items internet15 and graphing16.

Table 3. Inter-Item Correlation Matrix in Teacher's Misconception

	howto6	bestway7	correct8	right9	hearing10
howto6	1.000				
bestway7	.394	1.000			
correct8	.541	.664	1.000		
right9	.076	.352	.181	1.000	
hearing10	.113	-.073	.000	-.068	1.000

Table 4. Inter-Item Correlation Matrix in Using Technology

	calculat14	internet15	graohing16
calculat14	1.000		
internet15	.014	1.000	
graphing16	.358	.508	1.000

From Table 5, the items ways4 (teachers should ask students to solve problems in more than one way), ask11 (teachers should regularly ask students to formulate problems that arise in mathematics as well as in other context), and opport12 (teachers should give students frequent opportunities to explain their problem solving strategies) were not highly correlated with the other items. With these items deleted, Cronbach's alpha was .809 for the 'Teacher's role' sub-scale.

Table 5. Inter-Item Correlation Matrix in Teacher's Role

	ways4	ask11	opport12	diccuss18	create19	gormul20	reflect21	monitor22
ways4	1.000							
ask11	-.121	1.000						
opport12	.177	.000	1.000					
diccuss18	.147	-.127	.647	1.000				
create19	.141	.212	-.100	.046	1.000			
gormul20	.146	.467	.471	.392	.375	1.000		
reflect21	.016	-.167	.365	.388	.127	.280	1.000	
monitor22	.069	-.060	.488	.370	.223	.437	.748	1.000

After delineation of these items, means, standard deviations, number of items and internal reliabilities (Cronbach's alpha) of the scales were described in Table 6. The items in 'Students' learning' items mean score was 4.7 (very strongly agree). The items in 'Students' communication' had a mean score of 4.5. 'Teacher's misconception' items were 3.7, 'Using technology' items were 3.4 and 'Teacher's role' was 4.4. Correlations among the five sub-scales were all non-significant at the $p<.05$ level.

Table 6. Means, Standard Deviation, Number of Items, and Reliabilities (Cronbach's alpha) (n=124)

Scale	N of Items	Mean	S.D.	Cronbach's α
A. Student's learning	2	4.694	.941	.830
B. Student's communication	2	4.500	1.044	.725
C. Teacher's misconception	2	3.718	1.674	.781
D. Using technology	2	3.435	1.392	.674
E. Teacher's role	5	4.403	1.812	.809

From 22 items, 13 items were selected as final items shown in Table 7. These items were found to be reliable in the pilot test.

Table 7. Middle School Teachers' Beliefs about Teaching Problem Solving

Item number	Item	Scale
1	Problem solving promotes mathematical learning.	A
2	Well-chosen problems can be valuable in developing students' understanding of important mathematical ideas.	A
3	Students should explain how they solved a problem.	B
5	Students should be asked to defend their reasoning and answers in problem solving.	B
7	Teachers should tell students the best way to solve different types of problems.	C
8	Getting the correct answer should be the main focus of problem solving in middle school.	C
12	Teachers should give students frequent opportunities to explain their problem solving strategies.	E
15	Internet connections are useful in solving a wide variety problem.	D
16	Graphing calculators and easy-to-use computer software enable students to move between different representations of data useful in problem solving.	D
18	Teachers should engage students in discussing useful problem solving strategies.	E
20	Teachers should give students opportunities to formulate	E

	problems from given situations.	
21	Teachers should engage students in looking back over their solutions, reflecting on the solution and their solution process.	E
22	Teachers should encourage students to monitor and assess their own problem solving strategies.	E

Pearson Correlation Matrix showed a significant correlation (2-tailed level .05) between gender and teacher's misconception and between teachers' age and belief in student learning. After checking the significance, the difference was checked by comparing the means in t-test.

Table 8. Comparison of 'Teacher Misconception' by Gender

gender1	Mean	N	Std. Deviation
0 (male)	3.2682	41	1.81
1 (female)	4.1204	83	1.36
Total	3.8387	124	1.67

From Table 8, 0 (male) and 1 (female) mean score is highly different (<.05). From the result, female teachers disagreed with two statements (teachers should tell students the best way to solve different types of problems; getting the correct answer should be the main focus of problem solving in middle school) as inconsistent with the NCTM standards. Male teachers were undecided about the two questions.

As shown in Table 9, the older in age teachers are, the more they agree in 'students' learning' sub-scale. However, most of teachers strongly agreed with students' learning about problem solving.

Table 9. Comparison of students' learning with teachers' age

age2	Mean	N	Std. Deviation
1 (20s')	4.3000	30	.89
2 (30s')	4.5200	25	1.73
3 (40s')	4.9166	36	.40
4 (50s')	4.8182	33	.70
Total	4.6612	124	.94

V. Conclusion

Middle school teachers' beliefs about teaching problem solving in mathematics with respect to the 2000 NCTM standards needs to be examined in any reform of mathematics education. But an up-to-date instrument was needed and so was developed in this study. The question remains as to the adequacy of the instrument for investigating teachers' beliefs about teaching problem solving.

The study have analyzed that among the 22 items, 13 items might be used to further investigate teachers' beliefs about teaching problem solving. For the investigation of teachers' beliefs about teaching problem solving, those 13 items were reasonable in terms of reliability, inter-item reliability, and predict closely to the teachers beliefs about mathematical problem solving.

The study reported that older teachers had stronger beliefs than younger ones especially age 40s' teachers have strongest beliefs in problem solving. 40s' teachers are more likely to take into consideration of the NCTM 2000 standards. Because the years of teaching experience were not correlated with their teaching problem solving, this result may suggest that the older teachers' beliefs were more influenced by their experience in teaching problem solving since they have been taught mathematics longer more than the younger teachers.

There were no significant differences (<.05) in their teaching experience, degree held, professional development undertaken, and in-service teacher program involvement. These results differ from Drum's study (1984). The small sample size might not show the significant difference.

Teachers may know a lot about NCTM standards or they may have experience in their life because their course work, professional development, professional association, and degree were not factors influencing their beliefs. Only gender and age factors related to student learning and misconceptions. If their teaching were the factor influencing their beliefs, their beliefs would be influenced by their experience in classroom teaching. Thus life experiences were more influential in teaching problem solving and consistent with NCTM standards.

Implications and limitations

The similar study can be conducted in Korea. The interesting finding was that older teachers' age was related to commitment to teaching problem solving. Teachers' beliefs are changing and their practice too. This study is just beginning to investigate the teachers' beliefs about teaching problem solving with new NCTM standards. It will be meaningful to investigate Korean teachers' beliefs about teaching problem solving based on national standards.

This project was completed in one term. Time was the biggest limitation for this project. Design, instrument development, human subject approval, distribution of the survey, data collection, and data analysis were conducted in this one term. Because of the time limitation, the researcher did not send encourage mail out to respond the survey. Urge. If time is enough, the respond rate will be higher. Another limitation was the population. The subjects were identified on the Internet bounded by the Oregon geography. Only 150 teachers were invited to take part in the. study. The population can be the American Middle school mathematics teachers. Even other country middle school teachers can be the population. Also the researcher alone designed the subscale so the construct validity of subscale in survey was limited. The construct validity in making subscale could be increased with more attention.

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문제 해결 교수에 대한 중학교 수학 교사들의 신념

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초 록

이 논문은 전미교사협회에서 제시한 수학의 문제 해결에 대한 기준과 문제 해결 교수에 관한 중학교 수학 교사들의 신념에 대하여 연구자가 직접 디자인한 설문을 시험한 연구이다. 이 설문은 타당도가 검증되었으며 신뢰도가 있음이 판명되었다. 이 설문에 응답한 중학교 수학 교사 124명의 설문에 대한 반응을 분석하였다. 여교사와 남교사는 문제 해결 교수에 대하여 유의미하게 다른 신념을 가지고 있음이 밝혀졌다. 교사들의 나이는 문제 해결 교수 전략에 대한 신념에 영향을 미치지 않음이 나타났다.

주요용어 : 교사의 신념, 문제해결, 교수경험, t-테스트, NCTM 기준.

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Appendix

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Number	Item	Scale
1	Problem solving promotes mathematical learning.	A
2	Well-chosen problems can be valuable in developing students' understanding of important mathematical ideas.	A
3	Students should explain how they solved a problem.	B
4	Teachers should ask students to solve problems in more than one way.	E
5	Students should be asked to defend their reasoning and answers in problem solving.	B
6	It is better to tell students how to solve problems than to let them discover how to solve the problems on their own.	C
7	Teachers should tell students the best way to solve different types of problems.	C
8	Getting the correct answer should be the main focus of problem solving in middle school.	C
9	Students need to be given the right answer to all of the problems they work.	C
10	Hearing different ways to solve the same problem confuses students.	C
11	Teachers should regularly ask students to formulate problems that arise in mathematics as well as in other contexts.	E
12	Teachers should give students frequent opportunities to explain their problem solving strategies.	E
13	Problem solving should be the major emphasis of mathematics instruction.	A
14	Calculators are an important tool for solving "messy," complex problems.	D
15	Internet connections are useful in solving wide variety problems.	D
16	Graphing calculators and easy-to-use computer software enable students to move between different representations of data useful in problem solving.	D
17	Problems in middle grades should engage students' interest.	A
18	Teachers should engage students in discussing useful problem solving strategies.	E
19	Students should be allowed to choose or create some problems to be solved.	E
20	Teachers should give students opportunities to formulate problems from given situations.	E
21	Teachers should engage students in looking back over their solutions, reflecting on the solution and their solution process.	E
22	Teachers should encourage students to monitor and assess their own problem solving strategies.	E