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Teachers' Perception Toward Mathematics Teaching Innovation in Indonesian Junior High School: An Exploratory Factor Analysis

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A questionnaire was developed based on a number of themes, such as the ideas to distinguish between mathematics teacher society that have an orientation to traditional teaching approaches and those which have an innovative orientation. The results of the study indicated that by using statistical factor analysis, 31 items were reduced to be three main dimensions. Based on the construct factors, those dimensions can be identified as constructivist teaching, traditional teaching, and constructivist learning factors. The dimensions are constructed by using the factor similarity. As a consequences, a recommendation to conduct a special training on the realistic mathematics teaching approach as part of professional development program (PD) is needed. Prior to the PD session, the teachers were asked their perception toward innovation of mathematics instruction.

Key words: innovation, junior secondary school, realistic mathematic education

Innovation in education is a lever of change which is usually conducted by innovators. In mathematics education in particular, innovators are always offering unusual ideas. They are designing and trying out the program repeatedly to get information about the effectiveness of the programs of new teaching approaches.

Regarding the linking of teaching and professional development programs, Farmer, Gerretson, and Lassak (2003) noted that, "one of the two core premises from the Glenn report (US Dept of Education, 2000) is that better teaching is the lever for change and effective professional development is the indispensable foundation for high quality teaching" (p. 331).

Roger (1983) classified people as innovators, the big majority, and the followers. In order to introduce a new idea, groups of innovators and unresistant groups of people were needed tointroduce innovations into the current situation. Therefore exploring their perception toward teaching innovations of mathematics is a necessity.

To discuss teachers' perception toward teaching innovation, I need to explore the the idea of educational reforms in Indonesia. Innovations in mathematics education in Indonesia constitute an integral part of its educational system. Some innovations which particularly focus on the teaching and learning of mathematics that can be used as models have been developed by proponents or educators (De Lange, 2000; Gravemeijer,2000a; Lewis, 2000; Miller & Hunt,1994; Romberg, 1992; Stein, Silver & Smith,1998; Wood & Berry, 2003). Learning and teaching strategies which challenge students to learn mathematics need to be tested and monitored to yield the best and the most effective ways to learn and teach. This can be done by using "design research" (Wood & Berry, 2003), "development of new instructional techniques or program" (Romberg, 1992), "developmental research"(De Lange, 2000; Gravemeijer, 2000a), "collaborative learning experience in action research" (Miller & Hunt, 1994), "Japanese Lesson Studies" (Lewis, 2000), or "reflective practice groups and communities of practice" (Stein et al., 1998).

All these types of innovations are guided by the strategies advocated by Curriculum and Evaluation Standards for school mathematics (NCTM, 1989), Professional Standard for Teaching Mathematics (NCTM, 1991), Assessment Standards for School Mathematics (NCTM, 1995), Open-ended Approaches (Becker & Shimada, 1997), and the Australian Statement for School Mathematics (AEC, 1991).

However, current mathematics teaching in Indonesia still emphasizes traditional teacher-centered instruction. As stated by Zamroni (2000), Indonesian education orientation has traditionally been characterized by several points, namely, a tendency to treat students as objects, put the teachers as the highest authority holder, present courses as subject-oriented, and place management as centralized. As a consequence, educational practice is isolated from real life, with no relevance between what is taught and what is needed in the market place. It needs a stronger focus on the intellectual development of the students. In contrast, the new paradigm of education focuses on learning rather than teaching. Education is organized in a more flexible structure, the learners are treated as individuals with certain characteristics, and education is a continuous process and interacts with the environment (Zamroni, 2000).

Introducing a new teaching approach requires research to monitor and validate it. Regarding mathematical competence as an instructional goal, there is a common agreement that the final goal of student learning is the acquisition of a mathematical disposition rather than an accumulation of isolated concepts and skills. Accordingly, the way students acquire mathematical knowledge and skills should be re-organized. It must involve students in active learning (Verschaffel & De Corte, 1996). The international trend noted above leads to many new approaches for the teaching and learning of mathematics, such as realistic mathematics (De Lange, 1996), open-ended approaches (Becker&Shimada,1997), and problem solving (NCTM, 2000; Silver,1989).

This study takes as its central focus the realistic mathematics approach to education (RME). RME is a teaching and learning approach to mathematics based on problems taken from day-to-day experience rather than on abstract rules (De Lange, 2000). As this paper is part of my research thesis which focuses on the implementation of the RME in Indonesia, prior to the implementation stages, it needs to ask the teachers their perception is towards the teaching innovations of mathematics, whether they welcome the new idea of teaching mathematics. A number of questions were asked for the teachers in order to know the teaching atmosphere, their custom in teaching mathematics, their ability to encourage students' learning, their comments on students' thinking, their ability to encourage students to explain their strategies to solve mathematical problems, or whether the teachers instantly answer the students' questions. Overall to know whether the current teaching is in the corridor of innovation, or if teaching is still done in the conventional way.

Several small studies were conducted to investigate the effect of the RME approach on the students' attitude toward mathematics (Turmudi, 2001; Turmudi & Dasari, 2001; Turmudi & Sabandar, 2002). These were case studies, with data gathered by interviewing and observing the learners and teachers in the classroom. The results indicated that the students were motivated to learn more about mathematics, and the students also responded to the teaching strategies used by the teachers.

Though the case studies showed promise for improvement and innovation in mathematics education, I realize that mathematics teaching in Indonesia is still in a traditional perspective as mentioned by Hinduan, Hidayat and Firman (1995), Djojonegoro (1995), Somerset (1996) and Suryanto (1996). This situation is relevant to the statement of Silver (1989), Romberg and Kaput (1999), Senk and Thompson (2003), and Ernest (2004). However, research data explaining the current situation is not available yet, therefore one focus of the study is to explore the teachers' perception toward teaching innovations of mathematics in Indonesia.

Conceptual Framework

In the more traditional views, mathematics is perceived, by most people, as a fixed, static body of knowledge (Romberg & Kaput, 1999), and the corresponding teaching approach is viewed as a careful sequencing of tasks designed to enable students to accumulate bits of knowledge by drills on number facts and computations (Senk & Thompson, 2003). Manipulating numbers and algebraic symbols mechanically and giving proofs of axiomatic geometry are also characteristic of this approach. How students obtain mathematical knowledge in the traditional teaching approach has been called the 'copy method' by Koseki (1999). However, students who memorize facts or procedures without understanding are often not sure when or how to use what they know and such learning is often quite fragile (Bransford, Brown, & Cocking, 1999).

This traditional view of mathematics can also constrain the scope of the mathematical content and pedagogy covered by the curriculum. Romberg and Kaput (1999) described traditional mathematics classes as mostly consisting of three segments:

…an initial segment where the previous day's work is corrected. Next, the teacher presents new material, often working one or two new problems followed by a few students working similar problems at the chalkboard. The final segment involves students working on an assignment for the following day. (p.4)

Regarding the textbooks used in the traditional mathematics classroom, Senk and Thompson (2003) conclude, "each topic was usually introduced by stating a rule followed by an example of how to apply the rule; then a set of exercises was given" (p.5). Ernest (2004) critiqued the traditional class as follows, "the classroom tasks instruct learners to carry out certain symbolic procedures; to do, but not to think; to become automatons, not independent exercisers of critical judgment" (p.12). Similarly, Silver (1989) has argued that "daily activity for most students in mathematics classes consists of watching a teacher work problems at the board and then working alone on traditional problems provided by the textbooks or by a worksheet" (p.280). Activities in the traditional classroom often involve students copying what the teacher has demonstrated. Moreover, most students in the traditional framework "view mathematics as consisting mainly of memorizing rules, and fail to view that it is a creative activity" (Brown, Carpenter, Kouba, Lindquist, Silver & Swafford, 1988).

Despite the introduction of some innovative programs and practices described in the previous section, this traditional pattern of teaching mathematics is still common in Indonesian classrooms (Somerset, 1996; Suryanto, 1996).

Wardiman Djojonegoro, a former Minister of Education and Culture in the Republic of Indonesia in the era of the 1990s stated, at the opening ceremony of the International Seminar in Mathematics and Science (Djojonegoro 1995):

Most schools and teachers treat students as a 'vessel', something to be filled with knowledge… Another well-known example is the tendency towards right-answer/ fact-based learning. School and teachers focus on getting the right answer from the students at the cost of developing the processes that generate the answer. As a result, students resort frequently to superficial accomplishments. Rote learning falls into this category. (p. 36)

Throughout the more recent mathematics education research literature, there have been expressions of growing dissatisfaction with the limitations of the traditionally formal ways of teaching mathematics. For example, Lappan (1999, cited in Senk and Thompson, 2003, p.16) argued "We've had the longest running experiment in human history about whether rote memorization of facts and skills works. And it doesn't. Students are coming to universities and into the work place not understanding mathematics. Why wouldn't I want to try something new?"

Willingness to reform mathematics teaching was not only advocated by the President of the NCTM at that time (Lappan, 1999), but was also favoured by Djojonegoro (1995), who argued as follows:

I would like to challenge you to create greater understanding on how students learn as prerequisite for improving our teaching methods in mathematics and science, and improving the education of teachers for these subjects. (p.36)

The above quotation suggests that, according to the former Minister, students have rarely been given the opportunity to experience the intellectual excitement of generative mathematics inquiry.

Through the 'MGMP' the teachers are expected to discuss many of the teaching problems they face and are shown new teaching methods, books, and classroom management strategies. However, most of the professional development activities in mathematics teacher associations (PKG or MGMP) are more content knowledge oriented. Coribima (1999) adds that "Not many of the results of professional development or any other innovation are implemented as routine activities for the next steps… The results of professional development or innovation are mostly communicated through answer to questionnaires, interviews, and surveys" (p.77). This phenomenon indicates that an innovation through professional development (seminar, training, workshop) encountered sustainability problems.

Mathematics Education Reform

Mathematics teaching innovation tends to deal with three things: how to perceive mathematics, how to teach mathematics and how to assess mathematical understanding. There has been persistent criticism of previous views of mathematics in which mathematics was perceived as a fixed and static body of knowledge (Romberg & Kaput, 1999), as formal systems, rules, and procedures (Clarke, Clarke, & Sullivan, 1996), or as a large collection of concepts and skills to be mastered (Verschaffel & De Corte, 1996). Advocated instead is a view of mathematics as a dynamic subject, as a human activity (Freudenthal, 1991; Romberg & Kaput, 1999), as a human-sense and problem solving activity (Verschaffel & De Corte, 1996).

These innovative views also influence how teachers approach mathematics teaching and how they assess students' mathematics learning. This includes dealing with students' questions related to mathematical ideas, introducing mathematical concepts, encouraging and promoting discussion and cooperative group work, feeling dissatisfied with the current teaching approach, keeping up-to-date with the publications of a new movement in mathematics instruction, and assessing students' understanding of mathematics.

Constructivist Movement in Teaching

An important principle in the reform movement of teaching is constructivism. As is true of many ideas in education, the term 'constructivism' has developed different meanings for different people. According to Killen (2003) this term was originally used to describe a theory of learning. Recently it has become more associated with the theory that, "the world is inherently complex, that there is no objective reality, and that much of what we know is constructed from our beliefs and the social milieu in which we live" (Borich & Tombari, 1997, p. 177). According to this notion, knowledge is actively constructed by the cognizing subject and not passively received from the environment (Kilpatrick, 1987).

Constructivism has become relevant as a first principle of learning in mathematics. Wood, Cobb, and Yackel (1995) have argued that mathematics should not be viewed as objective knowledge. Instead, it is perceived as an active construction by an individual that is shared with others (p.405). Yackel, Cobb, and Wood (1992) further argue that in a constructivist perspective, assessment is an integral part of both development work and the teacher's instructional activity, not separate components that can be discussed in isolation. Mathematics is seen as both an interactive and a constructive activity. In brief, constructivism can be defined as an approach to learning in which learners are provided the opportunity to construct their own sense of what is being learned by building internal connection to or relation among the ideas and facts being taught.

Questioning—Treating Students' Questions

New understandings of the ways in which students learn mathematics play a key role in the new reform of mathematics. Educational findings from cognitive psychology and mathematics education indicate that optimum learning occurs as students actively assimilate new information and experience and construct their own meaning (NCTM, 1991). This is an important shift from learning mathematics as the accumulation of facts and procedures to mathematics as an integrated set of intellectual tools for making sense of mathematical situations (NCTM, 1991; Resnick, 1987). Changing to this perspective requires teachers to be able to shape instructional activities to improve their students' mathematical understanding within the new perspective. Hence the teachers' professional skills need to be improved continuously. How teachers respond to students' questions either in the classroom or outside the classroom is also an important consideration.

Some teachers, overly concerned with completing a set curriculum targets within a specified timeframe may respond instantly to the students' questions, possibly because the teacher thinks that the instant response will be effective and accelerate the teaching and learning process. Furthermore, teachers may encourage short answers and accept only responses that are correct and accurate. However, if that happens persistently, then learning may come to be regarded as no more than an accumulation of facts and procedures. As argued in the NCTM (1991) document, too often an 'unexpected response' elicits a negative response from the teacher. But such a response may hinder students' creativity. Instead, teachers should be encouraged to ask probing questions or ask students to clarify and justify their ideas to promote their understanding of mathematics (NCTM, 1991; NCTM, 2000).

The teachers' readiness to answer students' questions outside the classroom can also be seen as a confirmation that mathematics learning is not necessarily restricted to a particular space and time. Teachers and students can have a commitment to always keep in touch with respect to learning mathematics.

Conduct Mathematics Teaching

The philosophy underpinning the current curriculum influences the ways in which teachers teach. With regard to the effectiveness of their practice, the National Research Council (1989, cited by NCTM, 1991) stated that

"Effective teachers are those who can stimulate students to learn mathematics...to understand what they learn, they must enact for themselves verbs that permeate the mathematics curriculum; 'examine', 'represent', 'transform', 'solve', 'apply', 'prove', 'communicate'. This happens most readily when students work in groups, engage in a discussion, make a presentation, and in other ways take charge of their own learning. (p.2)

In a later document, NCTM (2000) stated "Teachers' actions are what encourage students to think questions, solve problems, and discuss their ideas, strategies, and solutions (p.18)." The teacher competences in this framework are important; they include encouraging students to discuss their mathematical ideas, working cooperatively, commenting on others' ideas, explaining their own strategies/ solutions, directing students to solve problems by themselves, discussing mathematical problems, applying new approaches/ methods, and not necessarily giving a final solution but instead asking more (probing) questions. These indicators reflect a student-centered approach to teaching and learning mathematics.

In general, reform of mathematics education in the RME context aims at shifting away from 'teaching by telling' and replacing it by students 'constructing' or 'inventing' ; shifting from what 'teachers do' to what 'students do' (Gravemeijer, 2000a). To do this, mathematics lessons should give students guided opportunities to re-invent mathematics by doing it; students begin with contexts, rather than abstract mathematics rules. RME is a reform of mathematics curricula which is intended to empower learners to be actively involved in a "re-invention" process of mathematical concepts and principles. The critical word here is 'actively', and one of the teaching principles in RME is an "interactivity principle" (Gravemeijer, 1994; Treffers, 1991). Freudenthal (1991) suggests that students should be given the opportunity to experience a process similar to the process by which a given piece of mathematics was invented. Students can build their knowledge of mathematics by making models and schemas, as well through symbols and informal mathematics notation. But it is only possible for the students to do these kinds of activities when an opportunity is provided for them. This is the second principle of RME theory (Freudenthal, 1991 Gravemeijer, 1994a, 1994b) and is relevant to the standard of mathematics "to gain mathematical power students need to make conjectures, abstract properties and relationship from problem situations, explain their reasoning, follow arguments, validate assertions, and communicate results in a meaningful form" (Silver, 1989, p.279). A part of the study is asking questions regarding whether the teachers welcomed the new approach by exploring their perceptions toward teaching innovation.

Methods

The purpose of the survey was to explore Indonesian teachers' perceptions of innovative mathematics teaching in general. I assumed that teachers who are highly motivated in orientation towards innovation would more easily accept an education reform. These kinds of people are what Rogers (1983) called innovators, early adopters, or early majority. One hundred fifty six teachers of the 210 participants responded to the survey. Data analysis of the teacher survey was based on this number of participants.

Research Questions – Problem Statement

The research question on paper related to teachers' perception toward the mathematics teaching innovation. The research question was "What are the teachers' perceptions toward teaching innovation of mathematics?"

This question was answered using a questionnaire (survey). Questions on the teacher survey, which directly related to this paper, are:

1. How many factors underpin the teacher's perception toward mathematics teaching innovation as the best and interpretable factors?
2. What are the latent factors (dimensions) underpinning the teacher's perception toward innovation of mathematics teaching?

Instrumentation

The RME teaching approaches were relatively new to Indonesian context, so one aspect which need to be explored was the teachers' perceptions toward mathematics teaching innovation.

Factor Analysis

The survey questionnaire was designed to explore the teachers' perceptions toward the teaching innovation of mathematics. The purpose of the questionnaire (survey) in this research paper was to collect data from participants about their experiences or opinions toward the innovation of mathematics teaching. The items of the questionnaire were developed and explored from the research question "How do mathematics teachers perceive an innovation of mathematics instruction?" This question was explored in more detail in six themes: (1) how the teachers teach and prepare mathematics lessons (TP), (2) how the teachers introduce mathematical concepts (IC) in the classroom, (3) how they conduct their teaching (CTT) approaches, (4) the extent to which the teachers feel satisfied (FS) with the teaching strategies they currently use, (5) how they maintain and keep up-to-date (KU) with current teaching innovation in mathematics, and (6) how they assess students'(AS) understanding of mathematics.

The exploratory factor analysis in this study was used to analyze the teacher survey data. The purpose of the exploratory factor analysis is to uncover a dimension of a set of items. Burn (2000) explains that, "Factor analysis is a very popular and frequently used way of reducing …variables to a few factors, by grouping variables that are moderately or highly correlated with each other together to form a factor" (p.272). Kaplan and Saccuzzo (1997) add ,"Factor analysis is a set of multivariate data analysis method for reducing large matrixes of correlation to fewer variables". In this study a number of items related to the teachers' perceptions of mathematics teaching innovation could be classified into a number of latent factors. There was no specified *a priori* restriction to see the patterns of relationship between measured variables and a common factor, so an exploratory factor analysis (EFA) was used (Fabrigar, Wegener, MacCallum, & Strahan, 1999). In the process of analysis using EFA, I first presented the descriptive statistic of the data to investigate the normality of the variables.

How the surveyed teachers perceived an innovation of mathematics teaching and how the subgroups of the sample perceived it was explored, compared, and contrasted, and the teachers' perception toward each latent factor dimension was also interpreted. The teachers' perceptions toward mathematics teaching innovation were investigated. An exploratory factor analysis was used to develop the latent factors that underpinned the teachers' perception on innovation. Each latent factor reflected the teachers' orientation toward mathematics teaching innovation. These dimensions of the innovation instruments were also used to verify the selection process of the teachers involved in the intervention program (CS=case study, and NCS=non case study teachers).

Results and Discussion

The teacher data includes a description of the teachers' beliefs about mathematics teaching including their orientation towards innovative practices. I used the survey data relating to the teachers' orientations toward innovation to verify my selection of teachers for the professional development program.
The survey was administered during January-February 2005. The sample survey was limited to the Bandung city area, in Indonesia. Random sampling was used to select 30 out of the 52 state schools. The decision to limit the number of schools to 30 (57% of the total) was, in part, a time and cost factor, but it was also believed that this would adequately represent the population of junior secondary teachers of mathematics in Bandung, and at the same time would likely result in an adequate response to the offer of the professional development program.

Validation of the Instrument

For the current study, aspects of the questionnaire data incorporated a number of variables suitable for factor analysis. These variables were constructed to broadly measure teachers' perceptions of how to teach mathematics and how to keep up to date with new innovations of mathematics teaching in junior secondary schools.
This section presents the latent factors underlying these variables from factor analysis. It also provides the internal reliability of these latent factors along with further descriptive statistics to describe the overall orientation of the teacher sample towards innovative practice.

To validate the instrument a series of processes were involved. The first step removed items for which the response pattern varied considerably from a normal distribution. Data from items which had absolute values of skewness and kurtosis greater than 1.0 were removed. The second step involved an Exploratory Factor Analysis (EFA) with oblique rotation (Direct Oblimin). The purpose of EFA is to uncover the dimensions of a set of variables (items). These dimensions are called factors (Aron & Aron, 1994) or latent factors (Giles, 2002) or latent structure (Garson, 2007). In the context of this study, the terminology used is latent factor. Each item in a certain latent factor needs to have a higher correlation compared to a correlation with other dimensions. This was taken to be evident by correlation coefficients equal to or greater than +.40 or less than -.40 with each latent factor (Gorsuch, 1983). Although other researchers apply different cut off points (e.g. Cattell, Khanna, & Harman, 1969) uses the rule > .10 or < -.10, and Wünsch (2004) uses the rule >.30 or < -.30); a stricter cut off was warranted to ensure all items contributed substantially to the latent factor. Items that had high multiple loadings across two or more latent factors were also omitted from further analysis for clarity (Gorsuch, 1983), as distinct measures are required (Darlington, Weinberg, & Walberg (2004). Direct Oblimin was used as this rotation method assumes there will be some relationship between the resultant dimensions, a common outcome in educational or psychological research (Cattell, Khanna & Harman, 1969; Clarkson & Jennrich, 1988; Jennrich & Sampson, 1966; West, 1991).

The third step requires justifying how many real latent factors are evident in the pattern matrix. In this study three methods were adopted to justify the number of latent factors: the scree plot; a parallel analysis (Thompson & Daniel, 1996) where both methods provide evidence of when latent factors appear to be 'noise'; and theoretical interpretability (that is the item groupings made sense in relation to the current literature). The final step in the analysis was to produce individual measures for the latent factors and to compare and contrast the perceptions of the various sub-groups of teachers (survey, PD=Professional Development, CS= Case Study, NCS= Non Case Study) who participated with respect to these scores.

Of the 31 items, from the 156 respondents, two items (Q02, Q17) had absolute values of skewness and kurtosis greater than 1. So this two items were removed prior to factor analysis as they did not provide an adequate measure to distinguish a range of beliefs among the teachers.

To determine the number of interpretable latent factors, from the scree plot either four or up to ten main factors were apparent for interpretation (see Figure 1).

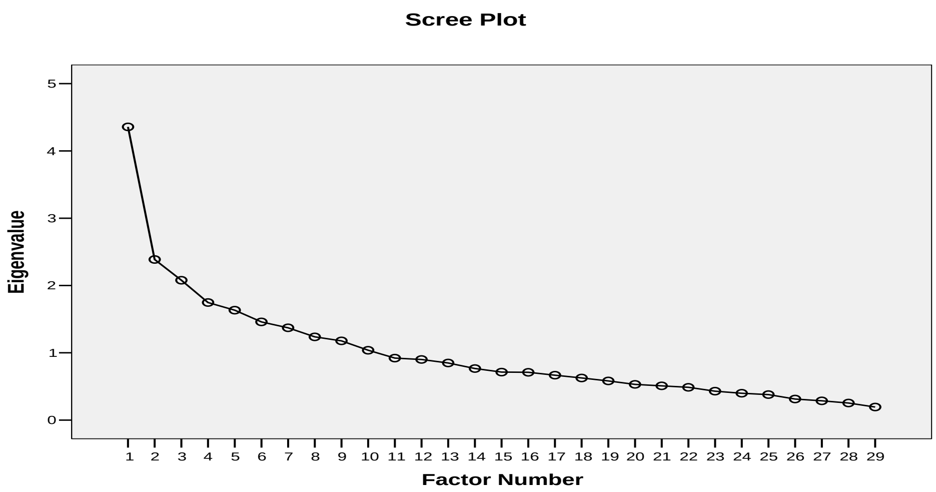

Figure 1, *Eigenvalues (Scree) plot for the teacher survey.*

The result of the parallel analysis is provided next. This process involves deriving a data matrix and associated eigenvalues using a random data set that has a comparable number of variables and cases as the real data set (Thompson & Daniel, 1996). According to Thompson and Daniel (1996, p.200) "parallel analysis requires the researcher to randomly generate a raw data set of the same 'rank' as the actual data matrix" and then comparing the real and random eigenvalues to determine which factors are likely to be 'noise'. Following this process, it was revealed that from the sixth factor onwards, the eigenvalues are essentially 'noise' (see Table 2); the percent of variance explained by the real data after this point is little more than that generated by a random data set. Arguably, from parallel analysis a five-factor solution is psychometrically valid. This is generally consistent with the scree plot. The second stage involved EFA using the remaining 29 items (Table 1).

Table 1
Total Variance Explained

Factor	Initial Eigenvalues			Extraction sums of Squared Loading		
	Total	**% of Variannces**	**Cummulative %**	**Total**	**% of Variances**	**Cummulative %**
1	4.357	15.025	15.025	2.100	7.243	7.243
2	2.386	8.229	23.254	1.238	4.268	11.511
3	2.079	7.167	30.422	2.867	9.887	21.398
4	1.747	6.024	36.446	1.615	5.571	26.968
5	1.633	5.633	42.078	1.323	4.563	31.531
6	1.459	5.032	47.110	1.244	4.288	35.819
7	1.371	4.729	51.839	1.024	3.533	39.352
8	1.237	4.265	56.104	.974	3.358	42.709
9	1.177	4.060	60.164	.732	2.524	45.233
10	1.03	3.579	63.743	.609	2.100	47.333

	8		
11	.921	3.177	66.920
12	.901	3.107	70.027
13	.849	2.926	72.953
14	.766	2.642	75.595
15	.713	2.460	78.054
16	.710	2.448	80.502
17	.667	2.300	82.802
18	.626	2.158	84.961
19	.582	2.006	86.967
20	.531	1.829	88.796
21	.509	1.754	90.550
22	.487	1.679	92.229
23	.429	1.481	93.710
24	.399	1.376	95.085
25	.379	1.306	96.391
26	.313	1.079	97.470
27	.286	.986	98.457
28	.253	.874	99.331
29	.194	.669	100.000

Extraction Method: Maximum Likelihood.

Table 2
Parallel Analysis

Factor	Real data eigenvalues	Randomly generated eigenvalues
1	4.357	1.859
2	2.386	1.713
3	2.079	1.602
4	1.747	1.505
5	1.633	1.417
6	1.459	1.336
7	1.371	1.261
8	1.237	1.188
9	1.177	1.119
10	1.038	1.051

Table 3
Final Pattern Matrix

Variables (items)	Factor 1	2	3
Q12: I look for opportunities to learn more about	**.65**	-	-
Q19: I look for opportunities to know more or ask questions	**.63**	.04	-
Q29: I encourage students to explain their own strategies of	**.57**	.02	.
Q10: I encourage other students to make comments on	**.45**	-	-
Q23: I am happy for students to challenge incorrect	**.42**	.10	-
Q25: When a student asks me a question about mathematics, I	**.40**	-	-
Q15: I accept students' unexpected responses to a question	**.39**	-	.
Q30: I do not instantly resolve students' questions about	**.38**	-	.
Q20: I respond to students' question s about mathematical	**.38**	.08	.
Q22: I keep up to date about current mathematics teaching	**.30**	.01	-
Q8: When introducing mathematical concepts, I copy directly	-	**.58**	-
Q18: I think it would be convenient to continue teaching in	-	**.53**	.
Q3: I copy textbook problem examples of mathematical	-	**.52**	-
Q7: I give students more drill-practice work than non-routine	.01	**.42**	.
Q13: Whatever mathematics education innovation is	.04	**.38**	.
Q9: I would rather give routine problems as practice for my	.05	**.27**	.
Q6: I promote discussion among students to solve	.09	.05	-
Q1: I encourage students to discuss their mathematical ideas	.13	-	-
Q14: During this Academic Year (2004/2005) I am using a	.23	-	-
Q5: I direct students to work by themselves on their problems	.06	.24	.

Table 4

Final items in EFA, Factor Loading, and Alpha Score (N=156)

Items	Factor Loadings	Alpha
Constructivist Teaching		0.72
Q10 Encouraging students to make comments other	0.46	
ideas	0.66	
Q12 Looking for opportunities to learn math education	0.40	
reform	0.63	
Q15 Accepting students' unexpected responses	0.38	
Q19 Looking for opportunities to bring new ideas into	0.30	
my mathematics classroom	0.42	
Q20 Responding to students' questions outside the	0.41	

classroom	0.61	
Q22 Keeping up with current mathematics teaching	0.39	
innovations		
Q23 Happy to challenge incorrect mathematical		
expressions for students		
Q25 Promoting probing questions		
Q29 Encouraging students to explain their own		
strategies		
Q30 I do not instantly resolve students' questions about		
mathematical ideas		
Traditional Teaching		0.59
Q03 Copying text problem on the blackboard for the	0.52	
students to copy	0.42	
Q07 Giving students more drill-practice work than non-	0.59	
routine problems	0.28	
Q08 Introducing mathematical concepts, I copy directly	0.38	
onto the blackboard	0.54	
Q09 I would give routine problems before introducing		
new concepts of mathematics		
Q13 Continuing to teach in the same way that I have		
always done		
Q18 Being convenience to teach in the same way that I		
have always done		
Constructivist Learning		0.53
Q01 Encouraging students to discuss their mathematical	0.52	
ideas with others	0.28	
Q05 I direct students to work on their problems	0.55	
(Recoded)	0.45	
Q06 Promoting discussion among students to solve		
mathematical problems		
Q14 Using a new teaching approach in mathematics in		
2004/2005		

The final and optimal pattern matrix was a three factor-solution that could be found in Table 3 (see Apendix: Final Pattern Matrix).

In the final factor pattern matrix, Q09 had a low correlation coefficient of .277 but was retained as it maintained the overall integrity of the three-factor solution, and it clearly was associated with the factor 2, not any of the other two factors. Factor 1 (F1) consisted of 10 items and both Factor 2 (F2) consisted of 6 items and Factor 3 (F3) consisted of 4 items each. F1 is conceived as being associated with constructivist teaching ideas; F2 is conceived as being related to traditional teaching ideas; and F3 with constructivist learning practices. As a consequence these dimensions are respectively called "Constructivist Teaching", "Traditional Teaching" and "Constructivist Learning".

Locating the Constructs in the Literature

The next step of the analysis involves the justification of the names given to the resultant factor dimensions underlying each latent factor with respect to the literature. As previously discussed, the survey instrument was originally designed to measure six themes. These, again, were how the teachers teach and prepare mathematics lessons, how they introduce mathematical concepts in the classroom, how they conduct their teaching approaches, the extent to which they feel satisfied with the strategies they currently use, how they assess students' understanding of mathematics, and how they maintain and keep up to date with current teaching innovations in mathematics.

Of the original 31 items, 20 items were retained and associated with the three factors. The other 11 items were removed for various reasons as previously discussed (normality; correlation coefficients less than an absolute value of 0.30; multiple loading across factors; and items that formed a fourth factor that was not interpretable theoretically).

Constructivist Teaching

To be an innovative teacher of mathematics for junior secondary school, one should have an openness and willingness to learn to teach and modify instructional strategies as appropriate. This characteristic is captured in a number of the items. For example, the teachers are looking for opportunities to learn about mathematics education reform (Q12) and how to bring new ideas into the classrooms (Q19). Within the constructivist point of view, when the students attempt to complete classroom tasks, mathematical knowledge is actively constructed (Cobb et al., 1992; Wood et al., 1995). This approach is captured by items Q10 and Q29.

Through constructivist teaching, the ideas of mathematics are learned by the students in whom the knowledge is constructed, enabling them to discover or re-discover mathematical concepts, methods, procedures, or algorithms. This latent factor captures the extent to which mathematics lessons place more emphasis on the students' mathematics rather than on a conventional school curriculum (Steffe, 1991). It is consistent with a level of agreement with the following items: "Q10: Encouraging students to make comments about others' ideas" (Maher & Altson, 1990); "Q25: Promoting probing questions or asking for clarifying" (Wood et al., 1995); "Q29: Encouraging students to explain their own strategies" (Wood et al., 1995); and

"Q15: Accepting students' unexpected responses" (Confrey, 1990). All of these items are indicators of a constructivist teaching paradigm.

When teachers agree with these indicators, they seem to be looking for opportunities to learn more about mathematics educational reform (Q12), to know how to bring new ideas into the classroom (Q19), and always trying to keep up to date with current teaching innovations (Q22). The teachers would not just copy the textual problems on the blackboard for students to copy, but they would always try to challenge students (Q23). They would try to not instantly resolve the students' questions (Q30), instead they would promote probing questions (Q25) which enable students to construct their own knowledge of mathematics. The teachers also would provide the time and opportunity for the learners to respond to the students' questions even though this might be outside the classroom (Q20). Keeping up to date with the current innovation (Q22) and always looking for an opportunity to learn new ideas of mathematics teaching innovations (Q12) are consistent with teachers' efforts to open broader knowledge and to always be receptive to a new teaching innovation.

When the CT construct can distinguish between teachers who exhibit high or low levels of support toward Constructivist Teaching, then this construct can be considered as valid. The Cronbach alpha score for the Constructivist Teaching construct is 0.72 which is considered to represent a moderate internal consistency. As stated by Nunnaly (1978), a score of 0.7 is an acceptable reliability coefficient, but lower thresholds are sometimes used in the literature.

Traditional Teaching

In a traditional teaching approach, mathematics is perceived by most people as a fixed static body of knowledge. According to Romberg and Kaput (1999) mathematics subject matter includes the mechanistic manipulation of a variety of numbers and algebraic symbols. This view influences the teachers in the way they teach mathematics in the classroom. The four most popular segments of the traditional teaching approach lesson include an initial segment where the previous day's work is corrected, then the teachers present new materials often working on one or two example problems on the board, followed by a few students working on similar problems at the chalkboard, and finally the students working on the assignment for the following day (Romberg & Kaput, 1999; see also Romberg, 2000).

Factor 2 is consistent with this conventional teaching approach. For example, "Q07: Giving students more drill-practice work than non-routine problems" or what Koseki (1999) describes as a copy method in mathematics teaching. De Lange (1996) also illustrates the traditional teaching approach as it is an "Activity mainly carried out by the teacher; he/she introduces the subject, gives one or two examples, may ask a question or two and invites the students who have been passive learners to become active by starting to complete exercises from the book" (p.86). Q03: "Copying text problems on the blackboard for the students to copy" and Q08: "Introducing mathematical concepts by copying directly onto the blackboard" are examples of practical traditional teaching approach as in the classroom.

The other items associated with F2 are consistent with a traditional teaching approach. Q13: "Continuing to teach in the same way that the teachers have always done", and Q18: "Being convenient to teach in the same way as they have always done". This traditional teaching approach emphasizes the product of the activity rather than the process (Steffe, 1991). The Cronbach Alpha value for this construct was .59, and hence represents only a low to moderate internal consistency which is still acceptable reliability (Nunnaly, 1978).

Constructivist Learning (CL)

Constructivist proponents ask that "Learning be viewed as an active, constructive process in which students attempt to resolve problems that arise as they participate in the mathematical practices of the classroom" (Cobb et al., 1992, p.10). The items Q01: "Encouraging students to discuss their mathematical ideas with others", and Q03: "Encouraging students to work collaboratively in pairs or small groups" are indicators of how to motivate the students to be active either in the whole class discussion or in small group discussions. This is relevant with the ideas of constructivism, as Davis et al. (1990, p.187) maintain that "constructivists recommend providing learning environments in which students can acquire basic concepts, algorithm skills, heuristic processes and habits of cooperation and reflection". Promoting discussion (Q06) and applying 'new ideas' in their teaching (Q14) are some of the ways to increase attention to children's thinking, to give less frequently leading questions and to promote listening to the students' explanations. This also provides opportunities for the teachers to shift from "telling and describing" to "listening and questioning" and "probing for understanding," (Maher & Altson, 1990).

The CL construct is consistent with the idea of enabling students to actively construct their own knowledge. The Cronbach Alpha value of this construct is .53 which has acceptable reliability in the literature (Nunnaly, 1978).

Conclusion

The main part of this research was then conducted in Indonesia. One hundred and fifty six mathematics teachers were surveyed to investigate their orientation toward teaching innovation of mathematics. The teachers who had a high orientation toward mathematics teaching innovation were offered a place in the RME-PD program, which was conducted because this teaching approach using constructivist principles was new in the Indonesian context. This paper has examined the question "What are the teachers' perceptions toward the teaching innovation of mathematics?" Exploratory factor analysis was used to classify and to construct dimensions about the teachers' perception toward the innovation of mathematics teaching. Maximum likelihood was used as an extraction method and direct oblimin was used to rotate factor matrix. The results indicated that there was a three-factor solution associated with Constructivist Teaching (CT), Traditional Teaching (TT) and Constructivist Learning (CL). The mean scores of CT, and CL of 3.47 and 3.68 respectively suggested that mathematics teachers in the surveyed sample practiced CT and CL. Moreover, their orientation toward TT was also slightly low (2.66) which suggested that the teachers in the surveyed sample were responsive to alternative teaching approaches instead of the traditional teaching approach. I conclude that mathematics teachers of junior secondary schools in Bandung, Indonesia have a positive orientation toward the innovation of mathematics instruction.

This situation indicated that there was a growing tendency in the teachers' awareness to accept (and 'welcome') a new teaching innovation instead of the traditional teaching approach.

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