IOP Conf. Series: Materials Science and Engineering **296** (2018) 012022 doi:10.1088/1757-899X/296/1/012022

Mathematics Pedagogical Standards: A Suggested Model of Instruction in Enhancing the Mathematics Teacher's Quality of Instruction

N S Saad[1], M Jemali[1], Z Hj Zakaria[1] and Q Yusof[2]

[1]Kolej University Perguruan Ugama Seri Begawan, Brunei Darussalam
[2]University Pendidikan Sultan Idris

noorshah5156@gmail.com

Abstract. The paper aims at identifying the standards for teaching and learning of mathematics based on National Council of Teacher of Mathematics (NCTM, 2000), The Australian Association of Mathematics Teachers (AAMT, 2006) and Training and Development Agency for School (TDA, 2007). These known standards were used as a guide in identifying the constructs of the mathematics teacher's instruction in the classroom. The survey method used in which a questionnaire instrument encompassed on the four identified constructs on the standards for teaching and learning of mathematics, namely *professional practices*, *professional attributes*, *professional knowledge,* and *professional instructional processes*. The instrument was tested during a pilot study and a Cronbach's Alpha reliability index of greater than 0.85 was obtained. The actual research was carried out in Peninsular Malaysia involving 224 secondary schools with 1.120 mathematics teachers and 108 primary schools with 540 mathematics teachers. From the selected schools, only 820 secondary mathematics teachers (73.2%) and 361 primary teachers (66.9%) gave a response to the mailed questionnaires. The findings of the study revealed that the secondary and primary mathematics teachers strongly agreed on three constructs; *professional practices*, *professional attributes* and *professional instructional processes*.

1. Introduction

Shulman highlighted the notion that, *'teaching necessarily begins with a teacher's understanding of what is to be learned and how it is to be taught'* [1]. As such, decisions made by the teacher before, during and after the instruction are crucial not only to the teacher but to the learners as well in enhancing the quality of the instruction. The decisions made must be based on a credible professional guidance. Hence, to help the teachers, NCTM [2], introduced '*The Professional Standards for Teaching Mathematics'*. The standards proposed by NCTM were to guide American mathematics teachers on how the teaching and learning of mathematics should be practiced in the classrooms. NCTM also described two types of standard namely the content standard for teaching specific mathematical topics and the process standard that involves pedagogy and the methods of instruction. This emphasized through the statement, '*Teachers*

need to know and use mathematics for teaching that combines mathematical knowledge and pedagogical knowledge' [2]. In the *'Teaching Principle'* NCTM [2] put forward three main aspects of effective instruction. These aspects are the needs of a sound knowledge and understanding of mathematics, the students as learners and sound pedagogical strategies.

The standards for teaching mathematics also introduced in Australia for teachers to practice and this known as the *'Standard for Excellent in Teaching Mathematics in Australian School'* [3]. The proposed standards would serve as a guide for mathematics teachers about the quality required to be an effective mathematics teacher, ways to implement his or her roles and responsibilities competently and creating his or her own teaching philosophy.

The situation in Malaysia is a bit different. Here, the various divisions in the Ministry of Education have the responsibilities towards the development of education. In addition to producing quality teachers, the Ministry also wishes that these quality teachers remain within the orbit of the national education system and sustain their quality until they retire from the educational service [4]. To achieve these aims the Ministry introduced the 'Malaysian Standards for A Quality Education' [5] to evaluate the quality of teaching in the classroom and 'Malaysian Standards for Teachers' [6] to enhance the quality and knowledge of pre-service teachers. These two standards are apparently different from the perspective of their respective aims. This paper discusses the constructs that have been identified as the bases for teaching mathematics and that have been evaluated by using the *Structure Equation Modelling (SEM).* SEM is used to determine the constructs that contributed greatly to enhancing the quality of teaching and learning of mathematics and hence forming a standard mathematics pedagogical model that can be practiced to achieve an effective mathematics instruction.

2. Methods

Four constructs or components of the pedagogical standards for teaching mathematics were identified and they were *Professional Knowledge*, *Professional Practices, Professional Instructional Processes* and *Professional Attributes.* Overall, 17 elements were identified from the literature review as in Table 1. The items for the questionnaire were constructed based on the four components or construct to gain a degree of approval from the respondents using a five-point Likert scale. Each item was then analyzed based on the frequencies and percentages of the degree approval towards the pedagogical standards for teaching mathematics. This was followed by the analysis of the average for each component of the standards. The degree of perception and the mathematics teachers' knowledge category were measured using the scales as proposed by Nugent, Sieppert dan Hudson [7] as in Table 2. In addition, Cronbach's Alpha Reliability Index of the instrument was determined during the pilot study with an index of 0.85 [8] and 0.95 [9].

Table 1. Mathematics Pedagogical Standards components

Element	Component
PA	**Professional Attributes**
SA	Self Attribute
PD	Professional Development
RSC	Responsibility for School & Community
PP	**Professional Practices**
PMI	Planning of Mathematics Instruction
PIMI	Pedagogical Implementation of the Mathematics Instruction
ME	Monitoring & Evaluation

Element	Component
PK	**Professional Knowledge**
MCK	Mathematics Content Knowledge
KICTAMI	Knowledge of ICT Application in Mathematics Instruction
KIQ	Knowledge of Intellectual Quality
KL	Knowledge of Learners
KMC	Knowledge of Mathematics Curriculum
PIP	**Professional Instructional Processes**
UTEMI	Usage of Tools in Enhancing Mathematics Instruction
ACLE	A Conducive Learning Environment
MMT	Meaningful Mathematical Tasks
TR	Teacher's role
LR	Learner's role
AMI	Analysis of the Mathematics Instruction

Table 2. Degree of Perception and Pedagogical Knowledge Category

Scale	Perception	Category
1.00 – 1.99	Very Low	Weak
2.00 – 2.99	Low	Moderate
3.00 – 3.99	High	Good
4.00 – 5.00	Very High	Excellent

In the second stage, the survey method was employed using the constructed questionnaire about the pedagogical standards for teaching mathematics. This was administered by post to 224 secondary schools and 108 primaries selected randomly throughout Malaysia. A total of five mathematics teachers from each selected school were asked to respond to the mailed questionnaire. However, only 73.2% or 820 secondary mathematics teachers and 66.8% or 361 primary mathematics teachers responded to the questionnaires.

3. Findings of the Study

The findings of this study were analyzed statistically (descriptive) on the four components of the pedagogical standards for teaching mathematics. Further, an exploration of the findings using the Structured Modelling Equation employing the Partial Least Squares Method was carried out to obtain the 'Pedagogical Standards for Teaching Mathematics Model' (Diagram 1).

3.1. *Profiles of the Respondents*

Table 3 shows the detailed profiles of the mathematics teachers who took part in this study. Based on gender, there were 888 female respondents (75.2%) and 293 male respondents (24.8%) involved in this study. Ethnically, there were 842 Malay respondents (71.3%), 224 Chinese respondents (18.9%), 104 Indian respondents (8.8%) and 11 respondents from other ethnicities (1.0%). Almost 90% of the secondary mathematics teachers and 36.3% of the primary mathematics teachers were first degree holders with education. Among the secondary mathematics teachers, 528 (64.4%) were graduates who majored in mathematics while the rest were graduates who majored in non-mathematics fields. Among the primary

mathematics teachers, 183 (50.7%) graduated with an option in mathematics while 178 (49.3%) graduated with a non-mathematics option. It was also discovered that 586 (71.5%) secondary mathematics teachers and 202 (55.9%) primary mathematics teachers were between 31 and 50 years old. As far as the teaching experience was concerned, 516 (62.0%) secondary mathematics have between one to ten years of experience in teaching KBSM Mathematics while 747 (91.1%) teachers claimed to have between one to ten years of teaching Additional Mathematics. Among the primary mathematics teachers, 209 (57.9%) of them claimed to have between one to ten years of teaching KBSR mathematics while 152 (42.9%) teachers have teaching experiences of more than 10 years.

Table 3. Profiles of Secondary and Primary Mathematics Teachers

Profile	Secondary No.	Secondary Percentage	Primary No.	Primary Percentage	Total
Gender					
Male	188	22.7	113	31.3	293
Female	640	77.3	248	68.7	880
Ethnicity					
Malay	651	77.3	191	22.7	842
Chinese	136	60.7	88	39.3	224
Indian	27	26.0	77	74.0	104
Others	6	54.5	5	45.5	11
Major					
Mathematics	528	64.4	183	50.7	711
Non-mathematics	292	62.1	178	37.9	470
Age					
< 31 years	234	59.5	159	40.5	393
> 31 years	586	74.4	202	25.6	788
Teaching Experience					
KBSM (1-10 years)	516	62.9	-	-	820
KBSM > 10 years	304	37.1	-	-	
KBSR (1-10 years)	-		209	57.9	361
KBSR > 10 years	-		152	42.1	

3.2 *Standards for Teaching Mathematics Components*

3.2.1. *Professional Attributes Component.* Table 4 shows the mathematics teachers' perception of the professional attributes component. There are three elements in this component which are self-attribute, professional development and school and community's responsibility. The overall mean score for this component is 4.06 (SD= 0.51 for the secondary teachers and 4.12 (SD = 0.46) for the primary teachers. This indicates that the level of perception of the respondents on this component is high and the teachers' knowledge is categorized as excellent. For the elements of self-attribute, professional development and school & community's responsibility the mean scores and standard deviations for secondary/primary teachers are (Mean = 4.29/4.20; SD = 0.50/0.45), (Mean = 4.08/4.10; SD = 0.54/0.49) and (Mean =

3.80/4.05; SD = 0.67/0.56) respectively. Therefore, it could be said that the respondents' levels of perception of the elements of self-attributed and professional development are very high and mathematics teachers' knowledge can be categorized as excellent.

Table 4. Secondary and Primary Mathematics Teachers Perception on the Professional Attribute Component

	Secondary		Primary	
Component	Mean	SD	Mean	SD
Self-attribute	4.29	0.50	4.20	0.45
Professional Development	4.08	0.54	4.10	0.49
School & Community's Responsibility	3.80	0.67	4.05	0.56
Overall	4.06		4.12	

3.2.2 *Professional Practices Component.* Table 5 shows the three elements of the professional practices component which are mathematics instructional planning, monitoring and evaluation and pedagogical implementation in the teaching and learning of mathematics. Overall, the mean scores for this component are 4.04 (SD = 0.53) and 4.15 (SD = 0.47) for the secondary and primary teachers respectively. This shows that the mathematics teachers' level of perception is very high and their knowledge can be categorized as excellent. For each of the element or construct, the mean scores and standard deviations for secondary/primary teachers are 4.08/4.16 (SD = 0.54, 049), 3.99/4.12 (SD = 0.59, 0.47), 4.06/4.14 (SD = 0.56, 0.52) respectively. Among the secondary mathematics teachers, the respondents show a high level of perception concerning the elements of mathematics instructional planning and pedagogical implementation in the teaching and learning of mathematics while the teachers' knowledge can be categorized as excellent.

Table 5. Secondary and Primary Mathematics Teachers' Perception of the Professional Practice Component

	Secondary		Primary	
Component	Mean	SD	Mean	SD
Mathematics Instructional Planning	4.08	0.54	4.16	0.49
Monitoring and Evaluation	3.99	0.59	4.12	0.47
Pedagogical Implementation in the Teaching and Learning of Mathematics	4.06	0.56	4.14	0.52
Overall	4.04		4.15	

3.2.3 *Professional Knowledge Component.* Table 6 shows the five elements associated with the professional knowledge components which are mathematics content knowledge, knowledge on the application of ICT in mathematics instruction, knowledge of learners, knowledge of the curriculum and knowledge on intellectual quality. Overall the mean scores for this component are 3.94 (SD = 0.54) for the secondary teachers and 4.04 (SD = 0.46) for the primary teachers. This indicates that level of perception for this component is high and the secondary teachers' knowledge is deemed good while the primary teachers' knowledge is categorized as excellent. Only the element of content knowledge is reported to be at a very high level with a mean score of 4.11 (SD = 0.59) while the teachers' knowledge is reckoned to be excellent. For the secondary teachers, the other four elements are said to have a high level of perception with mean scores of 3.70 (SD = 0.69), 3.92 (SD = 0.58), 3.98 (SD = 0.70), and 3.99 (SD = 0.61) respectively while the teachers' knowledge is deemed good. For the primary teachers, only the element of ICT with a mean score of 3.73 (SD = 0.64) can be said to have a very level of perception and the teachers' knowledge can be categorized as good. The other four elements; mathematics content knowledge (mean = 4.12, SD = 0.49), knowledge of learners (mean = 4.07, SD = 0.50), knowledge of the curriculum (mean =

4.17, SD = 0.55), and knowledge on intellectual quality (mean = 4.06, SD = 0.51) too have a very high level of perception among the primary teachers while their knowledge on the four elements can be described as excellent.

Table 6. Secondary and Primary Mathematics Teachers' Perception of the Professional Knowledge Component

	Secondary		Primary	
Component	Mean	SD	Mean	SD
Mathematics content knowledge	4.11	0.59	4.12	0.49
Knowledge of the application of ICT in mathematics instruction	3.70	0.69	3.73	0.64
Knowledge of learners	3.92	0.58	4.07	0.50
Knowledge of the curriculum	3.98	0.70	4.17	0.55
Knowledge of intellectual quality	3.99	0.61	4.06	0.51
Overall	3.94		4.04	

3.2.4 *Professional Instructional Processes Component.* Table 7 shows the six elements associated with the component of professional instructional processes namely knowledge on the application of tools in enhancing the mathematics instruction, knowledge of a conducive environment, knowledge of meaningful mathematical tasks, knowledge of the teacher's roles, knowledge of the learner's roles and knowledge of how to analyze the mathematics instruction. Overall, the mean scores for this component are 4.07 (SD = 0.53) for the secondary teachers and 4.05 (SD = 0.43) for the primary teachers. This indicates that for this component, the degree of approval for both sets of teachers is very high indeed, while their knowledge can be categorized as excellent. As for the element of application of tools in enhancing the mathematics teachers is concerned, the level of perception can be considered high for both secondary (mean = 3.76, SD = 0.62) and primary (mean = 3.72, SD = 0.55) teachers. It also revealed that their knowledge concerning this element deemed good. For the element of knowledge concerning the conducive environment, the mean scores for the secondary and primary teachers are 4.02 (SD = 0.62) and 4.03 (SD = 0.62) respectively. Similarly, the mean scores for the element of knowledge of meaningful mathematical tasks are 4.09 (SD = 0.59) and 4.10 (SD = 0.48). As for the knowledge about the teacher's roles, the mean scores are 4.2 (SD = 0.55) and 4.19 (SD = 0.48). Meanwhile, the mean scores for the element of the learner's roles, are 4.22 (SD = 0.58) and 4.17 (SD = 0.50) respectively. Lastly, the mean scores for the element of knowledge on the analysis of the mathematics instruction are 4.13 (SD = 0.62) and 4.12 (SD = 0.51) respectively. Moreover, the teachers' knowledge regarding this component is excellent.

Table 7. Secondary and Primary Mathematics Teachers' Perception on the Professional Instructional Processes Component

	Secondary		Primary	
Component	Mean	SD	Mean	SD
Knowledge of the application of tools in enhancing the mathematics instruction	3.76	0.62	3.72	0.55
Knowledge of a conducive environment	4.02	0.62	4.03	0.50
Knowledge of meaningful mathematical tasks	4.09	0.59	4.10	0.48
Knowledge of the teacher's roles in the mathematics instruction	4.20	0.55	4.19	0.48
Knowledge of the leaner's roles during the mathematics instruction	4.22	0.58	4.17	0.50
Knowledge about the analysis of the	4.13	0.62	4.12	0.51

mathematics instruction		
Overall	4.07	4.05

The overall mean scores for the four components are 4.06 and 4.09 respectively for the secondary and primary teachers. This indicates that both sets of mathematics teachers have a very high degree of approval for these components of the pedagogical standards for teaching mathematics. In tandem, their knowledge too can be categorized as excellent.

3.2.5. *Structural Equation Modelling for the Pedagogical Standards for Teaching Mathematics.* In the actual research involving 820 secondary mathematics teachers and 361 primary mathematics teachers, *Kuder-Richardson* and *Alpha Cronbach* coefficients are used to determine the reliability of the questionnaire items relating to all constructs: Professional Practices (PP), Professional Attributes (PA), Professional Knowledge (PK), Professional Instructional Processes (PIP) and Pedagogical Standards for Teaching Mathematics (PSTM). For the secondary teachers, the coefficient value is between 0.859 and 0.934 while for the primary teachers, the coefficient value is between 0.734 and 0.959. This range of values exceeds the range of values between 0.70 and 0.80 which is considered good as proposed by Kaplan & Saccuzzo [10]. Thus, all the items deemed reliable.

This study used the reliability value of the Dillon-Goldstein's composite variables indicator and Fornell & Larcker's extracted mean variance to test the reliability and fitness of the external structural equation modeling as suggested by Lohmoller et al. [11]. The reliability coefficient values for the five constructs of the tested external model are as in Table 8.

Table 8. Reliability coefficient values for the external model of PSTM

Construct	**Dillon-Goldstein (≥0.70)**	Dillon-Goldstein ((≥0.70)
	Secondary	**Primary**
Professional Practices (PP)	0.9478	0.8929
Professional Attributes (PA)	0.9205	0.8599
Professional Knowledge (PK)	0.9280	0.7481
Professional Instructional Processes (PIP)	0.7499	0.7381
Pedagogical Standards for Teaching Mathematics (PSTM)	0.9835	0.8196

The Dillon-Goldstein's coefficient values obtained from the study on the primary and secondary mathematics teachers exceed 0.70. Fornell & Larcker's value of 0.9013 also exceeds 0.70. Hence, based on the suggestion made by Lohmoller [11] concerning the acceptable values to be reckoned as significant, the developed pedagogical standards for teaching mathematics model in this study can be accepted. As for the external model that includes PP, PA, PK, PIP and PSTM, the Fitted Index (FI) is used in determining the acceptance of the model. The calculation of FI depends on the value of the extracted mean-variance and the determination coefficient. In this study, the FI values for the secondary and primary mathematics teachers are 0.8216 and 0.8666 respectively. According to Tenenhaus et al. [12], FI represents the overall fitted degree of a developed model. If the FI is more than 0.75, the model is considered fit. Based on the values of the FI obtained from this study that is 0.8216 and 0.8666, the internal model of the developed Pedagogical Standards for Teaching Mathematics (PSTM) can be accepted.

The Pedagogical Standards for Teaching Mathematics Model that involve PP, PA, PK PPI and PSTM is shown in Diagram 1.

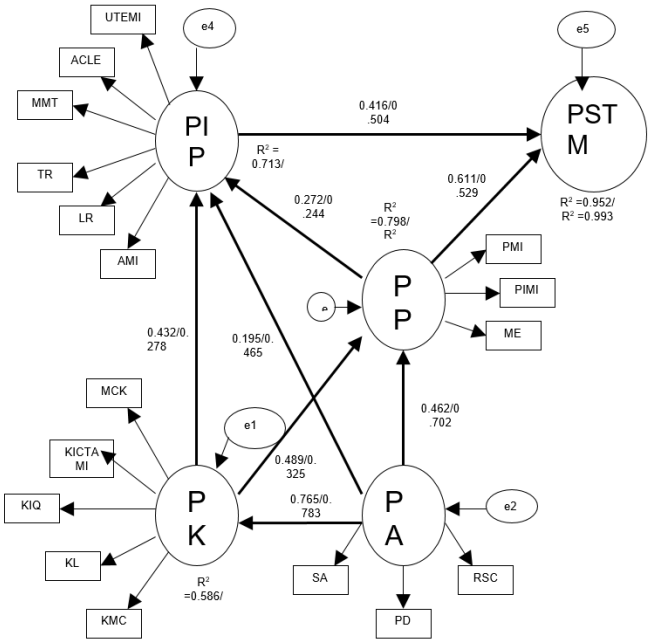

Diagram 1. Pedagogical Standards for Teaching Mathematics (PSTM) Model

The external model equations that have been successfully developed for secondary and primary schools' are as follows:

Secondary mathematics teachers:		Primary mathematics teachers:	
PSTM = 0.611 PP + 0.416 PPI	(i)	PSTM = 0.529 PP + 0.544 PPI	(i)
PP = 0.462 PA+ 0.489 PK	(ii)	PP = 0.454 PA + 0.465 PK	(ii)
PK = 0.765 PA	(iii)	PK = 0.783 PA	(iii)
PPI = 0.272 PP + 0.195 PA + 0.432 PK	(iv)	PPI = 0.244 PP + 0.465 PA + 0.278 PK	(iv)

These two sets of external model equations demonstrate that a causal relationship between the five latent variables that were developed in this model does exist. The structural equation modeling developed shows a direct relationship between PP against PSTM and as well as between PPI against PSTM. All of the regression coefficients for the exogenous and endogenous variables in the model display significant statistical testing values. The causal relationship mentioned earlier refers to the direct effect of the latent variable PP on PSTM and PPI on PSTM. The estimated correlational and regression coefficients values obtained between PP and PPI against PSTM are 0.611;0.529 and 0.416;0.544 respectively. Each of PP and PPI correlated significantly with PSTM. This explained vividly that PP and PPI are the main components in developing the pedagogical standards for teaching mathematics. The regression coefficient value indicates that a unit change in PP would cause an increase of 0.416;0.529 unit change in PSTM while a unit change in PPI would cause an increase of 0.611;0.504 unit change in PSTM.

The indirect effect shown in the PSTM model is the effect of PK on PSTM through the endogenous variables PP and PPI. The indirect relationship between PA and PSTM can also be found through the mediator variables PP and PPI.

4. Conclusion

The study was carried out with reference to the standards for teaching mathematics put forward by NCTM (USA), AAMT (Australia), and TDA (United Kingdom). However, these standards were not tested statistically as far as the significance and the suitability of the standards' constructs was concerned. As an example, the six standards for teaching mathematics espoused by NCTM came about from discussions among a group of experts that comprised teachers, teacher educators, administrators, researchers, and mathematicians. From these discussions, 30,000 drafts of the standards for teaching mathematics constructed were distributed throughout the United States. This was followed by presentations at various mathematics education conferences. In all, 650 individuals and 70 groups had voiced out their opinions on the standards for teaching mathematics. The feedback was given and the issues raised were used to improve the standards for teaching mathematics to be used in America.

AAMT is an Australian professional body of about 5,500 members that comprises mathematics teachers, teacher educators, and administrators at every level. The Standards for Excellence in Teaching Mathematics was constructed jointly by AAMT and University of Monash through a research project financed by the *'Industry Research Grant'*. This project utilized the *'grounded research methodology'* and was carried out continuously to obtain the mathematics teachers' feedbacks. A 'Teacher Focus Group' which comprised 50 members was formed in each province. This group held discussions for three years in order to produce the *'Standards for Excellence in Teaching Mathematics in Australian Schools* [3]. Three components of the standards were identified but were not tested statistically in determining the suitability of the components.

The model that is produced from this study is known as the Pedagogical Standards for Teaching Mathematics or in short PSTM. This model refers to the level of knowledge about professional knowledge (PK), professional practices (PP), professional attributed (PA) and professional instructional processes (PIP) that a mathematics teacher must have in order to make a transformation in carrying out these standards before, during and after the mathematics instruction. The finding from the study revealed that the secondary and primary mathematics concurred highly with PA, PP, and PPI. However, the respondents' level of knowledge on PK was only satisfactory. Based on the mathematics teachers' perception, the mean scores for the overall mathematics pedagogical standards were 4.09 for the secondary teachers and 4.06 for the primary teachers. This shows that the respondents displayed a very high degree of approval towards the PSTM. They concurred that the four knowledge components of PK, PP, PA, and PPI formed a crucial knowledge for mathematics teachers to achieve excellence in teaching.

The instrument for the Standards for Teaching Mathematics's Model Instrument that had been developed was successful in exploring and testing statistically the model that was based on the four components namely, professional knowledge, professional attribute, professional practice and professional process of instruction. The composite reliability indices of the indicator variables that consisted of constructed items were tested and the results indicated that the items fitted nicely into the Pedagogical Standards for Teaching Mathematics (PSTM) model. Testing on the five constructs of PP, PA, PK, PPI, and PSTM showed that values of the tested reliability coefficients satisfied the condition to be accepted as the constructs in the Standards for Teaching Mathematics Model. The results of the statistical test using the Structural Equation Modelling (SEM) based on the Partial Least Squares (PLS) method showed that the model could be fitted significantly. Consequently, the four components plus the items constructed could be used as indicators for the mathematics teachers' standards for teaching and in determining the excellent level of mathematics instruction in Malaysia.

The component of 'Professional Practices' (PP) is seen as a direct contributor towards PSTM while 'Professional Knowledge' (PK) gives an indirect contribution via 'Professional Attributes' (PA) and 'Professional Processes of Instruction' (PPI). This means that PA gives a direct contribution towards PPI and PPI, in turn, gives a direct contribution towards PSTM.

To achieve 'Professional Practice' (PP) a teacher needs to have 'Professional Attribute' (PA) and 'Professional Knowledge' (PK). These practices of PA and PK give indirect contributions towards PSTM. 'Professional Knowledge' is seen as a direct contributor towards 'Professional Process of Instruction' (PPI) and 'Professional Practice' (PP). Nevertheless, PI also contributes indirectly towards PSTM but through PA and PPI.

Furthermore, 'Professional Knowledge' (PK) and Professional Attribute' (PA) are looked upon as the pillars for 'Professional Practice' (PP) and 'Professional Process of Instruction' (PPI) in improving the quality of mathematics instruction. For these two components to be implemented successfully, the mathematics teacher needs to have knowledge of mathematical content, mathematics curriculum, tools of technology, the learners, the learners' intellectual qualities while delivering the instruction as well as displaying concerns for them, enhancing his or her professional development from time to time and contributing significantly to school and community in improving the level of mathematics achievement.

References

[1] Shulman L S 1986 Those who understand: Knowledge growth in teaching *Educ. Res.* **15** pp 4–14
[2] National Council of Teachers of Mathematics 2000 *Principles and Standards for School Mathematics* ed V A Reston (New York: Guilford Press)
[3] The Australian Association of Mathematics Teachers 2006 *Standards for Excellence in Teaching Mathematics in Australian Schools* (Adelaide: The Australian Association of Mathematics Teachers Inc.)
[4] Kementerian Pelajaran Malaysia 2007 Pelan Induk Pembangunan Kementerian Pelajaran *Learn. Sp. Websites*
[5] Kementerian Pelajaran Malaysia 2003 *Standard Kualiti Pendidikan Malaysia* (Jemaah Nazir Sekolah)
[6] Bahagian Pendidikan Guru 2007 *Draft Standard Guru Malaysia* (Malaysia: Kementerian Pelajaran Malaysia)
[7] Nugent W, Sieppert J and Hudson W 2000 *Practice evaluation for the 21st Century* (Pacific Grove, CA: Brooks/Cole)
[8] Saad N S, Tajudin N M, Mohamed Z, Musa M, and Boon L K 2009 Mathematics teaching standard: Raising the quality of mathematics teacher in Malaysian school *Prosiding 1st International Conference on Educational Research and Practice (ICERP 2009)* (Putrajaya: Marriot Hotel)
[9] Pazin A H 2012 *Standard Pengajaran Matematik Dalam Kalangan Guru Matematik Sekolah Rendah* (Malaysia: Universitas Sultan Idris)
[10] Kaplan R M and Saccuzzo D P 1997 *Psychological testing: Principles, applications, and issues* (Belmont: Brooks)
[11] Lohmoller J B 1989 *Latent variable path modeling with partial least squares* (Heidelberg: Physica Verlag)
[12] Tenenhaus M, Vinzi V E, Chatelin Y M and Lauro C 2005 PLS path modeling *Comput. Stat. Data Anal.* **48** pp 159–205