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DEVELOPING INNOMATTS TO IMPROVE MATHEMATICS TEACHERS' PEDAGOGICAL AND PROFESSIONAL COMPETENCES: AN INDONESIAN PERSPECTIVE

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ABSTRACT: This project proposes an integrated model of mathematics teacher training which is developed based on the real need and potential of Indonesian mathematics teachers in improving mathematics learning. The main objective of this research is to develop the training model called INNOMATTS which has characteristics of independency, innovative, sustainable and problem solver in providing wider chance for mathematics teachers to improve their pedagogical and professional competences. This study employs R&D design using 10 steps of development model of Gall. This article describes the result of exploration study, model validation and practical testing. A sample of 30 mathematics teachers from various schools joined the INNOMATTS and were tested of pedagogical and professional competences. The results indicate that INNOMATTS is a promising training model for mathematics teachers' improvement in pedagogical and professional competences.

Key words: Professional development, mathematics teacher training model, INNOMATTS model

INTRODUCTION

Teacher as a profession needs to be developed through several training methods. We see teacher as the one who organize learning and determine the quality of students. That is why teachers should have high competences and excellent characters to run their duties (Kunandar, 2007:40). The government of Indonesia has imposed a certification program for professional teachers. Teachers who can perform well in teaching and have high competences in pedagogy, social, personality and professional would be awarded by a significant insentive.

In order to run the program, the government provides several programs of professional development such as in-service training. However, these efforts can not significantly impact the improvement of teachers' quality. There are two reasons of why the training can not improve the quality of the teachers. The first is because the training was not based on the real problem in the classrooms. It seems that the program saw teachers from various regions in the same capacity and equal background while most of them came to the training with the different problems. The second is in the level of teacher practice, the knowledge or skill they got from training is not impelemented in their classrooms (Hendayana, 2007). This condition leads to the idea that teachers always need a sustainable training which provides follow up in order to make sure that the training can significantly impact toward the improvement of teaching practice.

This issue is strengthened by the result of Teacher Competence Test in 2012. This test was conducted by the Minsitry of Education and Culture to evaluate the certification program and to know whether the program brought significant impact toward teachers competence. The participants of this test were all certified teachers and those who have participated in in-service training held by the government. The result is not too satisfying. Among 217,766 teachers joined this test, the national average score is 49,57 which is below expectation with the minimum score is 0 and, maximum score is 95 and deviation standard 11.41.

The result in Central Java and Semarang City suggests the same condition as shown in Table 1. From the table, we can learn that the certified teacher, even those who have joined in-service training, still can not perform

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optimally in pedagogy and professional competence. In mathematics education, for instance, there are a lot of skill that the mathematics teacher should master, some of which are skill of organizing the appropriate mathematics class, skill of conducting classroom action research, and skill of analyzing the students' learning result. Those skills have not optimally covered in the recent training conducted by government.

Table 1. The Result of Junior High School (JHS) Teacher Competence Test 2012

Score of UKG	**Central Java**	**Semarang City**	**Semarang City (Mathematics Teacher of JHS)**
Average score of pedagogy and professional	53,99	55,22	69,71
Maximum	90	82	91,2
Minimum	0	21	26,3
Averageof pedagogy	14,72	14,91	55,41
Maximum of pedagogy	29	27	86,96
Minimum of pedagogy	0	2	8,7
Averageof professional	39,28	40,31	70,48
Maximum of professional	70	63	94,74
Minimum of professional	0	15	29,82

Source: BPSDMK-PMP Ministry of Education and Culture 2012/info-ukg.kemendikbud.go.id

Several studies of mathematics instruction suggests that the mathematics teaching practices in Indonesia still have not promoted either the innovative learning or innovative assessment (Ardhana, 2005; Iswahyudi, 2010; Marsigit, 2007). Most of them caused by the lack of knowledge and willingness to conduct and to explore various innovative mathematics instruction. From that condition, professional competence of teachers, especially mathematics teachers, should be paid attention by conducting in-service training or on job training based on the root problems in the classrooms. The training shall also be feasible to conduct independently by the teacher association and shall not always depend on the government program.

Teachers always question about a 'what next' program after such training conducted. This question commonly happens because most of training end up by less application in the classrooms. This phenomenon suggests that such training should accomodate the feasibility and empowerment that lead to the sustainability of the problem. It can be understood that once the program ended without any follow up to guarantee the sustainability, then the skills will be lost and the knowledge will be forgotten. In another hand, one of the keywords of professionalism is the capability to apply innovative learning in order to increase the learnng quality. Thus, any training for teachers would be meaningful if it also accommodates the innovative learning.

Now we have keywords of what kind of training that mathematics teachers demand. It is a training which have characteristics of independent, problem solver, innovative and gives sustainable impacts and wider chance for mathematics teachers to improve their competences. This article proposes INNOMATTS which stands for Innovative Mathematics Teaching Study. INNOMATTS training model is a model of professional development for mathematics teacher inspired by several professional development philosophies and has characteristics which are suitable with the grass-root problems of Indonesian mathematics teaching practice.

Research Problems

The problems of this research are: (1) what kind of professional development training that matematics teachers demand? (2) is the INNOMATTS model valid based on experts appraisal? and (3) how does it engage the teachers to improve their practice?

Professional Development Training Model

The establishment of INNOMATTS inspired by various professional development training model ideas. Some of which are:

(1) Pauline Roger Model;
It is believed that teachers need time to apply changes in their teaching and critically respond the changes. This process needs support from the mathematics education expert. In the end, if the changes positively impact the students' learning result, then the teachers' belief would also positively change, and conversely.

(2) Problem Solving Cycle (PSC) Model;
PSC believes that mathematics teacher profession development needs a long sustainable program. An iteration of PSC consists of 3 integrated workshops which allow teachers to share their experience.

(3) Lesson Study;
The idea of lesson study is collaboration in designing, observing, and reflecting the learning. There are 7 keywords in lesson study, namely profession development, learning analysis, collaboration, sustainable, collegial, mutual learning, and learning community.

(4) RCC Model;
The structure of RCC consists of 2 components, namely collective meeting and assignment both at classroom and at home. The main activities in the collective meeting are structure variation, group meeting, class taping, assignment discussion, sharing, and designing the next learning.

(5) Guskey Model;
The purpose of this model is to understand the trend as dynamic changes in learning. The model suggests that teachers experience determine the instruction changes. Once teachers see that the changes they made in their learning positively impact the students learning result, then the teachers' paradigm will change, too.

Characteristics of High-quality Teacher Professional Development

Burns (2011) stated that the professional development of teachers should have characteristics as follows.

(1) Be competency-based, focused on helping teachers develop the knowledge, skills, attitudes, and dispositions demonstrably shown to improve teaching;
(2) Be based on an understanding of teachers' needs and of their work environments;
(3) Focus on deepening teachers' content knowledge and pedagogical skills;
(4) Model the exact behaviors teachers are supposed to employ in their own classrooms;
(5) Include opportunities for practice, research, and reflection;
(6) Use information related to student learning for teacher development;
(7) Be embedded in educators' workplaces and take place during the school day;
(8) Be sustained over time;
(9) Be grounded in a sense of collegiality and collaboration among teachers and between teachers and principals to solve important problems related to teaching and learning;
(10) Build professional learning communities (technical and social support provided by professional learning communities helps to overcome inertia of status quo and helps teachers make complex changes);
(11) Build teacher leadership and distributed leadership;
(12) Focus on a small number of student learning goals; and
(13) Match adult learning processes to intended outcomes.

Furthermore, NCTE (2009) said that any effort to strengthen teachers' professional practice must equally respect them as professionals. This includes matters of training in content and approach, how trainings are announced and how they are implemented. Programmes must build on and strengthen the teacher's own identity as a professional teacher and in many cases also establishand nurture the linkage with the academic disciplines of their interest. Programmes that compromise on the professional identity of the teacher and his/her autonomy will be unsustainable in the long run, providing very little psychological motivation for teacher to internalize what they have been 'told' in their practice.

METHODS

The steps of research followed the R&D design of Gall (2007:571). There are 10 steps of researchadapted from the Gall design, namely: (1) Theoretical analysis; (2) Management analysis of the training implementation; (3) Exploration study; (4) Designing hipothetical model; (5) Designing the philosophical ground, purposes, characteristics and principles of the model; (6) Designing the strategy of implementation; (7) Designing the devices; (8) Evaluation (validation, practical testing, and effectiveness); (9) Revision; and (10) Final product. While this article focus on the desription of the result of exploration study, validation process, and practical implementation testing.

Exploration Study

Exploration study is the initial step of R&D. The main purpose is to collect information as a provision to develop INNOMATTS. The objects considered are: theoretical framework of teacher training model, mathematics learning theories, the description of the learning implementation, the description of mathematics teacher competences, factors influencing the mathematics learning, and the other supporting learning factors.
The participants of the exploration study are 40 mathematics teachers in Semarang Central Java Indonesia who join the mathematics teacher council in Semarang. They were asked about their perception toward professional development training that they have ever joined and toward INNOMATTS through questionnaire and interview. The study also explored phenomena of teachers and students activities by using observation sheet.

Validation of Hipothetical Model Design

The INNOMATTS hypothetical model is validated by using Delphi technique. The validation was conducted in two phases. Delphi technique is a way to get consensus among experts by using intuitive approach. This technique has two advantages, namely it can accommodate subjective opinion of each individual and enable the opinion expressed freely without any domination. The steps of validation process are:(1) preparation; (2) expert determination which consists of 3 academic experts (professors), 5 policy makers (school principals and assessors), and 10 teachers; (3) instrument development, (4) distribution; (5) data collection; and (6) analysis. The second phase was the follow up of the revision after the model was validated in the first phase.

Practical Implementation Testing

The INNOMATTS training model was being tested to train mathematics teachers in Semarang city. There were 30 teachers joined the training for 3 months. The teachers divided into 5 clusters, each cluster consists of 6 teachers. They were all required to produce lesson plan and implement the instruction in their classes in 4 meetings. In the beginning and the end of the training, the participants were assessed by using teacher assessment guidance from the Development Center of Teacher Profession Development of the Ministry of Education and Culture 2011. They were also tested by using Teacher Competence Test based on the guidance of mathematics teacher competence test 2013. The data was collected through direct observation and video taping. The competence is considered as good if they get score above 75.

RESULTS and FINDINGS

The exploration study suggests the perception of mathematics teachers as shown in the table 2

Table 2. The Contribution of Training toward the Improvement of Mathematics Teacher Competence

No.	Contribution	Percentage
	Motivation to join the training came from another party	72,5 %
	The suitability of training material toward the need of teachers	75%
	Experiencing the benefits of training	90%
	Demanding the innovative training based on the demand of the age	97,5%
	Demanding the character development training	97,5%
	Demanding the assistance of colleagues, supervisor, expert in improving teachers' competence	92,5%
	Joining training only if it is funded by central or regional government	60%
	Understanding the training principles joined	70%
	Understanding the training strategies joined	40%
).	Understanding training model joined	37,5%
..	Understanding training characteristics joined	37,5%

Based on the table above, it can be described that mathematics teachers in Semarang city need innovative training which answers their real problems. Before this research, they only joined training if there was government program which required them to join certain training. They also demand assistance from experts in improving their competences. The table also suggests that less than 50% of the training participants really understand the strategy, model and characteristics of the training they joined.

Table 3. Training Management in Improving Mathematics Teachers' Competences

No.	Contribution	Percentage
	Understanding the planning of the training	22,5%
	Understanding the consensus initial planning of the training	17,5%
	Understanding the purpose and target of the training	52,5%
	Understanding the supporting resources in the training	55%
	Understanding the way to analyze and identify activities or tasks to reach the target	45%
	Providing management activities and coordination in every level of responsibility	52,5%
	Evaluating the implementation of training	55%
	There is evaluation to see the impact of planning and result of training toward the related parties	55%
	There is evaluation process of training by giving comment about the suitability of result and expectation	57,5%
).	There is a follow up program after the training	27,5%

From the table above, only 22,5% of mathematics teachers in Semarang understand the planning, only 52,5% who understand the purpose of the training, and only 27,5% who suggests that there is follow up program of the training they ever joined. The result of exploration study suggests that mathematics teachers need training which gives deeper understanding toward purpose, strategy, evaluation mechanism and management activities of the training. In addition, they also demand follow up of training.

INNOMATTS Training Model

INNOMATTS training model is a model of professional development for mathematics teacher and has characteristics which are suitable with the grass-root problems of Indonesian mathematics teaching practice.

The Philosophical Ground

The INNOMATTS training model also have philosophical foundation according to the condition of Indonesian mathematics instructions below.

(1) There are 4 components that should be concerned in constructing teachers' mathematics knowledge, they are knowledge of content, general pedagogy, specific pedagogy, and contextual pedagogy.
(2) Any professional development program for teachers should be based on the government policy.
(3) Any professional development program for mathematics teachers should be based on the consructivist and innovative paradigm.
(4) Any professional development program for mathematics teachers should support the trend of mathematics education, especially the implementation of the 2013 curriculum.
(5) Any professional development program for mathematics teachers should accommodate the aspiration and needs of mathematics teachers. Thus, the program should be flexible and accommodative.
(6) Any professional development program for mathematics teachers should be in a form of collegial training, instead of individual.

The purposes of INNOMATTS model training are:

(1) To facilitate mathematics teachers in order to reach the required competences,
(2) To facilitate mathematics teachers in order to conduct innovative learning,
(3) To motivate mathematics teachers in order to keep committing to do the main duties as professional teacher,
(4) To give chance for mathematics teachers to share ideas, to help each other, and to give feed back,
(5) To increase the knowledge and skill of innovative learning, and
(6) To raise the image and dignity of mathematics teacher profession as well as the pride and respect toward the profession.

The INNOMATTS in Action

Based on the philosophical foundations above, the INNOMATTS is developed by the following ideas.
(1) The INNOMATTS can be initiated by policy maker (government), professional organization (teacher council), or teacher directly request to the regional council.
(2) The initiator analyzes the need and problems of the teachers dealing with the improvement of teachers' competence.
(3) The need analysis is then matched with the INNOMATTS.
(4) The government/teacher council establishes a team to design the INNOMATTS training based on the need analysis in a form of in-service training.
(5) The next is the in-service training in a group. The result of this step is the design of cluster activity in a form of lesson study.
(6) Implementing the on-service training in a form of Do and See parts of lesson study. The implementation of *Do* and *See* in this *cluster* is done by team consisting of 5 - 6 teachers. Each team can do the activities in different schools.
(7) The result of *Lesson Study* is then designed to be applied individually in teacher's own school.
(8) The result of *See* process in each cluster is used as the review material to design the next *in-service* activities. This cycle ends until the end of the proposed program.

The action of INNOMATTS can be explained as follows. The input of the model is Junior High School mathematics teachers. Within the model, cyclic activities happen in the first circle within the small IN circle, the activities are: (1) explanation about INNOMATTS model, (2) sharing ideas about desire, hope and problems in classrooms (3) material presentation, (4) initial data collection of teacher competence, and (5) designing the ON activities. The ON activities is the implementation of what designed in the IN. ON activities conducted in the cluster to implement lesson study. After that, the cluster implement R activities which is reviewing the implementation of ON activities. The ilustration about the IN, ON, and R activities can be seen in Figure 1.

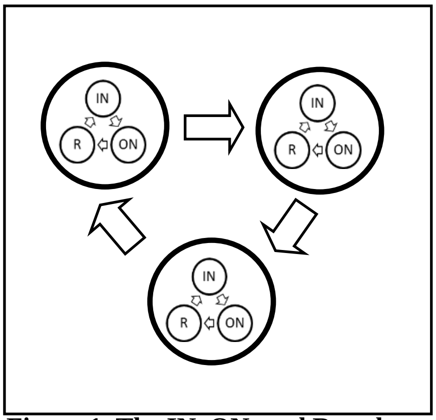

Figure 1. The IN, ON, and R cycles

From the figure above, there are three cycles of IN, ON, and R activities. In the second circle, what will happen in the IN, ON and R activities are the continued activities of the first circle, with IN is the designing, ON is the implementation and the R is the review activities.

In the third circle, we collect data of teacher competence in IN activities. After that, we collect data of students' learning result in each school, conducting interview with the principal, teachers and students in ON activities; and at last, we conduct R activities by reviewing the entire training activities and designing the follow up program.

In order to smoothen the implementation of INNOMATTS training model and to reach the training goals, we need several strategies as follows:

(1) INNOMATTS training model can be implemented in a scheduled program within mathematics teacher association, or else, it can be conducted under the authority of education foundation or another teacher association.
(2) INNOMATTS training model is designed and implemented in cyclic model (applying Deming cycle P-D-C-A/ *Plan-Do-Check-Act*).
(3) The training activities conducted in a group based project or in an individual project.
(4) The training provides expert advisor during the activities.

The structure of the INNOMATTS training program is shown in Table 4.

Table 4 The Structure of INNOMATTS

No	Subject	Theory (IN)	Practice (ON/ Cluster)	Practice (ON /Class)	Review (R)
A	GENERAL				
	Government policy about the curriculum and teacher professional development	3			
B	IC				
	The 2013 mathematics curriculum for JHS	6	2 x 3		
	Sustainable professional development for teacher	3			
	Brain storming about selected topics of mathematics teachers' need and problems	4	4 x 2		
	Mathematics learning theories	3			

	Innovative Learning Model and Approach in Mathematics (PBL/ problem based learning, PjBL/project based learning, RME/Realistic Mathematics	4	3 x 2	3x 2	4
	The use of ITC in mathematics learning	4	3 x 2		
	Lesson Study in mathematics learning	2	2 x 2		4
	Selected topics of comprehending the essential mathematics JHS material	6			
III	SUPPORT				
	Capacity Building	3			
	Follow up program	5			
IV	EVALUATION			6	

The Result of Validation

The validation process includes assessment toward the guidance of the implementation of INNOMATTS and the prediction of the result after the implementation of the training. Among the indicators, the percentage of item which is considered as good and very good (scored 3 and 4) is reaching 95%. Based on the validation, several recommendations addressed to revise the model as follows:

(1) The innovation should be expressed clearly;
(2) Evaluation after training shall be added;
(3) Several detail such as table of content, layout, the use of symbols, the meaning of several pictures shall be clear;
(4) The time allocation shall be wisely arrange and clear;
(5) It is necessary to add the advanced material such as mathematics Olympiad material;
(6) The monitoring and evaluation activities shall be well planned;
(7) The senior teachers shall be involved;
(8) The characteristics and steps shall be cleared

All the recommendation has been accommodated at above design by doing revision. Overall, the result of validation process suggests that among 34 indicators, they are considered as good and very good.

Furthermore, the result of Kruskall Wallis hypothesis testing shows that there is no difference assessment given by academic experts, policy makers, nor teachers. Below is the output of 3 independent samples testing of mean difference Kruskall Walis.

Researcher formulated hypothesis as follows:
H_0 :There is no significant difference among academic experts, policy makers, nor teachers
H_1 : There is significant difference among academic experts, policy makers, or teachers

Then we got output as shown in Table 5, Table 6, and Table 7 respectively.

Table 5. Descriptive Statistics Kruskall Wallis SPSS Output

	N	Mean	Std. Deviation	Minimum	Maximum
Data	41	3.4002	.30673	2.91	3.97
Validator	41	2.44	.776	1	3

From the table, there are 41 validators engaged in this validation process which the result shown in detail in Table 6 and Table 7.

Table 6. Ranks of Kruskal-Wallis Test

	Validator	N	Mean Rank
Data	1	7	23.00
	2	9	21.28
	3	25	20.34
	Total	41	

Among 41 validators, 7 validators came from academic experts, 9 validators came from policy makers, and the rest came from teachers.

Table 7. Test Statistics[a,b]

	Data
Chi-square	.276
df	2
Asymp. Sig.	.871

a. Kruskal Wallis Test
b. Grouping Variable: Validator

Based on Table 7, we gain *p value* of Kruskal Wallis is 0.871 > 0.05. It means that the H_0 is accepted. This result suggests that there s no revision for instrument validation.

Practical Implementation Testing Result

The result of practical implementation of INNOMATTS training model is shown in Table 8.

Table 8. Practical Testing Result

Cluster	Lesson plan (1 – 4)	Implementation (0-100)	Assessment Before Training (0-100)	Assessment After Training (0-100)	Competence Test
A	3.6	89	71	82	82
B	3.8	92	70	86	88
C	3.7	90	70	84	83
D	3.5	87	73	83	85
E	3.6	86	72	87	82

The result for each cluster shows that teachers improve their teaching and got their score of competence more than 75, which is good.

The Improvement of Pedagogical and Professional Competence

Teacher competence is defined as knowledge, skill, and behavior that shall be possessed, internalized, mastered, and actualized by teacher (Depdiknas, 2004:7). The pedagogical competence is the teachers' ability to understand their students and learning including: (1) wide perspective of larning foundation, (2) students understanding, (3) curriculum development, (4) planning of learning, (5) educated learning, (6) the use of information and computer technology, (7) evaluation, and (8) promoting students potential. While the professional competence is teachers' ability in mastering knowledge, technology, arts and culture in their field, including: (1) mastering the material based on curriculum, (2) mastering concepts related to their discipline, (3) application of concepts in life, (4) competing professionally in global context.

INNOMATTS is inspired by the principles of various models of professional development adapted with the need of Indonesian mathematics teachers. The principles of the implementation of INNOMATS include:
(1) Effective and efficient;

Mathematics teachers have chance and ability to see and discuss their teaching practice in intensive discussion by using the facilities in INNOMATTS. The parameter of effectiveness measured by the accomplishment of the goal of training, while the parameter of efficiency measured by the ability of the model to use and to empower all the supporting potential either human resources, equipment, or leadership in order to save the fund and time to reach the goal.

(2) Problem solving oriented;

INNOMATTS is formulized based on the need of mathematics teachers in implementing their learning, thus it is supposed to be able to encounter the core problem of mathematics learning.

(3) Easy to conduct;

The structure program of INNOMATTS is simple.

(4) Innovative;

Though it is inspired by various model of teacher professional development, the essence of INNOMATTS training model is philosophically different with the other model of professional developments. The excellent characteristics is in the IN, ON, and R activities which gives wider chance for teachers to develop and to improve their practices. The innovation can also be seen through the program structure and the material which promotes the innovation in mathematics learning.

The Characteristics of INNOMATTS

Based on the INNOMATTS principles, we can describe the characteristics of the training model as follows. First, INNOMATTS is a problem solver training model. Before the program structure of INNOMATTS constructed, the initiator of the training conduct a need analysis which can identify the core problems faced by mathematics teachers. Once the problems have been identified, then the training program can be formulated.

Second, INNOMATTS is independent. It means that whether the government can fund or support the program or not, INNOMATTS can be initiated and conducted by teachers community at schools, foundation, or association.

Third, the structure and programs of INNOMATTS accommodate the trend and innovation in mathematics learning. Patel (2011) suggests that innovation in teaching mathematics can be diversified in terms of methods, pedagogic resources and mastery learning strategy. Thus the training structure is designed in a hierarchy cycles, starts from the classical meeting, cluster activities or individual practice in each school. It is supposed that after the training, teachers can master the skills such as designing and implementing innovative learning model, namely *problem based learning*, *project based learning*, RME/*Realistic Mathematics Education*, MEA/ *Model Eliciting Activities*, and so on.

The forth is sustainability. INNOMATTS provides post-training program as a follow up of the training.

CONCLUSION

From the analysis about characteristics and implementation above, we learn that: (1) Indonesian mathematics teachers demand on the sustainable training to developtheir pedagogical and professional competences, (2) INNOMATTS training model is considered as valid based on theoretical framework by academic experts, (3) INNOMATTS can facilitate mathematics teachers to develop good practice in mathematics teaching and to improve their pedagogical and professional competences. Mathematics teachers get wider chance to design, discuss, and solve their problems in mathematics learning through cluster activities and collegial practice at schools. INNOMATTS can be an alternative training model which is excellent and feasible to be conducted independently through teacher association.

RECOMMENDATIONS

The INNOMATTS training model has been conceptualized and discussed through various teacher forum. Thus, it makes INNOMATTS a promising training program to improve the pedagogical and professional mathematics teachers.There are yet several questions which need to be addressed through further reasearch. We need more empirical evidence to claim the effectiveness of this model in order to accomplish the goal of Indonesian teacher professional development.Furthermore, we need to disseminate the model in order to spread the advantages and opportunities for mathematics teachers.

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