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How Could a Student Discover Something He/She Does Not Know It Before?: What Professional Development Those Mathematic Teachers Do Need?

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Abstract: Thirty teachers were observed, interviewed and provided with strategic training program based and derived from the understanding of the learning theory of constructivism. The program consists partially of topics related to learning, instruction, thinking, cognition, metacognition, teachers role, which was designed to fit their needs as an in service-teacher of mathematics. data were collected through observations, interviews and survey to help them reveal as much as possible of their believes and attitudes about different concepts related to learning of mathematics. Data were analyzed quantitatively and qualitatively. The impact of training showed positive significant impact on teachers; believes and attitudes and practices.

Key words: Professional development; Strategic; Principles of learning; Cognition; Instructional design; Learning theory

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1. INTRODUCTION AND THEORETICAL FRAMEWORK

It is somehow astonishing when tenth grade math teacher responded to a question was made by the author, “Why you did not wait for student to think and give some

suggestion for the measure of the exterior angel before you gave them the official definition for the exterior angel?" the teacher immediately said as he was deploring the suggestion, he said how could students discover the measure of the exterior angel while it has never been taught before... they did not know it before!

For such a teacher and similar ones, what type of professional development can be done for them? In another class, almost twenty minutes after the class began, as the teacher was giving third example about the intersection of two sets, a student raise his hand and ask "teacher, what does this symbol means", he refers to the symbol ($\cap$), the teacher immediately respond "it is intersection". This is another proof support the research finding; one of the biggest misconceptions is that if teacher teach then student must learn (Kelly, 2009). It is so true! In many instances, before my eyes, where different students ask the same question even though it was answered traditionally by teacher several times; an indication for misunderstanding or no understanding. Again what kind of professional development those teachers need?

Possible rational for such behaviors by teachers; it reflects part of their believes about the concept of discovery, learning, and teachers' role. Because teacher went on to say "Students has to know it through definition and examples solved first by me (referring to himself), and then students will be given examples to find the measure of the exterior angels, again at home, students will have the opportunity to read and understand the definitions given in the classroom."

Another rational, teacher may have doubt about students ability to think and discover or build new information or knowledge. Whereas research shows that learners should be given the opportunity to struggle, since it is by itself is rewarding; "we cannot even though with the most kindly of intentions, exclude students from those experiences that come from struggling with a problem. We must help them build concrete referent for mathematical concepts so that their experience will give them the necessary tools to develop understandings. We cannot cripple our students mentally by taking away from them the struggles that must come before understanding is brought to fruition." (Chatterley & Peck, 1995, pp. 429–436).

Strategic professional development must be design then to help teacher understand not only the process of learning but also relationship between learning and surrounding environment so that learners needs and demands can be met. Since understanding of such relation can help maximize the production of proper role by teachers. Just as Chatterley and Peck says "if we understand the process necessary to provide the referents within the minds of our students, we will cease to mentally cripple them by being overly kind and sympathetic and by helping too much and often too soon." (Chatterley & Peck, 1995, pp. 429–436). Although research also shows that continuous professional development does effect teachers perspectives on students' work, and explain to teachers that proper content of mathematical knowledge is needed for specific goal (Siegfried, Gordon & Garcia, 2007). Siegfried's study showed positive correlation between the years of professional development teacher has in cognitive guided instruction and teacher's understanding of the grade appropriate mathematical concepts (p. 94). On the other hand research show professional development does not have the same impact on all chines teachers. This due to major factors; training and refresher courses (Zhang, 2010). Zhang's research shows that providing many different types of training through professional development does not necessary help bring about effective or significant outcome (p. 270). This kind of results not only encourage us to provide but to

refine our strategic professional development. In the same research a quote from Ball, Hill and Bass (2005) can also beneficial to show the importance of professional development; every day in mathematics classrooms across the country, students get answers mystifyingly wrong, obtain right answers using unconventional approaches, and ask question and teacher are in the unique position of having to professionally scrutinize, interpret, correct, and extend this knowledge (p. 98).

Swan And Swain's research examined the impact of professional development program on the practice and beliefs of numeracy teachers shows teacher were positively affected. Teachers' beliefs were significantly affected and moved toward helping learners to discover and find connections between mathematical knowledge and moving away from transmitting knowledge to discovering of knowledge through the use of cooperative small group, use of higher-order questioning, focus on reasoning and build and connect on previous knowledge (Swan & Swain, 2010).

Ample research shows that professional development is a crucial factor for improvement of learners outcome (Thornton *et al.*, 2009). That coincide with the centrality of teachers as central fact in curriculum theory and its practices; success in achieving any educational goal depends solely on teacher. One concern that is never been taken into consideration seriously and critically is that professional development for the goal of improving teachers ability in the area of pedagogy and content specifically those teacher who have gone through traditional teacher certification that resulted in attainment of bachelors' degree. Research expose the importance of mastering the science of education ad positively correlated it to before teacher enter to students' achievement (Thornton, 2009).

Beside the general training with the professional development program, research shows that it is decisive to design professional development for specific grade level, for specific knowledge, and for specific needs. Since each has its own characteristics and required special skills and roles. The NCTM for example emphasize the importance of learning mathematics based on the constructivist philosophy to help learners to create or build their own mathematical knowledge through handsCon activities, models, collaborations and cooperation, and by considering students previous experience, knowledge, levels, goals, and promotion of freedom in the curriculum through by focusing on the richness of both the surrounding environment as well as the activities that should be design and provided. The impact it causes and the value that is aimed to develop and improve. Where value in mathematics is defined as the deep affective quality that education fosters through the school subject of mathematics in which the following seven criteria are to be seen to call something a value: Choosing freely, choosing from alternative, choosing after thoughtful consideration of the consequences of each alternative, prizing and cherishing, affirming, acting upon choices and repeating (Gates, 2001).

In addition, NCTM emphasize the importance of providing professional development based on grades level start from prekindergarten and pay attention to professional development for teacher who do not have enough training on how to connect between the theoretical knowledge and practicing and employing such knowledge. On the contrast of many teachers' believe which they say students at early grades such as first and second grades would not be able to reason, discover and solve problems, the NCTM emphasize the process standards; problem solving, reasoning and proof, and connections (NCTM, 2008). The example of problem solving standard demand teachers to be equipped with understanding of the what proper roles are teachers must play and achieve through the focus on the use of problem solv-

ing as framework for metaknowledge for intentional learning. Research shows that problem solving serve as the basis for investigation and mathematical enquiry. And warrant teachers from just presenting students with a problem and guide them for solution. Rather, it is assumed that problems are arise to students as they trying to achieve their goals during his/her investigation. This approach of instruction is parallel to the idea that problem solving should be a vehicles for identifying deficits in knowledge, abilities, directions and aptitude (Glasersfeld, 1991; Resnick, 1989).

This require teachers to master several domains of knowledge to be able to engineer or manage proper environment to assure strategic learning for every learner. Where strategic learning needs and requirements range between learners need to be able to set and use meaningful goals so that students can learn and keep an appropriate level of motivation, to self-assessment and self-evaluation (McKeachie, 1994). Since learning outcome depends on the instructional practices with the students' strategic learning strategies and skills (p. 350).

This require teachers to be strategically equipped with skills and abilities to help them deal with any circumstances that may arise. Research shows that teacher has to master several domains of knowledge in order to be competent and be able to produce the best teaching act. These domains are graphed in the figure below (Kennedy, Ball & McDiarmid, 1993). In addition to that, amply research shows a vital role for dynamic technology in improving motivation, thinking and understanding of mathematical knowledge (Shiyyab, 2013). Yet a dimension has to be studied and continue to be studied under the umbrella of the question of "what is the best use of technology in order to achieve the stated goal?" (Bitter & Legacy, 2009).

It is clear that teacher's decision depends on many vital variables where the knowledge of subject matters among the many domains play the role of vowels in professional development.

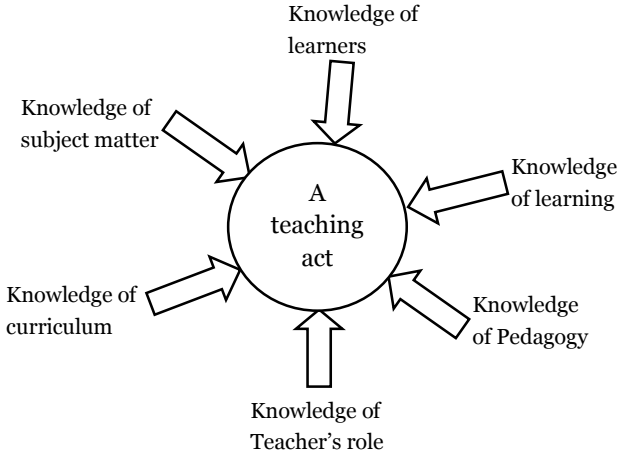

Figure 1
Teachers' Actions Influenced by Different Domains of Knowledge (Kennedy, Ball & McDiarmid, 1993, p. 9)

2. PROBLEM OF THE STUDY

The problem of this study arose as teachers were neither able to play different role nor to believe that students are able to discover information and knowledge, and therefore there is no need to give students opportunity to think and discover information or build their own knowledge. One of the teachers questioned the comment made by the author when the author ask the teacher at the end of the class meeting "why don't you give your students an opportunity to think of the measure of the exterior angel before you give them the formula for measuring it?" Immediately the teacher interrupt by objection saying "how could a student discover something he does not know before?" Such an objection reflect and allow for several areas of research: teacher's believe, teacher's role, teacher's pedagogy, knowledge of learning and knowledge of learners, learning and instruction. All the teachers believes that if they teach then students shall understand, they also believe students do not possess the capabilities to discovering information on their own. most of the teachers say we have first to give them the fact; or the rule, then give a question to see if they can apply or use the rule.

3. PURPOSE OF THE STUDY

The purpose of this study is to investigate the impact of strategically designed instructional activities; pedagogical content knowledge including theories of learning such as the constructivism theory on teachers believes about their role, students rule, instruction and learning process so that they become more competent in the classroom.

4. METHODOLOGY AND PROCEDURE

Twenty two teachers were asked to fill a survey (Appendix B) measuring the degree of their mastery level on the following seven principles:

1. Master teachers start where their students are.
2. Master teachers know where their students are going.
3. Master teachers expect to get their students to their goal.
4. Master teachers support their student along the way.
5. Master teachers use feedback to help them and their students get better.
6. Master teacher focus on quality rather than quantity.
7. Master teachers never work harder than their students (Jackson, 2009, p. 5).

In order to gain more insight about teachers' believes and needs they were asked to fill at the beginning of the training sessions a survey about the above seven principles, and again at the end of the training sessions. In addition to the survey, teachers were given sequential opportunities to discuss and talk about their believes, and experiences related to instruction and learning process through teachers interview to solicit answers about their knowledge and insight about educational topics and issues. Their answers were recorded and analyzed. At the end of the training sessions teacher again were asked to fill the same survey to test for any impact of the training sessions in empowering our teacher and affecting their beliefs.

Teachers interviews consists of answering the following questions:

1. Would you please tell me what do know about the term instruction.
2. Would you please tell me about the term learning.

3. Would you please tell me about what do you know about pedagogy.
4. Would you please tell me why we design and use method of teaching.
5. How can you help your students discover mathematical facts or procedures?
6. What is your obligations and expectations in the classroom?
7. What is the obligations and expectations for your students?
8. In your opinion what cognitions refers to?

Teachers' responses to the survey were scored, each response was given score between 1 out of 4 for response A's, a score of 2 for response B's, score of 3 for the C's answer and score of 4 for the D's responses in the survey items. Each principle was measured by scattered items (Appendix A). The scoring sheet was adopted from the Jackson instrument (Jackson, 2009).

Total score for each principle was calculated and also grand score for all the principles was calculated. Collected data through interviews, observation, and survey were analyzed qualitatively and quantitatively. Repeated measure design was used to test the impact of the training program on both male and female teachers. The following two hypothesis were tested:

4.1. Hypothesis of the Study

1. There is no significant difference in teachers' believes before and after the training.
2. Male and female teachers were effected equally.

4.2. Training Sessions

Training sessions were administered throughout three months period. The content and topics were specifically designed and chosen to fit and meet teachers' needs which were observed and identified through teachers' interviews, observation, and their answers to the survey. Sample of the session content was: instructional design, comparison between content-based curriculum, process-based curriculum, and development based curriculum. Some theories of learning; constructivism as a theory and learning, activities were chosen so that students can have a central role through cooperative and collaboration learning. Cognition as well as metacognition and the relationship between them was also discussed. Theories of misconceptions and remedial actions were also discussed through lectures as well as through workshops. Teachers role and role of effective teaching was discussed and articulated through the workshops. In addition to that teachers were interacting with different software. In specific algebra I and II along with the geometers' sketchpad and interactive calculus, in addition to other software which they allow students to draw, analyze and connect different functions and their related rate of change simultaneously on the same page. It provides learners with the freedom to move and change any parameters, hypothesis and discuss possible change and study the effect of that change on the underlined mathematical concept through the rest of other representations. All that can be seen on one page of the software.

All that were discussed within the framework of metacognition and several operational definitions were discussed and negotiated. To bring teacher's attention, interest, and to influence their believes and the needs for change. Examples were given to refer to the traditional teaching as well as teaching based on the constructivist and problem solving strategy.

4.3. Sample

Twenty three teachers conveniently sampled to suits the purposes of this study and to observe their attitudes and behaviors in the actual classrooms. Those selected teachers had their bachelor's degree in mathematics and their teaching experiences ranges between 4 to 16 years in the fields of teaching elementary as well as secondary school mathematics.

5. DATA ANALYSIS

Teachers' pre training answers for the 49 questions (Appendix, B) that measures the range of understanding for the seven principles were analyzed. It was found among 23 teachers, 19 teachers' scores of total between 98–137 (Table 1). This level indicates the Apprentice level (Jackson, 2009). Where apprentice teachers view for good teaching to be based on choosing the right strategies, and struggle in understanding the curriculum objectives and how they can accomplish them given the class limited time. They plan their assessment for each unit early but they do not consider it as a formative assessment to follow their observation with a proper action. Their strategies based on high and low levels of students not based on their needs. Apprentice teacher consider his/her and classroom values as standards and expect students to adopted them. Apprentice teachers lose faith and they often become disillusioned (Jackson, 2009).

Table 1
No. of Teachers at Each Level in Pre-Training

Level	**177–196 Master teacher**	**138–176 Practitioner**	**98–137 Apprentice**	**49–97 Novice**
No. of teachers	0	0	19	4

Four teacher out of the 23 teachers total score cross principles for each teacher was ranged between 49–97. This level is the novice level in which the main characteristics and behaviors of novice teachers are: sabotage change; the content or the book guide their practices and activities; and they believe it is difficult to accomplish goals and objectives related to students' thinking and values and understanding the subject matters simultaneously. They based their behaviors and actions based on the content-based curriculum approach. Novice teachers do not have nor use many devices and tools to help students build or discover mathematical concepts. Students who struggle or they not catching up with other students are treated through remedial program. Assessment though testing often comes after teacher have cover the unit. Those teachers usually work very hard and do the lion's share.

In comparison with Master teachers whose scores are ranged between 177–196. They spent most of their time up front engineering and designing their instruction through thinking about the teaching situations and analyzing what went on in the classroom in order to set new goal for their students based on students' needs. Ahead of time they set standards for what is considered acceptable and what evidence indicates students' mastery. Master teacher use formative assessment and design instruction and use specific support for students before they fail. They balance

ways of communication and work of learning between their students and themselves. They pay special attention to students values and abilities and help them use these assets to acquire ad achieve the shared goals and objectives. The expectations of master teacher are what they expect of themselves to help their students. Not what they expect students to do. On the post training survey responses show different results (Table 2). 6 teacher score at the mastery level, 10 teachers were categorized as practitioner level. 7 teachers at the Apprentice level, And no teacher score at the lowest—-Novice level.

Table 2
No. of Teachers at Each Level in Post-Training Survey

Level	**177–196 Master teacher**	**138–176 Practitioner**	**98–137 Apprentice**	**49–97 Novice**
No. of teachers	6	10	7	0

6. QUANTITATIVE ANALYSIS

The arithmetic averages and standard deviation for all the principles (Appendix B) were calculated (Table 3) before the training sessions and again at the end of the training sessions.

Table 3
Means and Standard Before and After Training

	Gender	**Mean**	**Std. deviation**	**N**
Before	Male	116.4667	26.03258	15
	Female	108.6000	26.63725	15
	Total	112.5333	26.18598	30
After	Male	151.2000	33.56699	15
	Female	130.4000	23.14489	15
	Total	140.8000	30.23973	30

Table 3 shows observed differences between the groups as well as within groups. To test for significant differences before and after as well as between male and female the repeated measure design data in Table 4 and Table 5 shows no significant difference between male and female ($F_{(1,28)} = 2.177$) at ($\propto = .05$). whereas there is a significant difference ($F_{(1,28)} = 110$) between due to the training program at ($\propto = .05$). There is no significant interaction between gender and training session.

To explore the extent of the impact of the training program the effect-size (ES) as a practical indicator eta-square (η^2) was calculated to be 0.797, which can interpret the impact as large or strong impact according to Cohen's guidelines (Cohen, 1992).

Teachers Interview Vignette

On the other hand, teachers' responses to the interview questions were approximately aligned with their level through the survey responses. This is a vignette of teacher interviewee. Most of the teachers almost have similar responses.

Interviewer: What does instruction means to you?

Table 4
Test of Between-Subjects Effects

Source	Type III sum of squares	df	Mean square	F	Sig	Partial eta squared
Gender	1540.833	1	1540.833	2.177	.151	.072
Error	19822.333	28	707.940			

Table 5
Tests of Within-Subjects Effects

Source		Type III sum of squares	df	Mean square	F	Sig	Partial eta squared
Factor 1	Sphericity assumed	11985.067	1	11985.067	110.003	.000	.797
Factor gender	Sphericity assumed	627.267	1	627.267	5.757	.023	.171
Error (factor 1)	Sphericity assumed	3050.667	28	108.952			

Interviewee: Instruction is what students learn through the help of others such as teacher, I mean when someone teach students something this is called instruction.
Interviewer: What does learning means to you?
Interviewee: Learning is changing in behaviors. We call learning we learner learn by him/herself.
Interviewer: What does pedagogy means to you?
Interviewee: I really do not know. This is the first time I hear about it.
Interviewer: Why you think we design and use method of teaching?
Interviewee: I use method of teaching to be able to transfer information and knowledge to our students, I mean to be able to deliver the mathematical knowledge to our students.
Interviewer: do you think if you teach then students must learn?
Interviewee: off course . otherwise why we teach. Unless some students may they do not want to learn. Or they have problem in their brains. By the way those students some years are many. What we have to do? I have curriculum to cover it by the end of the year. If I do not cover the whole curriculum I be held accountable by my you know... referred his intendant.
Interviewer: Tell me about cognition what does cognition means to you?
Interviewee: Cognition (Idrak in Arabic language) means understanding or learning if I am mudrik (the past tens of Idrak) something means I understand it).

Interviewer: Tell me about the obligation of your students and yours as well as yours expectations?

Interviewee: my obligation is to teach and explain the content, if students ask a question then I will be glad to answer it if it is related to the topic discussed in that classroom. I expect students to attend class and listen, learn, and do their homework, and if they do have a question or problem, if I have time I try to solve or help him, but you know we have to move on, we have curriculum to finish. after I give an example and show them how to do it, I expect students to be able solve similar problems.

Interviewer: what do you mean by curriculum?

Interviewee: off course, the mathematics book

Interviewer: how do you help your students discover or build mathematical knowledge?

Interviewee: I have to do my job, it is teaching. Then as you know I give the theory, prove it for them, I also give example and solve it, if someone does have a question I'll go ahead and answer it for him, then I give an exercise and ask students to solve, and ask someone to come to the board and show his solution.

Interviewer: what is thinking and how can you help students improve their thinking?

Interviewee: thinking is as you know mental operations something we do not see. May be there some relationship between thinking and mathematics. They say mathematics require thinking and I do agree with that.

7. OBSERVATION AND CONCLUSION

Out of this interview a lots of information can be deduced about teachers' knowledge and believes. Teachers says instruction is learning through person other than the learner, whereas learning is when learner learn by him/herself. In this episode reflect that teacher does not understand process of learning, process of instruction and whose obligations for learning and instruction. Driscoll defines instruction as "the deliberate arrangement of learning conditions to promote the attainment of some intended goal" (Tillman, 2005). Where Shiyyab defines instruction as the engineering or managing learners' environmental conditions; whether psychological, social, and materialistic conditions to achieve the projected goal (Shiyyab, 2013). Therefore it is the obligation of educational members; teacher, principles, designers, parents to design a proper environment so that learners can attain acquire their needs. One of the learning principles teacher should know that different goals, different students require different designs.

In the post training interviews several teachers explicitly expressed their understanding of instruction, learning, thinking and metacognition, curriculum and their roles well as students roles. Sample of what teachers felt and believes the following vignette has been recorded

"This means the process of instruction is a process of building human being through designing proper environment... it is so complex process... it is engineering the brain. It is even harder than the duty of medical doctors, because it is working

with the brain from remote. Whereas neuroscience or brain doctors work with brain from close distant".

Learning and the process of learning by its nature is the responsibility, duty and obligations of the learners themselves. On top of that, process of learning or process of building or rearranging the cognitive structure through the brain's process of searching for receptor nodes for bits of new information and then arranging or rearranging this bits of information into mental model in the cognitive structure by the process of relating and connecting related knowledge based on the characteristics of the previous and new bits of information. This require students active role; overtly and covertly, engagement, thinking and rethinking, discussion and students-students dialogue and students teacher dialogue.

In the pre-training interview all of the teachers indicates that cognition (Idrak C in Arabic language) refers to understanding and awareness of the mathematical content. Whereas post training informal interview teachers express the understanding of cognition through connecting it to several issues such as students active role, students' engagement; nature of the mathematical activities, and teachers encouragement. One of the Constructivist theory for learning pillar is that knowledge is not passively received but actively built up by the cognizing learner and the function of cognition is to help in the organization of the experiential world, not the sighting of ontological truth (Jaworski, 1994). Teacher then, understood that cognition refer to way Teacher start to realize that part of their vital role is to help learners invest the maximum of pupil's assets in and through the process of the underlined information until it is assimilated into the learner's cognitive structure.

Moreover, teachers start to realize that building concepts is not a one-time shot. Building concepts require a series of intellectual operation including centering of attention, abstracting, synthesizing and symbolizing, assimilation of meaning, all that requires context, Problem, proper teacher's role, and students role, enough time, designing right sociomathematical norm and society in an environment in which students are playing a major role where acknowledgments, appreciations, encouragement, challenging in a safe environment where students can freely operate in a complex environment is the general standard and the umbrella which teachers must think of and judge their design their instruction. This bring teachers before a formidable challenge; challenge of understanding comprehensively the whole process of education and interactions among all the related variables.

8. RECOMMENDATIONS

Although allowing teachers to teach without taking a curriculum theory course considered a sinister act. and although it is not only strange but forbidden to allow mathematics graduates to teach mathematics in schools without set of courses specifically designed from education field and mathematics to form a program to train newly graduates. Yet, three questions should be given a serious thought if we need to face the twenty first century with equip and capable teachers to flexibly and freely act in the classroom. These questions are; what mathematics is entailed by teaching?; what makes mathematical knowledge usable for teaching?; and how might teachers develop usable mathematical understanding?

Until these questions crowned by the thinking of bridging the chasm among the mathematics content, methods courses, and practice, where the themes for all these questions all are integrated and use to explain each other and any concern may

rise, we will continue to struggle with our mathematics teachers. A program where interaction, reflection, experience, and interest are the rudimentary ingredients for educative program may help in healing and weaving our wounded education system.

REFERENCES

[1] Bitter, G. G., & Legacy, M. J. (2009). *Using technology in the classroom.* Boston, MA: Allyn and Bacon.

[2] Chatterley, L. J., & Peck, D. M. (1995). We're crippling our kids with kindness!! *Journal of Mathematical Behaviors, 14*(4), 429–436.

[3] Cohen, J. (1992). Quantitative methods in psychology. A power primer. Psychological bulletin. *The American Psychologist Association, Inc., 112*(1), 155–159.

[4] Gates, P. (Ed.). (2001). *Issues in mathematics teaching.* NY: Routledge, Falmer.

[5] Glasersfeld, V. E. (1991). *Radical constructivism in mathematics education.* Norwell: Kluwer Academic Publishers.

[6] Jackson, R. R. (2009). *Never work harder than your students and other principles of great teaching.* Danvers: ASCD.

[7] Jaworski, B. (1994). *Investigating mathematics teaching: a constructivist enquiry.* PA: The Falmer Press, Taylor & Francis Inc.

[8] Kennedy, M. M., Ball, D. L., & McDiarmid, G. W. (1993). *A study paackage for examining and tracking changes in teachers' knowledge.* (Technical Series 93-1) [on-line]. Retrieved from http://ncrt.msu.edu/http/tseries/ts931/.htm

[9] McKeachie, J. W. (1994). *Teaching tips. strategies, research, and theory for college and university teachers.* U.S.A.: D.C. Heath and Company.

[10] NCTM, Principles and Standards for School Mathematics. (2008). The National Council of Teachers of Mathematics, Inc. Reston, VA. U.S.A.

[11] Resnick, B. L. (1989). *Knowing, learning, and instruction.* New Jersey: Lawrence Erlbaum Associates, Inc.

[12] Siegfried, M. J., Gordon, M. J., & Garcia, R. J. (2007). Barely in S.T.E.P: How professional development affects teachers' perspectives and analysis of student work. In *Proceedings of the 29th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education.* Stateline (Lake Tahoe), NV: University of Nevada, Reno.

[13] Swan, M., & Swan, J. (2010). The impact of a professional development program on the practices and beliefs of numeracy teachers. *Journal of Further and Higher Education, 34*(2), 165–177.

[14] Zhang, D. (2010). Effectiveness of professional development policies based on teachers' subjective evaluation. *Front. Educ. China, 5*(2), 270–289.

[15] Thornton, S. J., Crim, C. L., & Hawkins, J. (2009). The impact of an ongoing Professional development Program on prekindergarten teachers' mathematics practices. *Journal of early childhood teacher Education, 30*, 150–161.

[16] Smith, P., & Ragan, T. (2005). *Instructional design.* Danvers, MA: John Wiley & Sons Inc.

APPENDIX

Table 6
Appendix A

Principle 1	Principle 2	Principle 3	Principle 4	Principle 5	Principle 6	Principle 7
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	32	33	34	35
36	37	38	39	40	41	42
43	44	45	46	47	48	49

Resource: Jackson, 2009.

Table 7
Appendix B1

Student	Principle 1	Principle 2	Principle 3	Principle 4	Principle 5	Principle 6	Principle 7	Row total
1	24	18	17	16	19	19	19	132
2	22	22	20	17	19	19	16	135
3	20	21	21	17	19	17	19	134
4	19	12	17	20	20	22	16	126
5	19	17	19	19	22	16	18	130
6	19	20	17	19	20	19	20	134
7	10	9	9	12	12	13	16	81
8	15	16	15	18	18	18	16	116
9	12	12	14	15	15	13	12	93
10	15	13	15	15	17	17	18	110
11	16	18	16	15	16	16	19	116
12	7	6	6	5	7	6	6	43
13	18	19	20	20	21	17	20	135
14	22	17	16	22	17	20	17	131
15	22	18	17	19	18	18	19	131
16	19	20	18	20	18	21	19	135
17	22	19	21	17	18	18	19	134
18	19	21	20	19	16	18	19	132
19	20	20	16	20	20	19	20	135
20	19	20	17	19	18	19	19	131
21	13	13	16	15	18	15	19	109
22	17	20	21	19	20	19	19	135
23	6	7	7	7	7	6	7	47
Principle average	17.17391	16.43478	16.30435	16.73913	17.17391	16.73913	17.04348	117.6097

Table 8
Appendix B2

Student	**Principle 1**	**Principle 2**	**Principle 3**	**Principle 4**	**Principle 5**	**Principle 6**	**Principle 7**	**Row total**
1	24	23	23	23	23	22	22	188
2	26	26	27	27	28	28	27	189
3	24	25	25	27	25	26	26	178
4	23	16	21	24	24	26	20	154
5	25	25	24	24	27	28	27	180
6	23	24	26	27	24	27	28	179
7	14	13	13	16	12	13	16	97
8	15	16	15	18	18	18	16	116
9	12	12	14	15	15	13	12	93
10	15	13	15	15	17	17	18	110
11	16	18	16	15	16	16	19	116
12	15	14	14	13	15	14	14	99
13	18	20	24	21	21	21	21	146
14	26	27	27	26	26	28	27	187
15	26	26	22	22	25	26	27	174
16	25	25	18	24	18	21	19	150
17	22	19	21	23	22	20	22	149
18	19	21	23	19	22	18	19	141
19	26	25	20	24	24	27	26	172
20	21	20	21	23	22	21	20	148
21	17	19	20	19	22	19	23	139
22	17	20	21	19	23	19	19	138
23	12	13	13	13	13	12	13	89
Principle average	19.43478	19.30435	19.47826	20.13043	20.30435	20.26087	20.30435	139.2174