THE INFLUENCE OF TEACHER BELIEFS, OPPORTUNITY TO LEARN, AND PROPENSITY FACTORS ON CREATIVE MATHEMATICS TEACHING

BY

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A dissertation submitted in fulfilment of the requirement for the degree of Doctor of Philosophy in Education

Kulliyyah of Education
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DECEMBER 2020

ABSTRACT

The emphasis on nurturing students' mathematical creativity in schools is not new in Malaysian educational landscape. More than ever before mathematics teachers are now expected to foster creativity among students through creative teaching. However, not all mathematics teachers embrace creative teaching and many reject it especially at the secondary level mathematics. The present study was designed to investigate the effect of three teacher related factors namely beliefs, opportunity to learn and propensity on creative teaching in mathematics based on socio-cultural theories of teacher learning especially Goos' Teachers as Learners framework. The main purpose of the study was to evaluate the causal relationships between teachers as learners factors (mathematics teachers' beliefs, opportunity to learn, propensity factors) and creative mathematics teaching from one hypothesized to two alternative structural models. The study also examined the invariance of the structural model across samples of lower secondary (n=157) and upper secondary (n=197) mathematics teachers. The study involved 354 random samples of secondary mathematics teachers chosen by using stratified sampling from all eight districts of Selangor state. The instrument for the cross-sectional survey was adapted mainly from Palaniappan (2009) for creative teaching factor, Stipek (2001) for beliefs factor, Desimone (2009) for opportunity to learn and Kunter et al (2011) for propensity. The study hypothesized that creative teaching is directly or indirectly influenced by beliefs, teacher opportunity to learn and teacher propensity factors. Three alternative models were tested to examine which fit the data well. The hypothesis was supported by The Alternative Model II of which opportunity to learn was the only direct predictor of creative mathematics teaching. Teachers' beliefs indirectly influenced creative teaching via propensity factors. The findings revealed that opportunity to learn and propensity factors were positively correlated. The invariance analysis of the structural model across lower secondary samples and upper secondary samples revealed that the structural model was similar across both groups. The findings suggest for quality learning opportunity for teachers in order to foster creativity in classrooms

خلاصة البحث

التركيز على رعاية الإبداع الرياضي لدى طلاب المدارس لم يعد شيئا جديدا فى المجال التعليمى الماليزى.على أية حال فإنه ليس كل معلمى الرياضيات يتبنون مثل هذا التدريس الإبداعى في تدريس الرياضيات لطلاب المرحلة الثانويه. ولهذا تهدف هذه الدراسة إلى تقييم العلاقة بين عوامل المعلمين كدارسين (معتقدات معلم الرياضيات، والفرصة للتعلم، والميل للتعلم) وبين تأثير هذه العوامل على التدريس الإبداعى فى الرياضيات من مفترض واحد إلى اثنين من نموذج .(Goos' (2005 وتضمن البحث 354 معلماً كعينة عشوائية من معلمى الرياضيات للمرحلة الثانويه تم اخيارهم من ثمانية مناطق فى ولاية سيلانجور. والأداة المستخدمة هي استبانة من تصميم الباحث اشتملت على10 عناصر ديموغرافيه و 44 عنصرا آخر تم تبنيها من (Palaniappan (2009 فيما يخص عنصر التعليم الابداعى، ومن (Stipek (2001 فيما يخص عنصر الاعتقادات، ومن (Desimone (2002 فيما يخص عنصر الفرصة للتعلم و كذلك العالم Kunter (2011) et al فيما يخص الميل للتعلم، وقد افترضت الدراسة أن التعليم الإبداعى يتأثر بكل من المعتقدات، وفرصة المعلم للتعلم، وبعوامل الميل لدى المعلم وذلك بطريقة مباشرة وغير مباشرة. وباستخدام نمذجة المعادلة الهيكلية فقد تم اختبار ثلاث نماذج بديلة لفحص أياً منها يتوافق جيدا مع البيانات. وقد تم تدعيم الفرضية من خلال النموذج البديل الثاني حيث عنصر فرصة التعلم كان المؤشر المباشر الوحيد على التدريس الإبداعى للرياضيات. وكذلك أثَّر عنصر معتقدات المعلمين بشكل غير مباشر على التدريس الإبداعى من خلال عوامل الميل للتعلم. وكشفت نتائج البحث أن الفرصة للتعلم، والمعتقدات، وعوامل الميل مرتبطة بشكل إيجابي. وكشف التحليل الثابت للنموذج الهيكلى لعينة المرحلة الثانوية الأولى (n=157) وعينة الثانونة العالية (n=197) أن النموذج الهيكلى متشابه فى كلا المجموعتين. وتوصى النتائج بتوفير فرص تعليم جيدة للمعلمين من أجل تعزيز الإبداع فى الفصول الدراسية للرياضيات.

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DECLARATION

I hereby declare that this dissertation is the result of my own investigation, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at the IIUM or other institutions.

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TO MY BELOVED WIFE

ACKNOWLEDGEMENTS

Firstly, it is my utmost pleasure to dedicate this work to my dear parents and my family, who granted me the gift of their unwavering belief in my ability to accomplish this goal: thank you for your support and patience.

I wish to express my appreciation and thanks to those who provided their time, effort and support for this project. To the members of my dissertation committee, thank you for sticking with me.

Finally, a special thanks to Associate Professor Dr. Nik Suryani Nik Abd. Rahman and Associate Professor Dr. Sharifah Sariah Syed Hassan and Professor Dr. Sidek Baba for their continuous support, encouragement and leadership, and for that, I will be forever grateful.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

In recent years, creativity has become an issue of concern for many researchers in mathematics education. The 21st century citizenry requires mathematical proficiency and creativity more than ever before for making informed decisions and solving complex real-world problems. And therefore school mathematics education is held responsible for nurturing students' creativity in mathematics from young. Thus, it is imperative that the mathematics teachers include creativity as one of the important tenets of mathematics teaching.

Despite the importance accorded to mathematical creativity, school mathematics has not gained the recognition as a creative subject. This is because creativity has more often been associated with arts than with mathematics (Narges Yaftian, 2015; Mehdi Nadjafikhah & Narges Yaftian, 2013; Bolden, Harries and Newton, 2009). School teachers and students believe that mathematics is mainly acquisition of algorithms, strictly rule based (Boelar, 2016; Noraini Idris & Norjoharuddeen Mohd Nor, 2010; Kennedy, 2005; Beghetto, 2007), and a finished-product so students cannot discover or create anything new anymore because everything has been already discovered (Misfeldt & Aguilar, 2016). Nevertheless, this view that mathematics is not a creative subject has been repudiated by many mathematics educators and researchers (Boelar, 2016; Sinay & Nahornick, 2016; Wessels, 2014). Professional mathematicians assert that mathematics is a subject full of ideas and creativity, not just a logical-rational subject as claimed by Gardner (1993) because the essence of mathematics is thinking creatively (Guildford, 1957), not simply arriving at the right answer. In addition, any genuine mathematical activity or work is not possible without creativity (Silver, 1997). In recent years, contrary to the popularly held beliefs that school mathematics has no place for creativity, mathematics educators argue that even school mathematics can be taught and learnt meaningfully to foster mathematical creativity in students (Posanthier, 2014; 2010; Lin, 2011).

Many educators and government policies advocate for creativity in mathematics education (Pucaru & Florea, 2017; Shcrauth, 2014). Thus classroom teaching and learning has to bring out students' creative abilities in mathematics, nurtured by teachers (Smith, 2014; Suurtamm et. al, 2015; Sheffield, 2008; Lev-Zamir & Leikin, 2011). Mathematics teaching in the classroom has to be geared towards nurturing and developing students' mathematical creativity, not just focusing on applying mathematical formulas and rules to solve exam type problems. If this were to happen, mathematics teachers need to revisit and reclaim their roles as teachers of a creative subject. It is teachers who can make mathematics interesting which in turn can foster thinking and creativity among students. Polya(1973), a great mathematics educator ridiculed mathematics teachers for failing to make use of the great opportunity given to them by emphasizing too much drilling exercises rather than developing students' curiosity and intellectual abilities. In his own words:

> Thus a teacher of mathematics has a great opportunity. If he fills his allotted time with drilling his students in routine operations he kills their interest, hampers their intellectual development, and misuses his opportunity. But if he challenges the curiosity of his students by setting them problems proportionate to their knowledge, and helps them to solve their problems with stimulating questions, he may give them a taste for, and some means of independent thinking (Polya,1973,p.v).

In general, there is an increased interest for creativity in education among educators in all subject areas, and they call for a paradigm shift in the traditionally held views about teaching i.e., from teaching for merely understanding, remembering and applying content knowledge to learning to create new knowledge through the process where professional mathematicians produce original knowledge and extend the body of knowledge (Leikin, Subotnik, Singer & Pelzcer, 2012). The creation of new knowledge in school mathematics may not have to be original but it can be new to the student which is regarded as little-c and mini c- creativity (Shrauth, 2014). Thus the critical role of the teachers in recognizing and promoting students' ability to create across all subjects in school curriculum has been emphasized and promoted by many educators, psychologists, and professional organizations in the twenty-first century (Tang& Gruszka, 2017; Sinay & Nahornick, 2016; Diana & Suthagar, 2020). In addition, in differentiating between good teaching and bad teaching, it is generally believed that poor teaching inhibits the development of creativity and the normal classroom conditions of mass education generally impede the development of creativity of individuals. Consequently, educators and researchers have started suggesting ways for teachers to cultivate student creativity in educational environments (Purcaru & Florea, 2017; Sternberg, 2006).

In Rehm's (1989) words which is still relevant today:

> "Teachers should believe that everyone from Einstein to a slower student has creative light, which teachers can tap and help cultivate by creating a balance of standards and freedom to try ideas" (p.23)

Regardless of the subject teachers teach, teachers' role has been acknowledged to be crucial in fostering student creativity. In mathematics classrooms, some teachers make full use of the allotted time given to them and help develop students' mathematical creativity while some teachers promote rote learning of mathematics by totally rejecting creative thinking and creativity. Thus teachers' role is crucial for implementing creativity oriented curriculum because they filter the curriculum through to learners (Schrauth, 2014; Sandt, 2007). This implies that it is important to develop teacher capacity and change their instructional behavior in order to promote creativity in the classroom. But, in order to change teacher instructional behavior, it is essential to identify the factors influencing teacher behavior (teacher behaviors during classroom teaching that either embrace or reject creativity in teaching and learning) and understand the relationship between them. The knowledge of the factors that influence teachers to reject or embrace creative teaching can then be utilized to formulate strategies that can help develop teacher competency and so change their instructional behavior in helping to foster creativity in students. However, it was found that teachers' instructional behaviour is complex and many factors influence it.

The complexity of teacher instructional behavior in the mathematics classroom has been studied extensively by many researchers since 1990 (Koehler & Grouws, 1992, cited in Sandt, 2007). Examining research studies on mathematics teaching, Koehler & Grouws (1992) proposed a model which postulates that the outcome of learning (whether cognitive or affective) is based on student's own behaviors which are influenced by (a) their beliefs and attitudes about themselves as learners (b) their beliefs about mathematics as a discipline and (c) teacher instructional behavior in the classroom. However, this model did not take into account of the antecedent factors such as students' prior knowledge, opportunity to learn, parental encouragement and etc. as factors that can influence student learning outcome.

According to Koehler & Grouws (1992, cited in Sandt, 2007), teacher instructional behavior is influenced by (a) teacher's knowledge (of the mathematical content to be taught, student's understanding of the specific content, and methods of teaching of specific content) (b) teacher's attitudes and beliefs about mathematics and teaching mathematics and (c) learner characteristics in the classroom. It is important to mention, at this juncture, that teacher attitudes and beliefs are two distinct constructs. However, this model omitted the influence of school contexts such as teacher opportunity for professional learning and development, school policies, parental expectation, and the sociopolitical factors from outside the school. And this model did not specifically mention whether the intended teacher behavior is for or against creativity. Nevertheless, from this model, it can be predicted that teacher instructional behavior is influenced by teacher's own knowledge and beliefs about the nature of mathematics and how it should be taught and learnt. Several other research studies have supported the notion that teacher's beliefs and knowledge are powerful predictors of teachers' classroom practices (Beswick, 2012; Smith, 2014; Schoen & LaVenia, 2018; Campbell, Rust, Nishio, Depiper, Frank & Choi, 2014; Voss, Kunter, Kleickmann, & Hachfeld, 2013; Sandt, 2007, Muijs & Reynolds, 2002; Shoenfeld, 2001; Earnest, 1989; Cobb, Wood and Yackel, 1992; Thompson, 1992). In addition to teacher's knowledge and beliefs about the nature of mathematics, learning and teaching of mathematics, Sandt (2007) proposed teacher attitudes towards mathematics (like enjoyment and interest in mathematics, confidence in mathematical abilities including self-concept and valuing mathematics) and teacher attitudes towards teaching of mathematics (like enjoyment, enthusiasm for teaching mathematics and confidence in abilities to teach mathematics) as factors that influence teachers of mathematics. Sandt's (2007) categorization of teacher attitudes as attitudes towards mathematics and attitudes towards mathematics teaching overlaps with Kunter, Frenzel, Nagy, Baumert & Pekrun (2011) conceptualization of teacher enthusiasm as (a) interest and intrinsic motivation to teach the subject and (b) enjoyment and strong liking for the subject itself which according to Kunter et al (2011), is a key factor for effective teaching. Enthusiasm, enjoyment, motivation, willingness and confidence in their ability to teach mathematics may be named as propensity factors based on Byrnes & Miller (2007) and Wang, Shen & Byrnes' (2013) definitions of propensity. Hence, the present study predicted teacher propensity as a factor that influences teacher instructional behavior for creative teaching.

In identifying the factors that influence teaching (or teachers' instructional behavior) in mathematics classroom, researchers have begun to draw idea from sociocultural theories (Goos, 2014). According to these theories, teachers gain their professional identity (as a good teacher, expert teacher, creative teacher and etc.) after subjecting themselves into continuous learning through various professional, social and cultural contexts. In this vein, in-service teachers are regarded as learners because they need to continuously learn in order to be identified as an effective or creative teacher. In relation to innovative teaching, Goos (2005) asserts that it is a worthwhile effort understanding how teachers learn in their professional and socio-cultural contexts and how they become motivated and enabled to apply their knowledge and skills in promoting students' creativity (added) and innovations in classrooms.

As teachers, the mathematics teachers' professional identities do not develop independently or separately from the context they are situated in. Teachers' professional identities (whether they are excellent teachers, expert teachers, creative teachers and etc.) develop gradually by subjecting themselves in the professional and socio-cultural context. Holding to this view, many mathematics education researchers have begun to draw on socio-cultural theories in proposing that teachers' learning is better understood as increasing participation in socially organized practices that develop their professional identities (Lerman, 1996). The framework for understanding teachers' teaching and identifying the factors influencing teaching is drawn from their learning and thinking that originate in social interactions in the socio-cultural contexts. Lerman (1996, p.4) asserts:

> "Frameworks which build on the notion that the individual's cognition originates in social interactions…. and therefore the role of culture, motives, values, and social and discursive practices are central, not secondary".

This view forms the theoretical foundation for the teachers' instructional behavior in the classroom.

Socio-cultural research has enhanced understanding of how mathematics teachers learn from their experiences in different socio-cultural contexts, such as college or university pre-service course, the practicum, the school they are employed in, and the professional learning opportunities they obtain as in-service teachers. Socio-cultural perspectives have perhaps been used less effectively to inform research on why teachers embrace or reject innovative teaching approaches. In this regard, the present research has chosen Goos' (2014) Teachers as Learners (TasL) framework to develop stronger socio-cultural frameworks for creative teaching research.

According to Goos (2014), teacher related socio-cultural factors play crucial role in determining teachers' choice whether to embrace innovative (creative) teaching or not. That is, teachers' knowledge, learning opportunities, passion, enthusiasm, willingness, motivation, attitudes and beliefs about the subject matter they teach can affect their choice of teaching approaches they adopt (Goos, 2014).

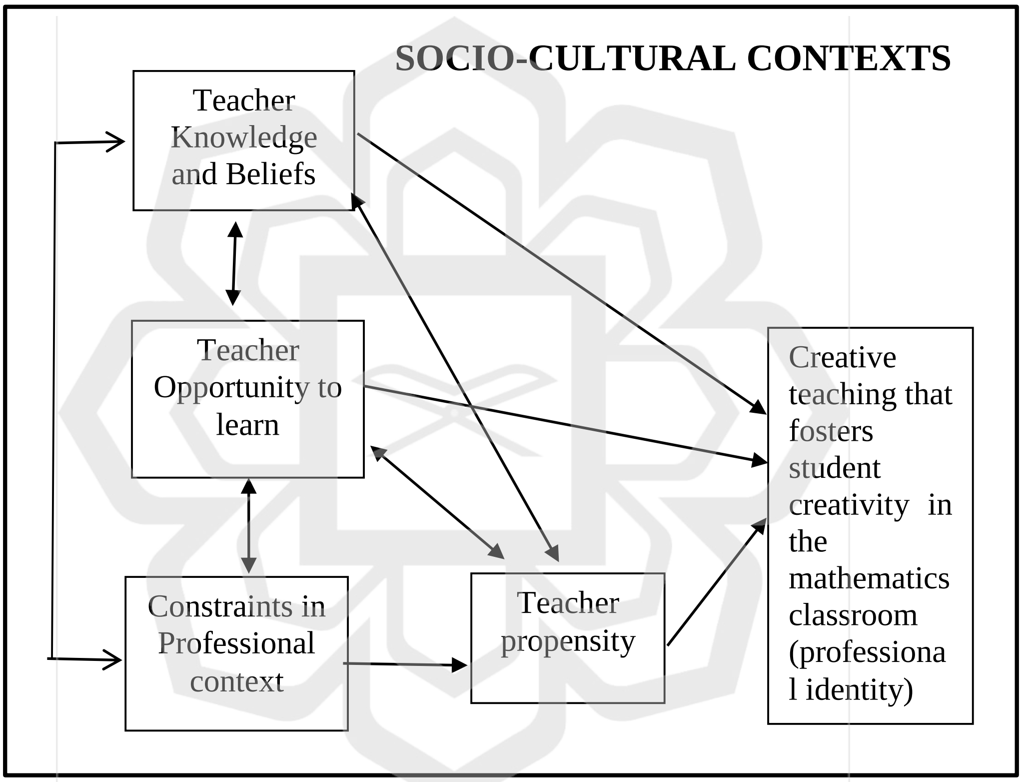
These socio-cultural factors are discussed under the Teachers as Learners Theory (TasL) proposed by Goos (2014). The Tasl theory is an extension of Valsiners'(1997) zone theory and Vygotsky's(1960) theory of Zone of Proximal

Development (ZPD) that explains why teachers embrace or reject innovative or creative teaching and postulates that teachers' professional behavior (what the teacher does or say in the classroom), thinking (creative thinking), and identities (like expert teacher, creative teacher) are based on their social interactions in the professional, social and cultural contexts (both inside and outside school). The emergence of professional behavior, thinking, and identities is the result of interactions between teachers' opportunity to learn, teachers' knowledge and beliefs, and teachers' professional constraints in the context (like student characteristics, administrators' policies, learning culture and etc.) which can in turn influence teachers' motivation, ability and willingness to apply what they learn. Further elaboration on the theoretical framework of the TasL is briefly discussed in the following section.

However, another theoretical framework also contributed to the present research. Drawing from socio-cultural theories, Byrnes (2003), Byrnes and Millers (2007) and Byrnes & Wasik (2009) developed Opportunity –Propensity framework which explains the influence of multiple socio-cultural factors on students' learning and achievement. This framework was used by many researchers in mathematics and science education to examine the influence of variables such as student, teacher, classroom, and school factors on achievement in science and mathematics (Wang & Byrnes, 2013; Lewis & Farkas, 2017; McElyea, 2016) The variables described in the Opportunity- Propensity framework predicted that propensities factors (skills, willingness and motivation) and learning opportunities are strong predictors of learner's achievement (Lewis & Farkas 2017; Wang, Shen and Bynrnes, 2013). As per Goos'(2014) conceptualization of mathematics teachers as learners, their achievement as professional teacher can be attributed to the opportunity they received to learn and their motivational factors (propensities) which can be aligned with

Opportnity-Propensity framework. In the present study, variables from both the Teachers as Leaners framework and Opportunity-Propensity framework were incorporated and hence the following conceptual framework was formed (Figure 1.1).

Figure 1.1 illustrates the conceptual framework of this study drawn by adapting and combining Goos' (2005;2014) Teacher as Learner framework and Byrnes & Miller (2007) Opportunity-Propensity framework.



Note:Based on Goos'(2005;2014) Teachers as Learners framework and Byrnes (2003) and Byrnes &Miller (2007) opportunity-propensity framework.

Figure 1.1 The Conceptual Framework of the Study