AN EXPLORATORY STUDY OF ELEMENTARY BEGINNING MATHEMATICS TEACHER EFFICACY

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Referring to the significant factors affecting teacher quality, “teacher efficacy” deserves to be in the heart of this dilemmatic evolution. The purpose of this study aimed to examine beginning teachers’ sense of efficacy in elementary schools, as well as its influential factors. Beginning teachers whose background were and were not in mathematics and science were compared to explore the differences of their teacher efficacy. According to research findings, we should devote all efforts to establish a positive and effective learning organization in order to promote their teacher efficacy internally, externally, and promptly starting from the beginning year.

INTRODUCTION

The significance of enhancing teacher quality becomes the core in the process of global educational reform, where teacher preparation programs must take this responsibility (e.g., Holmes Group, 1995; Ministry of Education [MOE], Taiwan, 2001; MOE, Taiwan, 2004; National Research Council [NRC], 2001; Wright et al., 1997; Wu, 2004). The integrity and implementation of the teacher education program had actually a great influence on a teacher’s acquisition of subject matter knowledge and instructional strategy, and even more on teacher efficacy (Chang & Wu, 2006). In another word, teacher efficacy was considered as not only the key indicator on examining the appropriateness and adequacy of a teacher’s personal instructional readiness (e.g. Allinder, 1995; Ashton & Webb, 1986; Denham & Michael, 1981; Rosenholtz, 1989) but also a warning of showing critical problems the teacher education program faced and orienting future directions of its reform movement (Chang, 2003; Chang & Wu, 2006). However, most studies conducted in Taiwan (e.g. Chu-Chen, 2002; Hong, 2002) focused on investigating elementary teacher efficacy “quantitatively” and “generally” (i.e. not specifically for certain subject areas), few of them chose single subject area such as mathematics for their examinations. Consequently, understanding elementary mathematics teacher efficacy under the circumstance of executing practical instruction, the processing trend of their efficacy change, and factors influencing their efficacy qualitatively would be essential and helpful at the current stage. Especially for those beginning teachers who lacked practical teaching experiences, how would they apply theories learned from the pre-service training program to instructional problems they faced on-site? Would the development of their efficacy be influenced while confronting struggles between theories and practices? What would be the trend of their efficacy development and change? These critical issues should be explored qualitatively and deeply.
According to the report of attending “Trends in Mathematics and Science Study 2003 (TIMSS 2003)” from the National Science Council [NSC] (2004), Taiwanese elementary students ranked the fourth position in mathematics. However, their performance had a significantly difference from those at the first (Singapore) and the second (Hong Kong) positions. Further, comparing to the result of TIMSS 1999, there were 16 percentage increases in the response of students who disagreed “I like mathematics”. This finding showed that more and more students join the train of “lacking interests in mathematics”. Why did our students’ achievement and interest step back? What kind of role did teacher efficacy play in affecting students’ achievement and interest?

“Beginning with research in the 1970s (e.g., Armor et al., 1976; Berman et al., 1977), teacher efficacy was first conceptualized as teachers’ general capacity to influence student performance” (Allinder, 1995, p.247). Since then, the concept of teacher’s sense of efficacy has developed continuously and currently is discussed relevant to Albert Bandura’s (1977) theory of self-efficacy, which indicates the significance of teachers’ beliefs in their own capabilities in relation to the effects of student learning and achievement. Ashton (1985) also stated that teacher efficacy, that is, “their belief in their ability to have a positive effect on student learning” (p.142). Several studies further reported, “Teacher efficacy has been identified as a variable accounting for individual differences in teaching effectiveness” (Gibson & Dembo, 1984, p. 569) and had a strong relationship with student learning and achievement (Allinder, 1995; Gibson & Dembo, 1984). Consequently, in order to better understand the reasons of the reduction in mathematical achievement and interest as well as finding out ways of improving both teaching and learning quality, an in-depth processing study would be the best choice at the moment.

PURPOSE AND METHOD

The purpose of this study aimed to examine beginning teachers’ sense of efficacy in elementary schools, as well as its influential factors. Beginning teachers whose background were and were not in mathematics and science were compared to explore the differences of their teacher efficacy. A mixed methods design was employed in this processing study. “Participant Main Survey” and “Mathematics Teaching Efficacy Beliefs Instruments (MTEBI Chinese version, Chang, 2003)” were used as the instruments of the qualitative part of this research. Participants were 64 beginning elementary mathematics teachers in Taichung, Taiwan. Pre- and post-tests were administered to obtain their efficacy ratings quantitatively. In the qualitative part, beginning teachers with and without background in mathematics and science were selected purposefully as participants according to their efficacy ratings of pre-tests. They were then divided into three groups: high, medium, and low; three teachers were randomly selected from each group. All together, six beginning mathematics teachers participated in the qualitative part of this study. Influential factors to beginning teachers’ sense of efficacy were identified through interviews, recordings, observations, and researchers’ reflection notes for exploring practical strategies to
improve their efficacy. The analysis in context strategy was employed for reaching the research objectives, which was the integration of descriptive and inferential statistical analyses (i.e. ANCOVA) and the qualitative analysis.

**FINDING AND DISCUSSION**

**Quantitative teacher efficacy comparison**

Findings of this study were reported in two parts. For the quantitative part, there were 18 elementary beginning mathematics teachers with mathematics and science (M&S) background and 46 without mathematics and science background. In regard to the pre-test, beginning mathematics teachers with M&S background had a significantly superior rating in both cognitive dimensions of Personal Mathematics Teaching Efficacy (PMTE) and Personal Science Teaching Efficacy (PSTE). After receiving four-years of training, beginning mathematics teachers with M&S had more confidence in their own teaching abilities than those who did not specialize in either mathematics or science. With regard to the post-test (one year later), beginning mathematics teachers with M&S background still scored significantly higher in both PMTE and PSTE than those without M&S background. In order to obtain a better understating of the differences between these two groups (i.e. with and without M&S background) in the performance of PMTE and MTOE, a one-way analysis of co-variance (ANCOVA) was conducted to determine the effects of the two backgrounds on the efficacy scores. After eliminating the differences in the pre-test, beginning mathematics teachers with M&S background still scored significantly superior in both PMTE and PSTE in the post-test than those without M&S background. Table 1 showed the comparative statistics of PMTE and MTOE.

<table>
<thead>
<tr>
<th>Program</th>
<th>Value</th>
<th>Sig.</th>
<th>Mean Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test PMTE</td>
<td>$t=2.808$</td>
<td>$p&lt;.01$</td>
<td>3.379</td>
</tr>
<tr>
<td>MTOE</td>
<td>$t=3.393$</td>
<td>$p&lt;.001$</td>
<td>2.297</td>
</tr>
<tr>
<td>Post-test PMTE</td>
<td>$t=4.947$</td>
<td>$p&lt;.001$</td>
<td>5.461</td>
</tr>
<tr>
<td>MTOE</td>
<td>$t=4.958$</td>
<td>$p&lt;.001$</td>
<td>4.292</td>
</tr>
<tr>
<td>ANCOVA PMTE</td>
<td>$F=19.770$</td>
<td>$p&lt;.001$</td>
<td></td>
</tr>
<tr>
<td>MTOE</td>
<td>$F=18.759$</td>
<td>$p&lt;.001$</td>
<td></td>
</tr>
</tbody>
</table>

Note: 1. Mean Differences = Mean with M&S — Mean without M&S

Table 1: Comparative Statistics of PMTE and MTOE

However, considering the average mean scores of PMTE and MTOE, those beginning mathematics teachers without M&S background only had approximately 71.94 percent of confidence (post-test) in their own teaching abilities. This information provided a warning for all teacher training programs: If these beginning teachers believed they were not ready to assume the teaching responsibility, teaching quality would be potentially jeopardized. Moreover, they did not have adequate confidence (only
72.83%) in providing efficient teaching in the classroom either. Thus, even though they believed effective teaching was vital for students’ learning and achievement in mathematics, the quality of teaching and learning could still not be assured. These findings just matched the results of previous studies, such as Ball (1990), Chu-Chen (2002), Hong (2002), and Chang (2003). As Gibson and Dembo (1984) stated, teachers with high efficacy should “persist longer, provide a greater academic focus in the classroom, and exhibit different types of feedback than teachers’ who have lower expectations concerning their ability to influence student learning” (p.570). Further, “when it comes to the education of our children…failure is not an option!” said President George W. Bush (2001). Accordingly, since there was no time for waiting and no room for going back and regret, how to enhance beginning mathematics teachers’ efficacy quickly and effectively for the purpose of providing quality teaching process and learning environment would be urgent and critical task for all in-service training programs.

Influential Factors of Teacher Efficacy

For the qualitative part, 6 beginning mathematics teachers were selected for discovering influential factors of their teacher efficacy. Table 2 and 3 showed their background information. According to the qualitative findings, two categories of factors that influenced the change of their teacher efficacy were generalized, teacher’s teaching belief and practical instruction (internal factor) and peer interaction and administrative support (external factor). The internal factor had three sub-categories: mathematics background knowledge and previous experience, instructional belief and action, and teacher-student interaction. The external factor was divided into three sub-categories too: peer interaction, administrative support, and teaching resource.

<table>
<thead>
<tr>
<th>Teacher Efficacy</th>
<th>Sex</th>
<th>Grade Level</th>
<th>Major</th>
<th>Pre-test (total score) (average: 80.61)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 High</td>
<td>M</td>
<td>6</td>
<td>Science Education</td>
<td>86</td>
</tr>
<tr>
<td>M2 Middle</td>
<td>M</td>
<td>3</td>
<td>Math Education</td>
<td>80</td>
</tr>
<tr>
<td>M3 Low</td>
<td>M</td>
<td>3</td>
<td>Math Education</td>
<td>71</td>
</tr>
</tbody>
</table>

Table 2: Information of Teachers with M&S Background

<table>
<thead>
<tr>
<th>Teacher Efficacy</th>
<th>Sex</th>
<th>Grade Level</th>
<th>Major</th>
<th>Pre-test (total score) (average: 74.93)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1 High</td>
<td>F</td>
<td>5</td>
<td>Food Science</td>
<td>83</td>
</tr>
<tr>
<td>N2 Middle</td>
<td>F</td>
<td>5</td>
<td>Music Education</td>
<td>74</td>
</tr>
<tr>
<td>N3 Low</td>
<td>F</td>
<td>4</td>
<td>Art Education</td>
<td>68</td>
</tr>
</tbody>
</table>

Table 3: Information of Teachers without M&S Background

A. Internal Factor

First of all, the findings indicated that beginning mathematics teachers had inadequate mathematical background knowledge and practical experience before they entered the
This inadequacy led to several obstacles, such as the difficulty in preparing the lessons, mistakes made in the teaching process, and low teacher efficacy. For example, when students proposed a difficult question, teachers with low efficacy usually could not decide how to deal with this situation. Same conditions happened while students applied various strategies to solve the problem that was different from the strategy used by the teacher. What should the teacher do? Should s/he explain and present every strategy that could solve the problem or just ignore it? This dilemma would definitely resulted in an inadequate and ineffective instruction and learning. As Allinder (1995) indicated, “Teachers with high personal efficacy and high teaching efficacy increased end-of-year goals more often for their students ... Teachers with high personal efficacy effected significantly greater growth” (p. 247). While thinking how to promote mathematical teaching outcomes, educators should consider deeply how to increase beginning mathematics teacher efficacy first.

Secondly, beginning mathematics teachers who had low efficacy tended to have insufficient instructional strategy and bad teacher-student interaction. They usually did not know how to propose questions and guide the classroom discussion. Consequently, they mostly used “lecture” while teaching. Even if they had a discussion, it was always ineffective. This situation led to not only decrease their teacher efficacy but also reduce students’ learning interests and motivations, as well as less teacher-student interaction. This finding corresponded with Czerniak’s (1990) opinion: Teachers with a high sense of efficacy have been found to be more likely to apply inquiry and student-centered teaching strategies, while low efficacious teachers are more likely to use teacher-centered strategies, e.g. lecture and reading from the textbook. Therefore, teacher efficacy did play a significant role in considering how to improve the quality of teaching, and was one reasonably important part of learning quality. Only if the teacher efficacy were increased, students’ interests in learning mathematics and their active learning habits would be promoted effectively.

Another internal sub-category was techniques applied for classroom management. In this study, beginning mathematics teachers with low efficacy were likely to spend a great deal of time in managing the classroom order. They often felt powerless and pressured, which led to an unsuccessful teaching. In fact, employing body language and specific movements appropriately could keep students’ attention to the instruction and cultivate positive agreements between the teacher and students simultaneously. Thus, providing relative information of classroom management would complement the instructional strategies and teacher-student interactions effectively for enhancing both teaching and learning quality.

B. External Factor

All six beginning teachers mentioned that they felt more comfortable and confident in preparing or implementing their instruction once receiving active care and assistance from experienced teachers or teachers of the same grade level within the school. Several studies (e.g. Piaget, 1970; Rogoff, 1990; Saxe, Gernart, & Guberman, 1987) indicated that these experience sharing and encouragements were so helpful that they
learned a lot and felt full of enthusiasm to keep going forward. However, they all complained of the inadequacy of the sharing and encouragement environment. Consequently, how to manage the working environment within one elementary school, build up the opportunity of cooperative learning among all teachers, and promote the interchange of instructional knowledge and experience would be crucial to assist beginning mathematics teachers’ professional development. Further, the school administrators should rethink their management belief and strategy for the purpose of establish an effective learning organization for all teachers (Borko, 2004), where they could learn from each other efficiently and grow together professionally.

Moreover, all six teachers indicated that the school administrative level excessively interfere their teaching in the classroom. This interference worsened the communication channel and led to an unfavourable relationship that became another external factor of the decrease of teacher efficacy. In addition, beginning teachers were often assigned to participate in competitions within or outside of the school that were not relevant to their major or the subject they taught. They had to spend more time for these extra tasks and resulted in less time for preparing their own teaching in the classroom. Consequently, instead of giving extra interferences and duties, the school administrative level should reconsider what realistic supports should be provided for beginning teachers in order to assist them to enhance their teacher efficacy and focus on their own teaching.

CONCLUSION

According to the findings of this study, beginning mathematics teachers who majored in mathematics and science education had a significantly higher increase in their efficacy ratings than those who did not major in mathematics and science both at the beginning and the end of the first year. Also, beginning mathematics teachers who majored in mathematics and science education had a significantly higher increase in both personal teaching efficacy and teaching outcome expectancy than those who did not major in mathematics and science. Further, two categories of factors found in this study influencing beginning mathematics teacher efficacy included: teacher’s teaching belief and practical instruction (internal factor) and peer interaction and administrative support (external factor). As Hermanowicz (1966) and Ladd (1966) stated, “Teachers repeatedly have indicated that their teacher training did not prepare them to be effective teachers. Many have made suggestions for improving teacher education” (p. 53). Benz et al. (1992) further confirmed their opinion 26 years later. Especially for those mathematics beginning teachers, under the condition of having low teacher efficacy and inadequate readiness in teaching, how to assist them in regard to their belief, confidence, and practical instruction would be the first task of teacher professional development. Accordingly, as teacher educators, we should reflect from these previous recommendations and research findings, and further devote all efforts to establish a positive and effective learning organization in order to promote their teacher efficacy promptly starting from the beginning year.
Acknowledgement
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References


