The Effects of Early Childhood Teachers’ Pedagogical Content Knowledge in Mathematics, Attitude towards Mathematics and Mathematics Teaching Efficacy on their Problem-solving Ability

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Abstract. This study designated problem-solving ability as the factor affecting the early childhood teacher’s behavior, pedagogical content knowledge in mathematics as the factor affecting that behavior, attitude towards attitude mathematics as the factor affecting the early childhood teacher’s attitude, and mathematics teaching efficacy as the factor affecting the teacher’s self-efficacy.

Keywords: Early Childhood Teacher, Pedagogical Content Knowledge in Mathematics, Attitude towards Mathematics, Mathematics Teaching Efficacy, Problem-solving Ability

1 Introduction

Problems that continue to take place in education are difficult to be removed by only one solution, for education itself is so dynamic and full of uncertainties. This is the very reason why teachers need problem-solving skills. With this ability, teachers can interpret problems in various ways and choose the best solution to those problems(Cha, 1991). KABF(Knowledge – Attitude – Belief – Practice) is a model on the reason and process of human behavior. According to this model, right knowledge forms positive attitude and belief mediates right behavior(Glanz, Rimer, Viswanath, 2008). If they face a particular environment, people perceive and then recognize that environment and finally have their own attitude towards it. This successive process provides a power that causes them to behave or respond(Lee, 1991).

This study defines the problem-solving ability as the early childhood teacher’s skills of clarifying problems on question, analyzing their causes, developing alternatives to solve the problems, making plans to implement those alternatives and managing in an organized way results from the implementation. In short, the problem-solving ability is the skills of rational problem-solving. Promoting that ability necessities mathematical knowledge and skills. According to a research by Lee(2014),

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mathematical knowledge is a critical factor that contributes to a better understanding of concepts or relations. It plays an important role in promoting problem-solving skills. Menmuir and Adams (1997) claimed that the more basic knowledge of mathematics teachers have, the more easily they detect children’s mathematical potentials. This suggests that teachers’ attitude towards mathematics contributes to their way of mathematical thinking which supports and activates mathematical knowledge and skills (Lee, 1997). In mathematics, thinking models that are used to solve problems are not so different from one another. And mathematical knowledge supports a better understanding of concepts or relations, improving the problem-solving ability.

According to the KABP model, therefore, this study designated problem-solving ability as the factor affecting the early childhood teacher’s behavior, pedagogical content knowledge in mathematics as the factor affecting that behavior, attitude towards attitude mathematics as the factor affecting the early childhood teacher’s attitude, and mathematics teaching efficacy as the factor affecting the teacher’s self-efficacy. With these factors, this study had the purpose of determining correlations and interactions between early childhood teachers’ pedagogical content knowledge in mathematics, attitude towards mathematics, mathematics teaching efficacy and problem-solving ability, ultimately helping comprehensively understand the ability and providing some effective ways of improving the early childhood teacher’s problem-solving skills.

For this purpose, this study raised the following questions.

Question 1. What relations exist between early childhood teachers’ pedagogical content knowledge in mathematics, attitude towards mathematics and mathematics teaching efficacy and their problem-solving ability?

Question 2. What effects do early childhood teachers’ pedagogical content knowledge in mathematics, attitude towards mathematics and mathematics teaching efficacy have on their problem-solving ability?

2 Methods

This study conducted a questionnaire survey of teachers who were serving at early childhood education institutions located in Busan, Gyeongnam and Ulsan. from 1st week, Sep. to 3rd Nov. 2014. From the survey, responses by 610 of those teachers were obtained, and analyzed through the SPSS 20.0 Program. The reliability of both the entire measurement device used in this study and each of its components was verified using Cronbach’s $\alpha$. The descriptive statistics, correlation analysis and the multiple regression analysis were conducted to identify the current trends of pedagogical content knowledge in mathematics, attitude towards mathematics, mathematics teaching efficacy and problem-solving skills that early childhood teachers have.
3 Findings

Relations between Early Childhood Teachers’ Pedagogical Content Knowledge in Mathematics, Attitude towards Mathematics, Mathematics Teaching Efficacy and Problem-solving Ability

Table 1. Relations between Early Childhood Teachers’ Problem-solving Ability, and Pedagogical Content Knowledge in Mathematics, Attitude towards Mathematics and Mathematics Teaching Efficacy (N=610)

<table>
<thead>
<tr>
<th>Pedagogical content knowledge in mathematics</th>
<th>Attitude towards mathematics</th>
<th>Mathematics teaching efficacy</th>
<th>Problem-solving ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedagogical content knowledge in mathematics</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude towards mathematics</td>
<td>.44**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mathematics teaching efficacy</td>
<td>.48**</td>
<td>.52**</td>
<td>1</td>
</tr>
<tr>
<td>Problem-solving ability</td>
<td>.67**</td>
<td>.40**</td>
<td>.46**</td>
</tr>
</tbody>
</table>

As shown in this table, correlations between early childhood teachers’ pedagogical content knowledge in mathematics, attitude towards knowledge, mathematics teaching efficacy and problem-solving ability are in the range of r=.40-.67 (p<.01), so they are all statically significant. In more details, pedagogical content knowledge in mathematics and problem-solving are correlated at .67 (p<.01). Attitude towards knowledge and problem-solving ability, at .40 (p<.01), mathematics teaching efficacy and problem-solving ability, at .46 (p<.01). And pedagogical content knowledge in mathematics and attitude towards mathematics are correlated at .44 (p<.01), pedagogical content knowledge in mathematics and mathematics teaching efficacy, at .48 (p<.01) and attitude towards mathematics and mathematics teaching efficacy, at .52 (p<.01).

Table 2. The Effects of Early Childhood Teachers’ Pedagogical Content Knowledge in Mathematics, Attitude towards Mathematics and Mathematics Teaching Efficacy on their Problem-solving Ability (N=610)

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>B</th>
<th>β</th>
<th>t</th>
<th>R²</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>(constant)</td>
<td>.878</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pedagogical content knowledge in mathematics</td>
<td>.457</td>
<td>.565</td>
<td>12.81***</td>
<td>.48</td>
<td>112.99***</td>
</tr>
<tr>
<td>Attitude towards mathematics</td>
<td>.104</td>
<td>.064</td>
<td>1.41**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mathematics teaching efficacy</td>
<td>.265</td>
<td>.156</td>
<td>1.41**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Before determining the effects of early childhood teachers’ pedagogical content knowledge in mathematics, attitude towards mathematics and mathematics teaching
efficacy on their problem-solving ability, this study examined the multicollinearity and residual independence of those variables to find that the Durbin-Watson value is 1.964 and VIF is 1.39~1.54, proving that basic hypotheses set here are acceptable. The multiple regression analysis found that pedagogical content knowledge in mathematics, attitude towards mathematics and mathematics teaching efficacy significantly account for problem-solving ability, with the explanatory power of 48%. And the goodness-of-fit of the regression model is high (F=112.99, p<.001). β values shown in the table say relative influence differences between the independent variables. In other words, pedagogical content in mathematics has the most significantly static effect on problem-solving ability, followed by mathematics teaching efficacy and attitude towards mathematics in order.

4 Discussions and Conclusion

This study found that pedagogical content knowledge in mathematics, attitude towards mathematics and mathematics teaching efficacy account significantly for that efficacy. Thus, early childhood teachers' problem-solving skills are influenced by their pedagogical content knowledge in mathematics, attitude towards mathematics and mathematics teaching efficacy. In the following, discussions are provided based on the KABF model as the conceptual framework of this study.

Yeo(2004) said that the higher early childhood teachers are in the perception of mathematics teaching methods and the pedagogical knowledge of mathematics, the higher they are in mathematics teaching efficacy. In a study about attitude towards mathematics, Borden(1993) suggested that what and how mathematics teachers instruct depend on their attitude and belief towards mathematics. According to a research by Poffenberger and Norton(1959), the teacher who is willing to help children have a positive attitude towards mathematics is a devoted class manager who is more likely to be positive and knowledgeable about mathematics, very interested in mathematics and enthusiastic in making young learners better understand mathematics. Whether teachers can be successful in coping with problems that they face depends on how much they expect they can solve problems effectively. Indeed, the more important thing when a person tries to solve problems is not whether he actually has problem-solving skills, but whether he is aware of the fact that he has those skills(Yang, 2011).

Many people experience difficulty in solving problems that they face, despite they have knowledge or skills enough to solve those problems. This is because they are less able to choose from or properly use such knowledge or skills. In order to improve their problem-solving ability, therefore, early childhood teachers should try to improve their pedagogical knowledge in mathematics. This effort changes their attitude towards mathematics, contributing to their confidence in teaching mathematics. If armed with mathematical thinking and positive attitude toward mathematics, early childhood teachers could cope more effectively with each stage of problem-solving.

Though it is much stressed that early childhood teachers need problem-solving skills, empirical factors of those skills have been so far researched not wholly, but just
partially. Considering this situation, this study investigated how early childhood teachers’ problem-solving ability is influenced by their pedagogical content knowledge in mathematics, attitude towards mathematics and mathematics teaching efficacy, according to the KABF model. In other words, this study focused on mathematics as it assumed that early childhood teachers’ problem-solving ability depends heavily on their mathematical thinking. But in fact, that ability may be assessed in various dimensions. Therefore, further researches need to also focus on many other factors as well as mathematical thinking in dealing with the early childhood teacher’s problem-solving ability.

References

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