Determination and comparison of the competency levels of in-service and pre-service mathematics teachers

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Abstract

This study mainly aims to determine and compare the teacher competency levels of in-service and pre-service mathematics teachers. It also aims to help eliminating possible problems about training of pre-service and in-service teachers. This research is a descriptive study carried out with 105 in-service mathematics teachers with various professional experience levels and 115 pre-service mathematics teachers. “The Mathematics Teachers’ Competencies Scale (MTCS)” was used to collect data. The results demonstrate that the pre-service teachers had higher levels than the in-service teachers both in general and in sub-headings of the scale. Nevertheless, qualification levels of both groups were lower than expected.

Keywords: Mathematics; mathematics teaching; teacher training; teacher competencies; competency levels

1. Introduction

Emerging as a result of the rapid increase in the available information in line with scientific and technological developments and the resulting increase in its importance in human life, the concept of information society can be defined in the most general way as a lifestyle in which individuals use information at high levels. In the information society, expected individual qualifications have increased both in terms of type and level. As a natural consequence of this, the notion of a more qualified education has been highlighted. Undoubtedly, the changing and developing notion of education has raised the question of teacher training due to the fact that teachers constitute one of the variables that determine the quality of education. Therefore, enhancing the quality of education first relies on identification of the required teachers’ competencies and making pre-service teachers acquire them (Erdem, 2005). In other words, increased educational quality requires identifying both the standards of teacher training institutions and their employees and the minimum qualifications that pre-service teachers should acquire (National Council for Accreditation of Teacher Education [NCATE], 2008). The characteristic qualifications of today’s teachers are encapsulated in their competencies about content knowledge, professional knowledge, and pedagogical content knowledge around the world (Shulman, 1986). On the other hand, a teacher’s competency is associated with student achievement for Ashton and Webb (1986), with his/her motivation for Eccles (1986), and self-efficacy for Anderson, Greene and Loewen (1988). In general terms, content knowledge involves the knowledge about the
principles and concepts in that particular field, the reason why they are accurate, and how the information in that discipline is generalized and structured (Shulman, 1986). If this approach is applied to the qualifications of mathematics teachers in particular, it involves the teachers’ understanding of mathematical concepts and their formation processes, their knowledge of the relationship between different mathematical knowledge, of interpreting information, and of assessing students’ thinking and understanding and teaching decisions (Fennema & Franke, 1992).

In Turkey, it is believed that re-identification of teacher qualifications in this context and thus improving pre-service teachers’ training will contribute to solving many problems in the system, and there are ongoing attempts to realize this (Ministry of National Education [MNE], 2008). To this end, it is inevitable that the qualification levels of the pre-service teachers currently being trained and the in-service teachers currently employed first be assessed at certain intervals. Because teacher competencies serve various purposes such as contributing to support the national education objectives, creating a framework to compare teachers’ qualifications and quality, and creating consistency in social expectations toward the status and quality of teaching profession (MNE, 2008). In this regard, it is evident that theoretical and applied studies should be raised above a certain level to help pre-service teachers acquire the qualifications in question throughout their education process. In a similar way, it is indispensable to exert efforts to increase the competency levels of in-service teachers through in-service training programs.

The present study should be thought to be useful in directing teacher training and enlightening in-service teacher training by determining the competency levels needed to be acquired by in-service and pre-service mathematics teachers and by highlighting their shortcomings.

The study problem was identified as, “What are the in-service and pre-service mathematics teachers’ teacher competency levels and the differences between them?”. In this context, its sub-problems were selected to include the following:

1. What is the competency level of the in-service mathematics teachers?
2. What is the competency level of the pre-service mathematics teachers?
3. What are the in-service and pre-service mathematics teachers’ strengths and weaknesses in terms of their competency levels?

2. Method

The present research is a descriptive study aiming to determine and compare the competency levels of the in-service and pre-service mathematics teachers and to suggest recommendations to eliminate the identified shortcomings.

In this framework, the study was carried out with 105 mathematics teachers employed in various secondary education institutions and 115 pre-service teachers studying in the final year of secondary mathematics teacher training departments in the province of Izmir. Of the in-service mathematics teachers in the sample, 53 were male and 52 were female. As for these teachers’ professional experience in years, 2.9% had an experience between 0–5 years, 29.5% between 5–10 years, 22.9% between 10–15 years, and 44.8% over 15 years. In terms of their fields of employment, 20% work in vocational high schools, 27.6% work in general high schools, and 52.4% in Anatolian high schools requiring higher points than others for entering and involving foreign language education more than others. Of the 115 pre-service mathematics teachers, 57 were male and 58 were female.

Based on other scales theoretically developed for status identification (Yüksek Öğretim Kurumu [YÖK]/Dünya Bankası, 1999; Fabiano, 1999; Kenedy, 2002; NCATE/NCTM Program Standards, 2003; Hudson, 2004; Kenedy, 2004) and analyzed for validity and reliability, “The Mathematics Teachers’ Competencies Scale (MTCS)” was used to collect the study data (Alkan, Bukova, and Elçi, 2006). The scale consists of three components, each a five-point Likert-type scale: “General Teaching Competencies (GTC)”, “Mathematics Content Knowledge Competencies (MCKC)” and “Mathematics Teaching Competencies (MTC)”. In the scale, the teacher competencies covered under the GTC and MCKC components were divided into 5 sub-standards, and those under the MTC component were grouped in 4 sub-standards.

Before data collection, the following weight coefficients were assigned to the participations levels in the five-point Likert-type scale, respectively: 1 (Never), 2 (Rarely), 3 (Occasionally), 4 (Usually), 5 (Always). The data obtained from the participants in this framework were analyzed using a statistical software package. The in-service and pre-service teachers’ mean scores on each component of the scale were calculated. “Independent t-test” was
used in different intergroup dual comparisons according to data type, while “dependent t-test” was employed in the
dual comparisons within the same group. In parallel, the frequency distribution was examined. Furthermore,
variance analysis and the Scheffe test were applied to analyze suitable data. The data obtained from the analyses
were grouped and interpreted in accordance with the scale and its sub-headings.

3. Results (Findings)

The findings obtained as a result of the analyses from the scale in general and its sub-headings in particular could
be summarized as follows.

3.1. Findings about the teacher competency levels of the in-service mathematics teachers

In the sub-headings of the scale, the teachers find their competencies sufficient at the level of 3.71 in the GTC
component, at the level of 4 in the MCKC component, and at 3.03 in the MTC component, respectively. The level
reaches approximately 3.58 in overall MTCS. It follows that the teachers feel themselves as competent in the
MCKC, GTC and MTC domains, respectively. Under the GTC component, the standard in which the teachers
perceive themselves as possessing the highest level in performing what is expected is the sub-heading
“Familiarizing with students” (X=4.12), while the standard perceived with the lowest level was expressed as
“Common teachers’ behaviors” (X=3.29). Under the MCKC component, the standard with highest perceived level is
“Knowledge of solving mathematical problems, questioning, and proving” (X=4.22), while the standard with lowest
perceived level is “Knowledge of the structure of mathematics” (X=3.85). Of the standards under the MTC
component, “Knowledge and skills of mathematics teaching methods” (X=3.78) is the standard with the highest
perceived level, while “Knowledge of mathematical assessment” (X=1.91) is the standard in which they perceive
themselves as possessing the lowest competency level. It was determined that particularly in the MTC component in
which the teachers perceive themselves as incompetent, they did not perceive themselves as sufficiently competent
in the other components of “Learning environment and learning approaches used” (X=3.46) and “Technology use in
mathematics teaching” (X=2.98).

One-Way ANOVA was performed to determine whether there were significant differences in overall MTCS and
in each of its components according to the three different types of schools in which the teachers were employed. As
a result, it was determined that there were significant differences in teacher competencies according to whether the
school of employment was a vocational, general or Anatolian high school (F=8,764; p=0.000). Scheffe’s test was
carried out to determine the direction of the difference and in favor of which groups it was and the results
demonstrated that the difference was in favor of the teachers working in Anatolian high schools in general and in
favor of those working in vocational high schools in particular when compared to those working in general high
schools (see Table 1).

Table 1. Scheffe’s test results of MTCS according to school of employment

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>(I)School of employment</th>
<th>(J)School of employment</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTCS</td>
<td>Vocational high school</td>
<td>General high school</td>
<td>64.933(*)</td>
<td>18.73</td>
<td>0.003</td>
<td>18.4 111.47</td>
</tr>
<tr>
<td></td>
<td>General high school</td>
<td>Anatolian high school</td>
<td>7.548</td>
<td>16.811</td>
<td>0.904</td>
<td>-34.22 49.31</td>
</tr>
<tr>
<td></td>
<td>Anatolian high school</td>
<td>General high school</td>
<td>-64.933(*)</td>
<td>18.73</td>
<td>0.003</td>
<td>-111.47 -18.4</td>
</tr>
<tr>
<td></td>
<td>General high school</td>
<td>Anatolian high school</td>
<td>-57.385(*)</td>
<td>15.049</td>
<td>0.001</td>
<td>-94.77 -20</td>
</tr>
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<td>20 94.77</td>
</tr>
</tbody>
</table>

*The mean difference is significant at the .05 level.

The One-Way ANOVA performed also indicate that teachers’ experience do not statistically contribute to
competency levels in general of the scale (F=1,638; p=0.199).

The t-test performed to investigate whether gender caused a significant difference in teacher competency among
the teachers responding to the MTCS yielded (t=0,566; p=0.573) in overall MTCS, and GTC (t=1,290; p=0,200),
MCKC (t=0.213; p=0.832), MTC (t=0.354; p=0.724) in its sub-headings and this indicates that gender did not cause a statistically significant difference.

3.2. Findings about the competency levels of the pre-service mathematics teachers

In the sub-headings of the scale, the pre-service teachers perceive their competencies at the level of 3.91 in the GTC component, at 3.81 in the MCKC component, and at 4.06 in the MTC component, respectively. The level reaches 3.93 in overall MTCS. The obtained analysis results revealed that the pre-service teachers usually perceived themselves at the highest level in the MTC component. However, the amplitude difference is the lowest between the sub-domains. Nevertheless, it was found that the pre-service teachers had the lowest level in the MCKC component. Under the GTC component, the standard in which the pre-service teachers perceive themselves as possessing the highest level in performing what is expected is the component “Familiarizing with students” (X=4.45), while the standard perceived with the lowest level is “Establishing effective communication in learning” (X=4.06). Of the standard in the MCKC component, the standard in which they perceived themselves as possessing the highest level is “General mathematics knowledge” (X=3.92), while the lowest was “Knowledge of establishing connections between mathematical concepts” (X=3.56). One of the standards in the MTC component, “Knowledge of mathematical assessment” (X=4.15) was the standard in which they found themselves the highest, while the lowest standard was “Knowledge and skills of mathematics teaching methods” (X=3.94). The findings about the other sub-standards in the MCKC, the component in which the pre-service teachers perceived themselves as possessing the lowest level of competency, include “Knowledge of the structure of mathematics” (X=3.84), “Knowledge of solving mathematical problems, questioning, and proving” (X=3.91), and “Knowledge of mathematical communication” (X=3.75).

The t-test performed to investigate whether gender caused a significant difference in teacher competency among the pre-service teachers responding to the MTCS showed that there was no statistically significant difference in the overall MTCS (t=0.569; p=0.571) and in each of its components GTC (t=1.113; p=0.268), MCKC (t=-0.126; p=0.900) and MTC (t=0.546; p=0.586).

3.3. Findings about the comparison of the competency levels of the in- and pre-service mathematics teachers

The results of the “independent t-test” performed to compare the competency levels of the in-service and pre-service mathematics teachers demonstrated that there were statistically significant differences in favor of the pre-service teachers in the overall MTCS and in the GTC and MTC components, and in favor of the in-service teachers in the MCKC component (see Table 2).

<table>
<thead>
<tr>
<th>Components of MTCS for in- and pre-service teachers</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>t</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTC in-serv.-GTC pre-serv.</td>
<td>-18.2952</td>
<td>23.25524</td>
<td>-8.061</td>
<td>0</td>
</tr>
<tr>
<td>MCKC in-serv.-MCKC pre-serv.</td>
<td>6.60952</td>
<td>23.04281</td>
<td>2.939</td>
<td>0.004</td>
</tr>
<tr>
<td>MTC in-serv.-MTC pre-serv.</td>
<td>-29.7404</td>
<td>45.65127</td>
<td>-6.644</td>
<td>0</td>
</tr>
<tr>
<td>MTCS in-serv.-MTCS pre-serv.</td>
<td>-41.6381</td>
<td>83.11474</td>
<td>-5.133</td>
<td>0</td>
</tr>
</tbody>
</table>

4. Discussion

The teacher competency levels of the in-service and pre-service teachers seem to be above the theoretical mean value. However, the amplitude difference between the various types of competency levels among the in-service teachers is 0.97, but the difference falls down to 0.25 among the pre-service teachers. This indicates that there is a gap between the in-service teachers’ competencies in various domains, while the pre-service teachers are more or less at the same level in the components. This result might perhaps be explained as an indicator that the in-service teachers have accommodated themselves to current educational system. The teachers who perceive themselves as possessing the highest level in the methods of mathematics teaching had the lowest competency level in the MTC which creates a conflict in itself. We believe that this originates from the fact that the method skills are simply
perceived as operational skills. A similar conflict lies in the fact that the mathematics teachers perceive themselves as possessing the highest level of competency in “Knowledge of solving mathematical problems, questioning, and proving”, but feel that they have the lowest competency level in “knowledge of mathematical assessment”. Another study result is that increased desire to learn among students forces teachers to raise their competency potentials. On the other hand, teachers’ gender is not effective for high school teachers at qualification level.

It is an expected result that pre-service teachers perceive themselves as possessing a high level of competency in general. Nevertheless, their inability to establish connections between mathematical concepts indicates that they have problems with regard to the knowledge of the methods. The pre-service teachers feel that they have a high competency level in “familiarizing with students”, but a low competency level in “effective communication”, which creates a conflict. The higher level of competency perceived by the pre-service mathematics teachers in the overall scale can be attributed to the fact that they are still within the education process and have been recently exposed to information. On the other hand, the higher level of competency perceived by the in-service teachers in the MCKC could be interpreted as indicating that they consider content knowledge equal to mathematics used at high school level.

5. Conclusion and Recommendation

Through in-service education seminars, mathematics teachers should be helped to improve themselves so as to attain certain qualities in the knowledge of the valid methods used in current teaching practices, in problem solving and operations, and in assessment. In parallel, through similar seminars, teachers’ skills to perform activities, creating animations, and making presentations using technology should be raised to higher levels. Students at high school level should be encouraged to actively participate in learning by all means.

In a similar way, throughout their education process, pre-service teachers should certainly be encouraged to take courses to enhance their methodological knowledge, to improve their skills to establish connection between mathematical concepts, and to maintain effective communication in learning environments.

As a consequence, it seems inevitable to readdress the mathematics teaching programs at education faculties and to reorganize their infrastructure to this end. If training of teachers and pre-service teachers is taken as a whole, cooperation needs to be maintained between the MNE and education faculties to overcome the shortcomings.

References


