

Competencies of mathematics teachers who prepare students to mathematics olympiads

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The aim of this paper is to explore competencies of mathematics teachers who prepare students to mathematics olympiads. Competencies related to mathematics teachers and gifted students' teachers were investigated in literature. Experts' opinions were taken to determine related competencies. Competencies determined by experts were classified into three sub-competency groups as "Professional Knowledge", "Professional Skill" and "Attitudes and Values" by using the Delphi method. After determination and classification of competencies, the order of importance of these competencies was calculated by using Analytic Hierarchy Process (AHP) which is a multiple criterion decision making method. Pairwise comparison of all competencies in the same groups were made and competencies were ordered according to their order of importance. The most important competencies are "he/she uses proof techniques such as induction, contrapositive and direct proof in order to demonstrate mathematical propositions", "he/she constructs classroom environment which promotes mathematical thinking and reasoning" and "he/she renews himself/herself perpetually".

Keywords: Competencies of mathematics teachers; mathematics olympiad teachers; mathematics olympiad preparation

Introduction

Nowadays, there is an increasing attention towards problems of mathematics education. This increasing attention is related to increasing value of mathematics for humanity. Mathematics is used intensively in not only quantitative areas but also areas such as linguistics, history, archaeology etc. Mathematical methods and mathematical thinking are needed in many different fields. Every year different usages of mathematics are found (Krutetskii, 1976). Therefore, finding mathematically gifted students and educating them in accordance with their abilities is a very important issue for societies. Moreover, students who prepare for mathematics olympiads can be seen as mathematically gifted because they need extraordinary mathematical thinking, reasoning ability and creativity to be successful in mathematics olympiads. Since these students are different from other students, their teachers also must have different competencies.

Fennema and Franke (1992) stated that what a teacher knows is the most effective factor of what students learn. They searched which knowledge is the most important for students' learning and suggested a model including mathematics knowledge, pedagogic knowledge, students' cognitive knowledge and teacher beliefs.

Moreover, there is research about competencies of gifted students' teachers. Feldhusen and Hansen (1988) and Cheung and Philipson (2008) studied to determine

order of importance of these competencies. Both of the researchers found that “has knowledge of the nature and needs of gifted” (1988, p.86 & 2008, p.26) was the most important competency. In his research, Chan (2011) used gifted students’ point of view about their teachers’ competencies. Students evaluations showed that “can develop (or select) methods and materials for use with the gifted” (p.165) was the most important competency. Similarly, “has knowledge of the nature and needs of gifted” (p.165) was founded second important competency.

A brief review of literature indicates that there is much research about competencies of mathematics teachers and gifted students’ teachers. However, competencies of teachers work on mathematics olympiad preparation has not been researched. Therefore, the aim of this study is to explore competencies of teachers who prepare students for mathematics olympiads and to determine the order of these competencies.

The Study

In this study, expert opinions were used to determine competencies. There were twelve experts. These experts were chosen from academic staff in universities, in-service math teachers related to mathematics olympiads and former medallist in international mathematics olympiads. Three of them were academics, five of them were mathematics teacher and four of them were former medallists. Academic staff were chosen from mathematics education and special education departments. It was taken into account that in-service teachers should be successful in mathematics olympiad preparation while being selected. All of them had certificate of merit because of their students’ successes in mathematics olympiads. Lastly, all former medallists were in Turkish national mathematics team.

The study has four important parts. The first part is collection of competencies from different studies. The second part is choosing important competencies in mathematics olympiad preparation. The third part is distribution of competencies to sub-competency groups. The last part is determination of the order of importance of competencies.

Methodology

In order to determine competencies, firstly the related literature was investigated and competencies related to this subject were collected from different studies (Akar, 2015; Chan, 2011; Cheung & Phillipson, 2008; Feldhusen & Hansen 1988; Gülteke, 2013; General Directorate of Teacher Training and Development, 2017; Yuen, 2004). These competencies were analysed by experts. Lawshe’s (1975) Content Validity Ratio (CVR) was used for analysis. Competency items were evaluated by experts as “essential”, “useful but not essential” or “not necessary”. By this analysis, 144 items were decreased to 34 items.

After first analysis, competency items were distributed to sub-competency groups as “Professional Knowledge”, “Professional Skill” and “Attitudes and Values”. These sub-competency groups were given in “General Competencies of Teaching Profession” (General Directorate of Teacher Training and Development, 2017) published by the General Directorate of Teacher Education in Turkey. Distribution of competencies to subgroups was made by the Delphi method. In the first round of

Delphi, data were collected by using the Internet, statistics of data were constituted and delivered to experts again for reevaluation. Experts reevaluated the statistics and changed some of their choices. Consensus about which competencies belonged to which sub-competency group were reached in second round.

The most important part of the study is the last part. Pairwise comparison matrices were constituted for every sub-competency group. In these matrices, every competency item was compared with all of the other competencies in their group. After these comparisons, calculations of AHP method were carried out and the order of importance of competencies were determined.

Findings

Table 1 shows the order of importance of competencies in professional knowledge sub-competency group after AHP calculations of experts' opinions.

Competencies	Order of Importance
he/she uses proof techniques such as induction, contrapositive and direct proof in order to demonstrate mathematical propositions	0.160
he/she uses strategies that support higher order thinking	0.132
he/she explains mathematical roots of frequently used concepts, facts, formulas, rules and operations in mathematics by using examples	0.121
he/she uses mathematics language well and expresses concepts and solutions mathematically.	0.116
he/she makes sense of problems and he/she is persevering about solving problems.	0.085
he/she knows concepts, definitions, principles and theorems	0.085
he/she uses appropriate strategies (diagram, table drawing, preparing list, searching pattern, simplifying problem) to solve a problem	0.081
he/she thinks abstract	0.078
he/she knows mathematics beyond the curriculum	0.060
he/she knows which subject is hard to understand for students	0.052
he/she identifies mathematically gifted students	0.029

Table 1. order of importance of competencies in professional knowledge sub-competency group

According to table 1, the most important competency is “he/she uses proof techniques such as induction, contrapositive and direct proof in order to demonstrate mathematical propositions”. Its percentage is 16%. Moreover, the first four competencies have nearly 53% importance in this sub-competency group.

Table 2 shows order of importance of competencies in professional skill sub-competency group after AHP calculations of experts' opinions.

Competencies	Order of Importance
he/she constructs classroom environment which promotes mathematical thinking and reasoning	0.110
he/she improves students' creative thinking and problem solving skills	0.105
he/she focuses on higher order thinking skills and questioning techniques.	0.101
he/she creates an opportunity for students to be more successful	0.091
he/she directs students to deep in thoughts	0.089
he/she has knowledge of the nature and needs of the mathematically gifted	0.079
he/she sets effective and comprehensive targets in order to support and enhance mathematics ability	0.063
he/she makes arrangements in teaching by using results of assessment and evaluation process	0.059
he/she takes into account both results and process in assessment and evaluation	0.054
he/she lectures clearly and understandably	0.050
he/she takes into account students' level when lecturing	0.044
he/she makes students active in learning process	0.044
he/she lectures actively	0.032
he/she gives appropriate homework and evaluates	0.031
he/she uses time effectively	0.024
he/she can do individualized instruction or group instruction.	0.022

Table 2. order of importance of competencies in professional skill sub-competency group

According to table 2, the most important competency is "he/she constructs classroom environment which promotes mathematical thinking and reasoning". Its percentage is 11%. Moreover, the first five competencies have nearly 49% importance in this sub-competency group.

Table 3 shows order of importance of competencies in attitudes and values sub-competency group after AHP calculations of experts' opinions.

According to table 3, the most important competency is "he/she renews himself/herself perpetually". Its percentage is nearly 22%. Moreover, the first four competencies have nearly 69% importance in this sub-competency group. In addition to these, the least important competency is "he/she likes mathematics". Its percentage is 7,7%.

Competencies	Order of Importance
he/she renews himself/herself perpetually	0.222
he/she knows his/her students: their learning speeds, interests, wishes, academic capacity and goals	0.178
he/she behaves sympathetically, talks to them about any subject, listens to them and he/she is accessible	0.151
he/she likes teaching mathematics	0.142
he/she knows how to guide gifted students	0.124
he/she behaves as guide and leader	0.108
he/she likes mathematics	0.077

Table 3. order of importance of competencies in attitudes and values sub-competency group

Discussion and Conclusion

The aim of this study was to explore competencies of mathematics teachers who prepare students for mathematics olympiads and to determine their order of importance. For this aim, competencies related to mathematics teacher and gifted students' teacher were gathered from former studies and experts evaluated these competencies by AHP. Results of AHP calculations indicated that the most important competencies were "he/she uses proof techniques such as induction, contrapositive and direct proof in order to demonstrate mathematical propositions", "he/she constructs classroom environment which promotes mathematical thinking and reasoning" and "he/she renews himself/herself perpetually". Furthermore, other important competencies of each sub-competency group were determined.

This research' s results can be use to select mathematics teacher in private or public schools who want to do mathematics olympiad preparation. They can find the answer of the question "which competencies should the teacher have?" in this study. Moreover, universities can make use of this study in order to train their preservice mathematics teacher. They can learn which competencies are needed, which competencies are more important for this subject.

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