Profiling Mathematics Teachers Regarding Factors Affecting Promotion of Students' Metacognition

Vuslat Şeker and Engin Ader

Abstract
The purpose of this study is to describe mathematics teachers' profiles regarding factors affecting their promotion of students' metacognition through developing profiling tools. Therefore, four factors from the Framework for Analysing Mathematics Teaching for the Advancement of Metacognition-FAMTAM (Ader, 2009) were used. The sample includes 314 middle and secondary school mathematics teachers. In this study, associational research designs were adopted. Findings indicated that mathematics teachers' conceptualizations of metacognition were parallel with those commonly accepted in the literature. Teachers' responses indicated their awareness of students' characteristics and needs. They stated that they were in favor of a learning environment where mathematical authority was exercised by students. They also stated that they perceived high external pressure from various factors influencing their promotion of students' metacognition.

Keywords: Mathematics, metacognition, teaching of metacognition, promotion of metacognition

Introduction

Metacognition

Metacognition is briefly defined as the regulation of and knowledge about cognitive activities (Flavell, 1979). It is a complex and multifaceted phenomenon consisting of two components: (a) metacognitive knowledge and (b) metacognitive skills (Veenman, Van Hout-Wolters, & Afflerbach, 2006). Metacognitive knowledge refers to one's declarative knowledge about self, task, and strategy (Flavell, 1979). However, metacognitive knowledge could be neither constructed without domain-specific knowledge (Veenman et al., 2006) nor used effectively without metacognitive skills (Veenman, Wilhelm, & Beishuizen, 2004). Metacognitive skills such as monitoring, planning, evaluating and control of cognitive activities help learners use their metacognitive knowledge, since they involve the procedural knowledge on how to regulate cognition (Veenman et al., 2006). Metacognitive knowledge and metacognitive skills are commonly accepted as conceptualizations of metacognition in the related literature.

Metacognition is an important part of self-regulation (Dinsmore, Alexander, & Loughlin, 2008; Veenman, Van Hout-Wolters, & Afflerbach, 2006; Zimmerman, 2000).

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Zimmerman (1990) explained self-regulated learners with respect to metacognitive aspects in the cyclic process such that "learners plan, set goals, organize, self-monitor and self-evaluate at various points during the process of acquisition" (p. 5). Metacognition appears in early stages of problem solving process with accurate representations and the planning of problem solving (Desoete & Veenman, 2006). Metacognitive activities improve students' mathematical learning (Jacobse & Harskamp, 2012). Therefore, teachers are urged to create learning environments where students are encouraged to learn mathematics through exercising metacognition (Lombaerts, Engels, & Athanasou, 2007).

Metacognitive Development

When it comes to how metacognition can be developed, the onset of its development should be considered. Early studies of metacognition suggested that metacognitive skills such as monitoring and evaluation start to appear between the ages of 8 and 10 (Veenman & Spaans, 2005; Veenman et al., 2004; Veenman et al., 2006). However, Whitebread et al. (2009) argue that metacognitive development can start at the age of 4-5. Investigation of ealy metacognitive development in children requires the use of appropriate tasks and methodology. In order to form such a repertoire from early ages to adulthood, the role of educational settings and especially that of the teacher within this setting are important (De Jager, Jansen, & Reezigt, 2005).

Metacognitive development is also related to the practice of metacognition (Larkin, 2010), which can be facilitated by effective teachers who use a variety of teaching strategies (Paris & Winograd, 1990; Schraw, Crippen, & Hartley, 2006). Possible solutions have been offered to teachers to improve their students' metacognition (Fisher, 1998; Goos, Galbraith & Renshaw, 2002; De Jager et. al., 2005; Larkin, 2010; Kontos & Nicholas, 2001; Paris & Winograd, 1990; Schraw, 1998; Schraw et. al., 2006; Veenman et al., 2006). For example, Schraw et al. (2006) stated six ways to promote metacognition: (a) inquiry-based learning; (b) the role of collaborative support; (c) strategy instruction to improve problem solving and critical thinking; (d) strategies for helping students construct mental models; (e) experience of conceptual change; (f) the use of technology; and (g) the impact of students' and teachers' beliefs. Furthermore, Paris and Winograd (1990) offered four approaches: (a) metacognitive explanation and modeling; (b) scaffolding instruction; (c) cognitive coaching; and (d) cooperative learning. Lombaerts, Engels, and Vanderfaelli (2007) created guidelines for teachers to design a supportive learning environment for students who are less self-regulated. While some of these suggestions are predominantly teacher led in that teachers are expected to pave the way towards students' metacognitive functioning by modeling what is expected from students or explicitly telling them what to do, others are more subtle in the sense that teachers only facilitate and students are expected to adapt ways of working offered to them. In short, all of these suggestions emphasize teachers' effective instructional practices such as being attentive to students' learning process and creating a community in which teachers and students share their ideas and feelings in a respectful environment (Paris & Winograd, 1990).

Factors Effecting Promotion of Student Metacognition

There are various instructional practices for supporting metacognitive development. Several factors affecting the instructional practices have also been mentioned in recent studies (Dignath-van Ewijk & Van der Werf, 2012; Lombaerts, Engels, & Van Braak, 2009; Lombaerts et al., 2007). Factors affecting teaching practices on promotion of self-regulation can be considered in 3 broad categories (Lombaerts et al., 2009). First of all, teacher beliefs, teaching experiences, and background variables are grouped as *teacher characteristics*. Secondly, curricular changes, timetables, number of students, textbooks, and the relationship among teachers are examples for *school context characteristics*. Lastly, *pupil characteristics* affecting teaching practices of metacognition or self-regulation are cognitive and metacognitive abilities of learners.

The literature shows a variety of methodologies used for exploring factors affecting promotion of metacognition. Within quantitative methodology, scales such as Self-regulated Learning Teacher Belief Scale by Lombaerts et. al. (2009), Self-Regulated Learning Inventory for Teachers (SRLIT) by Lombaerts et. al. (2007) were developed. Qualitative methodology through classroom observations of teaching practice and interviews was also used in order to examine how teachers use instructional practices to promote self-regulation (Lau, 2012).

Framework for Analysing Mathematics Teaching for the Advancement of Metacognition (FAMTAM)

Ader (2009) developed a framework for analyzing mathematics teaching for the improvement of metacognition of students. The reason for developing such a framework is mostly “the lack of emphasis on teacher’s role and teaching practices within the efforts to incorporate metacognition into mathematics classrooms” (Ader, 2013, p.7). It aims to shed light on the determinants of teaching practice towards specific student outcomes. The framework consists of four factors: (1) teachers’ conceptualization of metacognition; (2) teachers’ perceptions of students’ features and needs; (3) distribution of mathematical authority in the classroom; and (4) external pressures perceived by teachers. These factors were believed to be a good source for “exploring the teachers’ approaches to promotion of students’ metacognition” (Ader, 2009, p.282).

The conceptualization of metacognition (Flavell, 1979) is defined as a factor in FAMTAM. Conceptualization of such complex and multifaceted phenomenon is worth investigating deeply since the complex phenomena can be interpreted and implemented in different perspectives (Ader, 2009). Secondly, teachers’ perceptions of students’ features and needs is another component of FAMTAM since it is an indicator of how teachers act with respect to the features and needs of students for effective mathematics teaching (Jaworski, 1992). Teachers’ perceptions influence their encouragement for students to use metacognition in their learning progress. Thirdly, the distribution of mathematical authority is a factor described as the way teachers encourage learners to use mathematics since “mathematics as a discipline” can be taken as authority where members of mathematical communities are working on mathematics (Schoenfeld, 1992). Boaler (2002) identified the members of a community of a classroom that lack mathematical authority as not contributors in each other's mathematical learning, not doing mathematics, but only as receivers of mathematical knowledge. Hence, metacognition can be conceptualized as a way of practicing mathematical authority because metacognitive processes and mathematical problem-solving processes are intertwined (Ader, 2009). Lastly, external pressures perceived by teachers are given as another factor in FAMTAM. External pressures stem, not from classroom practices, but from policies of the educational system and demand or expectations of educational institutions that make teachers feel pressure on their teaching practices (Ader, 2013; Lombaerts et. al., 2009). Curriculum content, national exams, and time constraints etc. can be listed among such external pressures.

The Purpose and Significance of the Study

The purpose of the present study is to describe mathematics teachers' profiles with regard to factors affecting promotion of metacognition through developing profiling tools validated based on FAMTAM. Specifically, the study aims to explore how mathematics teachers' promote students' metacognition and the role of teachers' background in their approach to promotion of students' metacognition. Profile identification employed in the study can help researchers and policymakers make sense of teachers' efforts towards promotion of metacognition. It can serve also as a tool for reflection. When teachers' profiles based on pre-determined factors are portrayed, teachers can also tackle some of the issues that influence their promotion of metacognition by eliminating negative conditions and supporting positive ones. As such, the following research questions were investigated in the present study:

(1) What are mathematics teachers' profiles with regard to the variables: (a) teachers' conceptualization of metacognition; (b) teachers' perceptions of students' features and needs; (c) distribution of mathematical authority in the classroom; and (d) external pressures perceived by teachers?
(2) Are there significant correlations among variables (a) teachers' conceptualization of metacognition; (b) teachers' perceptions of students' features and needs; (c) distribution of mathematical authority in the classroom; and (d) external pressures perceived by teachers ?
(3) Are there differences among the four variables derived from FAMTAM according to teachers' demographic variables including gender, age, educational background, years of experience, school type, and school level?

Method

Research Design

This is an explanatory study that aims to explain teachers' profiles with regard to the factors affecting promotion of metacognition. Thus, associational research designs were adopted. Specifically, the correlational research design which aims to determine the relationships among variables (Fraenkel & Wallen, 2006) was adopted to examine the relationships between factors affecting promotion of student metacognition. The causal comparative research which aims to examine the differences among already created groups (Fraenkel & Wallen, 2006) was used to explore the differences in factors affecting promotion of student metacognition in terms of teachers' demographic variables such as gender, age, educational background, years of experience, school type, and school level.

Sample

Through convenience sampling, which includes participants already available for the researcher (Fraenkel & Wallen, 2006), the study was conducted with 314 (161 from middle schools and 153 from secondary schools) mathematics teachers from İstanbul and Eskişehir, Turkey (see Table 1). There were 175 female and 139 male participants. Of these, 34 participants were from private schools and 280 were from public schools. Moreover, 116 of 163 middle-school and 43 of 153 secondary-school teachers were graduates of faculties of education. 4 middle school mathematics teachers did not state the faculty they graduated. Remaining teachers graduated from faculties of science and arts with a teaching certificate. 199 of 314 mathematics teachers filled out web-version of the instruments. 105 of 314 mathematics teachers filled out hard-copy version of the instruments.

Table 1. Demographic information for participants of the study

Demographic variables	Categories	N (%)
Gender	Male	175 (55.7)
	Female	139 (44.3)
Age	20-29	103 (32.8)
	30-39	110 (35.0)
	40-49	62 (19.7)
	50 and above	39 (12.4)
Years of experience	1-5	87 (27.7)
	6-10	55 (17.5)
	11-15	78 (24.8)
	16 and above	93 (29.6)
Education level	Undergraduate	239 (76.1)
	Graduate	75 (23.9)
School level	Middle	161 (51.3)
	Secondary	153 (48.7)
School types	Public school	280 (89.2)
	Private school	34 (10.8)
Total		314 (100)

Data Collection Procedures

Ethical permissions were obtained from Boğaziçi University's ethical committee and National Education Directorates. Then the profiling tools were validated and implemented. The researchers created web and hard-copy versions of the instruments. To reach more mathematics teachers, web-version of the tools were sent to over 1000 middle and secondary school mathematics teachers through e-mail obtained from National Education Directorates for three times over three months. Only 199 middle and secondary school mathematics teachers filled out the web-version of the instruments. Then the researchers visited middle and high schools, which were most accessible to them to have the hard copies of the tools filled out through one-to-one encouragement.

Instruments

Four profiling tools addressing the four factors in Ader's (2009) FAMTAM framework were developed and validated by the researchers. The four profiling tools are (1) The Teachers' Conceptualization of Metacognition Scale; (2) The Teachers' Perceptions of Students' Features and Needs Scale; (3) The Distribution of Mathematical Authority Scale; and (4) The External Pressure Perceived by Teachers Scale. The first three profiling tools are designed as a five-point likert-scale: completely disagree (1); disagree (2); neutral (3); agree (4); and completely agree (5). The External Pressure Perceived by Teacher Scale is also five-point likert-scale: (1) no impact; (2) little impact; (3) neutral; (4) partially impact; (5) high impact. Within the process of development of four profiling tools, two pilot studies were conducted. The first sample was used in order to develop the four tools. The second sample was used for assessing psychometric qualities of the tools that were revised after the pilot study. For the face validity of the scales, expert opinions were obtained from four university professors and one middle school mathematics teacher in a public school. The experts coded the appropriateness of each item for related scales and they provided feedback for each item in terms of the content and the clarity. The items were then revised based on the expert opinions. Furthermore, a Turkish language expert reviewed the items for correct grammatical structure and appropriate wording. Sample items are presented in Table 2 (see Appendix A for all scales in Turkish).

Table 2. Sample items of FAMTAM scales

Scale name	Sample items
The teachers' conceptualization of metacognition scale	Students' planning of their thought is important
The teachers' perceptions of students' features and needs scale	Teacher should help learners improve metacognitive skills and knowledge by using various teaching methods (e.g. modelling, thinking aloud, direct teaching)
The distribution of mathematical authority scale	A learning environment should be constructed where the teacher and students reason together
The external pressure perceived by teachers scale	Changes in curricular and teaching approaches

The Teachers' Conceptualization of Metacognition Scale consists of nine items. The teachers are asked to state to what extent they agree with the importance of issues stated in each item. The total score for this scale indicates the level of fit between teachers' conceptualization of metacognition and what has been mainly documented in literature (e.g. metacognitive knowledge and metacognitive skills). The Cronbach's alpha of this scale is calculated as .91 indicating a high reliability level. Exploratory factor analysis with varimax rotation revealed two structures as metacognitive knowledge, having corresponding items 7, 8, and 9 with loadings between .93 to .81 and metacognitive skills having corresponding items 1, 2, 3, 4, 5, and 6 for which factor loadings were ranging from .88 to .59. These results constituted evidence for construct validity.

The Teachers' Perceptions of Students' Features and Needs Scale consists of six items. The items of this scale asked teachers how much they agreed with the statements in the items. Cronbach's alpha of this scale is calculated as .81. Exploratory factor analysis with varimax rotation was conducted to measure construct validity of this scale. However, the observed factor structure did not fit the theoretical structure assuming that the items were developed based on two concepts, students' characteristics and teachers' actions on students' needs. Furthermore, after the psychometric properties of this scale were assessed, two items were deleted because of low item total correlations (.07 and .03 respectively). After eliminating two items and conducting an exploratory factor analysis, expert opinions of mathematics teaching professors were obtained to check the accuracy of each item in terms of representing the construct. Experts agreed on the items that within this scale they covered important issues regarding content provided through literature on teachers' perceptions of students' features and needs. Therefore, the researchers decided to use the scale based on the indicators of content validity.

The Distribution of Mathematical Authority Scale consists of 10 items. The questions in this scale asked teachers to code the items according to the following criteria: (1) they need to consider mathematics having a variety of tools, procedures, concepts etc. to reveal the rights and wrongs; and (2) they need to imagine a classroom environment where mathematics is practiced based on the first criterion. Cronbach's alpha of this scale is calculated as .65. For construct validty, an exploratory factor analysis with varimax rotation was run in order to explore dimensionality of the scale with eigenvalue over 1.There were 4 factor loadings observed. Items 6, 7 and 10 were loaded to factor 1 representing "teaching dimension of mathematical authority", with values ranging from .86 to .71. Items 1, 3 and 4 were loaded to factor 2 representing "classroom environment dimension of mathematical authority" with values ranging from .81 to .63. Items 2 and 5 loaded on factor 3 representing "teachers' knowledge dimension of mathematical authority" with values .85 and 72. Lastly loadings for items 8 and 9 to factor 4 representing "doing mathematics dimension of mathematical authority", were .91 and .76.

The External Pressure Perceived by Teachers Scale consists of nine items. The items asked teachers to state the extent to what they agree or disagree with the listed factors about their effect on their teaching practices. Cronbach's alpha of this scale is calculated as .73. Two dimensions obtained from the exploratory factor analysis with varimax rotation supported the construct so there was also evidence of construct validity for this scale. When the exploratory factor analysis was run based on eigenvalues over 1, the scale was found to consist of three factors. Each factor was consisted of items that represented same sources of perceived pressure. Items 2, 3, 4, 5 and 7 were loaded to factor 1 representing "internal sources of perceived pressure" with values ranging from

.85 to .61. Items 1, 6, 8 and 9 were loaded to factor 2 and 3 representing "external sources of perceived pressure" with values ranging from .82 to .75.

Data Analyses

Means, standard deviations, and possible ranges for four scales were calculated in order to describe the data (see Table 3). Pearson Product Moment correlation coefficient was calculated in order to show how much these four variables were related to each other (see Table 4). Group comparisons were made in order to observe how the profiling tools discriminated between scores of groups of teachers according to gender, age, years of experience, education level, school level and school type. Thus, histograms were obtained to check normality assumption. The histograms revealed that the data for teachers' conceptualization of metacognition variable had a negatively skewed distribution. The distribution of scores on the External Pressure Perceived by Teachers Scale was slightly negatively skewed. For the remaining variables, the distributions were normal. When the assumptions of normality and homogeneity of variances were satisfied, a one-way Analysis of Variance (ANOVA) was used. When the assumptions were violated, Brown-Forsythe F-ratio was used. In order to explore practical significance of the study, partial eta squared was calculated.

Results

The descriptive statistics (Table 3) showed that most mathematics teachers (83.8 %) stated that they conceptualized metacognition in accordance with the commonly accepted conceptualizations in the literature (e.g. metacognitive skills and metacognitive knowledge). In addition, a majority of mathematics teachers (87.9 %) reported high levels of awareness of students' features and needs. Their reports also indicated that they were in favor of a learning environment where mathematical authority was exercised by students. However, they perceived high external pressure from various factors which influenced the promotion of students' metacognition.

Table 3. Descriptive statistics

FAMTAM Variables	N	Possible Range	Mean	SD
Conceptualization of metacognition	314	9-45	38.53	7.06
Perceptions of students' features and needs	314	6-30	25.89	3.23
Distribution of mathematical authority	314	25-50	38.83	5.55
Perceived external pressure	314	9-45	34.07	6.36

Pearson Product Moment correlation coefficients are provided in Table 4 and show the relationships between variables relating to factors affecting mathematics teachers' promotion of metacognition.

Table 4. Correlation analyses

	PSFN	MA	PEP
CM	.43**	.16**	.20**
PSFN	-	.21**	.23**
MA		-	-.07

Note. ** $p < .01$; CM = conceptualization of metacognition; PSFN = perceptions of students' features and needs; DMA = distribution of mathematical authority; PEP = perceived external pressure

The relationship between conceptualization of metacognition and perceptions of stuents' features and needs was found to be significant and moderate, $r = .43$, p < .01, suggesting that when the teachers had high levels of compatibility between their conceptualization of metacognition and commonly accepted conceptualizations in the field (e.g. metacognitive skills and metacognitive knowledge), they also had a better perception of students' features and needs based on metacognition. The other relationships were weak, albeit significant ranging from .16 to .23. Finally, a non-significant relationship was observed between distribution of mathematical authority and perceived external pressure.

Various group comparisons on variables based on factors affecting mathematics teachers' promotion of student metacognition were conducted. Significant gender differences were observed on teachers' claims about their distribution of mathematical authority, $F(1, 312) = 8.86$, $p = .05$, $\eta_p^2 = .01$; perceived external pressure, $F(1,312) = 18.05$, $p < .001$, $\eta_p^2 = .05$; and conceptualization of metacognition, $F(1, 263.96) = 8.24$, $p < .001$, $\eta_p^2 = .03$, in favor of female teachers. Significant differences according to age, $F(3, 310) = 15.12$, $p < .001$, $\eta_p^2 = .13$, and years of experience, $F(3, 282.90) = 6.57$, $p < .001$, $\eta_p^2 = .06$, were observed only on teachers' distribution of mathematical authority in favor of teachers in 20-29 age group compared to other age groups and teachers with 1-5 years of experience compared to teachers with more years of experience. There were also significant differences on distribution of mathematical authority, $F(1,312) = 8.06$, $p < .001$, $\eta_p^2 = .03$ and perceived external pressure, $F(1,148.78) = 1.76$, $p = .01$, $\eta_p^2 = .02$ according to teachers' educational background. Teachers with a master's degree perceived less external pressure ($M = 32.53$, $SD = 5.40$) than teachers with a bachelor's degree ($M = 34.55$, $SD = 6.57$). Furthermore, teachers with a master's degree ($M = 40.40$, $SD = 5.13$) supported the distribution of mathematical authority more than teachers who had undergraduate degrees ($M = 38.33$, $SD = 5.59$). In addition, statistically significant school level differences were found on each factor in favor of middle school mathematics teachers. The findings showed significant differences among mathematics teachers working at different school levels on conceptualization of metacognition variable, $F(1,298.46) = 13.21$, $p < .001$, $\eta_p^2 = .04$ and on perceived external pressure variable, $F(1, 302.83) = 4.46$, p = .04, $\eta_p^2 = .01$. Furthermore, middle school mathematics teachers and secondary school mathematics teachers differed from each other on the perceptions of students' features and needs variable, $F(1,31) = 3.77$, $p = .05$, $\eta_p^2 = .01$, and on the distribution of mathematical authority variable, $F(1,31) = 9.46$, $p < .001$, $\eta_p^2 = 0.03$. Lastly, perceived external pressure, $F(1,31) = 5.75$, $p = .02$, $\eta_p^2 = .02$ and teachers' conceptualization of metacognition, $F(1,59.22) = .01$, $\eta_p^2 = .01$ significantly differed according to school types. Teachers working at a public school ($M = 34.37$, $SD = 6.27$) perceived significantly higher external pressure than teachers working at a private school ($M = 31.62$, $SD = 6.68$). Public school teachers' conceptualization of metacognition scores ($M = 38.27$, $SD = 7.29$) were significantly lower than teachers working at a private school ($M = 40.70$, S$D = 4.30$).

Discussion and Conclusion

The purpose of this study was to describe mathematics teachers' profiles with regard to factors affecting promotion of metacognition through developing profiling tools based on the Framework for Analysing Mathematics Teaching for the Advancement of Metacognition (FAMTAM). This study does not aim to measure actual performance of mathematics teachers on promotion of student metacognition. The aim is to explore mathematics teachers' self-report considerations on their approaches to promotion of students' metacognition with regard to the four factors through associational research designs. While exploring self-reported considerations, teacher background information is also considered because teachers' responses to educational changes are affected by teachers' demographic information (Hargreaves, 2005).

First of all, the findings showed that mathematics teachers conceptualized metacognition as a multiphase and multicomponent phenomenon which include those commonly accepted conceptualizations (e.g. metacognitive knowledge and metacognitive skills) in the relevant literature. Most teachers stated they agreed on the importance of student metacognition including components related to metacognitive knowledge and metacognitive skills. It shows that teachers' beliefs about the presence of metacognition in their teaching were positive. Although the positive results might be a result of social desirability, it is important to keep in mind that the teachers were aware of the importance of metacognition in mathematics classrooms. The awareness of teachers might lead them to introduce and promote metacognitive activities within their teaching practices (Lombaerts et. al., 2009). It can be stated that better teacher conceptualization of metacognition parallel to those in the literature reflecting the details and sophistication of subcomponents and elements, might influence teachers' promotion of metacognition positively when hampering factors are diminished or eliminated.

Secondly, the results indicated a significant difference between teachers working at different school types. Conceptualization of metacognition was in favor of mathematics teachers working at private schools. It could be a result of the differences in educational experiences or working conditions since in a previously conducted study teachers working at private institutions stated having a good working condition, positive relationships with colleagues, the opportunity of reflection on their teaching and reaching their teaching goals (Karaköse & Kocabaş, 2006). As a remarkable and significant difference on teachers' conceptualization of metacognition was observed on teachers working at different school types in favor of public school teachers. This significant difference could be a result of the fact that secondary school mathematics teachers are mostly graduates of faculties of science and art (111 out of 153). Teachers' beliefs related to their professions could be affected by their educational background. Teachers from different faculties might have different perspectives and experiences towards teaching profession because of the differences of the visions and missions among faculties they studied (Kaplan & İpek, 2002). The study conducted by pre-service mathematics teachers showed that the significant difference was present among preservice mathematics teachers' attitudes towards their professions in terms of the faculty they studied in favor of preservice mathematics teachers from the faculty of education (Kaplan & İpek, 2002). Teachers' educational background (e.g. undergraduate studies they completed and the university they studied) might implicitly direct their teaching beliefs and experiences with regard to adopting educational innovations such as metacognition (Peeters, Lombaerts, De Backer, Kindekens, & Jacquet, 2013).

Thirdly, participants' statements on their perceptions of students' features and needs in terms of metacognition are positive in the sense that they can be supportive of promotion of student metacognition. Regardless of any type of grouping, teachers mostly stated that they were aware of metacognitive characteristics of students and acting upon it. Teachers who give priority to students' characteristics in terms of their developmental milestones, their way of knowledge construction, and participation in the learning process, are described as the ones taking "learning needs and experiences of students as starting point" (Vandevelde, Vandenbussche, & Van Keer, 2012, p.1563). Therefore, teachers might adopt a positive approach to promoting metacognition considering students' features and needs. Furthermore, considering the variable of perceptions of students' features and needs, the only significant difference found was according to school level in favor of middle school teachers. This could be a result of an extended emphasis on student centered teaching approaches at middle school level compared to high school or higher education levels. In a previous study, primary school teachers were found to adopt student-centered teaching practices more than secondary school teachers (Arseven, Şahin, & Kılınç, 2016). Arseven, Şahin, and Kılınç (2016) also found out that teachers' beliefs related to adopting teaching practices considering students' features and needs have become negative towards later grades.

Mathematical authority is a recently developing concept that paves the way towards a student-centered learning environment for teachers and learners (Wilson & Lloyd, 2000). As Amit and Fried (2005) pointed out when authority in classroom is discussed, most people including teachers imagine the teacher as "the head of a classroom" (p.145). However, mathematical authority in the classroom might exist within a classroom when teacher authority as expert authority is eliminated (Amit & Fried, 2005). The results of the study showed the majority of participants stated a distribution of mathematical authority in which mathematics teachers guide learners to use mathematical concepts and procedures in order to reach conclusions through creating an environment where learners share their knowledge, discuss their mathematical thinking and form communities of practices (Schoenfeld, 1992). Findings of this study show that most teachers expressed their inclination to provide students with a learning environment where mathematical activities, processes or problems can be interpreted and conceptualized through multiple viewpoints that students share and discuss. Teachers expressed that students' mathematical ideas develop through taking responsibility of their learning (Wilson & Lloyd, 2000). When group comparisons were investigated in terms of teachers' considerations upon distribution of mathematical authority, there are remarkable results found with respect to gender, age and educational level. Younger and less-experienced teachers distributed mathematical authority well. This might be due to the fact that they are more willing and open to integrating educational innovations into teaching practices (Ghaith & Yaghi, 1997). Furthermore, teachers' educational background might also be a factor that contributes to their adaptation of new perspectives in their teaching practices through learning more about reform changes. As a further investigation, it is important to examine teachers' varying features (e.g. their age, career stage, generational identity of teachers) with respect to authority within the classroom to have an idea about the effectiveness of educational changes (e.g. student-centered learning environments for promotion of metacognition) (Hargreaves, 2005).

Lastly, external pressures are highly perceived by most mathematics teachers. Especially change in curriculum, timing, content, and students' attitudes towards mathematics, classroom size, parental expectations and achievement tests were found to be important factors affecting teaching practices such as promotion of metacognition. School context characteristics consisting of classroom size, curriculum, parental expectations, expectations from principal and timing creates occupational stress or pressure on teachers, which affects promotion of self-regulation or metacognition negatively (Lombaerts et. al., 2009). When group comparisons were taken into account in terms of perceived external pressure, on the contrary to literature (Karaköse & Kocabaş, 2006), public school mathematics teachers were found to perceive higher external pressure than private school teachers in this study. Karaköse and Kocabaş (2006) stated that private school teachers feel more pressure because of high expectations from them. However, other than high expectations from the teachers, the teachers in this study had a chance to score their perceptions of external pressure on different issues including time, content, attitudes of students, workload etc. This difference in findings might be the result of the differences between the scopes of the studies. Furthermore, the study indicated middle and secondary school mathematics teachers also differed with respect to perceived external pressure in favor of middle school mathematics teachers. The reason for this result could be given as the characteristics of age group taught and primary learning environment (Kokkinos, 2007).

All in all, the results described mathematics teachers' self-reports in terms of factors affecting promotion of student metacognition. Although most teachers have positive approaches towards promotion of metacognition, external pressure they perceived might have a negative influence on promotion of student metacognition as an educational innovation. The negative factors might create pressure or stress on teachers so teachers hesitating to integrate educational changes in their classrooms may have problems with generally adjusting their learning environment and specifically with promotion of students' metacognition (Lombaerts et al., 2009). One limitation of this study is the use of self-report instruments as the single data source. There is a need for supporting such findings with multiple methods and data sources. For further research, factors affecting promotion of metacognition could be supported by teaching practices of promotion of metacognition through establishing and validating a structural equation model. Furthermore the interviews might be conducted to support teachers' beliefs related to factors affecting promotion of metacognition. It would be informative to describe such data in-detail through using qualitative methods. Furthermore, group comparisons for factors affecting promotion of metacognition are statistically significant, but effect sizes of the group comparisons were found to be relatively small. However, Brewer (1978) stated that effect size is open to subjective interpretations of the researchers and added that what researchers should think of is the results of previous research. Therefore, small effect sizes could also be meaningful for the literature on factors affecting teachers' approaches or practices of supporting students' metacognitive development. The reason is that although there are studies related to promotion of self-regulation, number of studies on promotion of student metacognition is very limited. Therefore rather small effect sizes calculated for this study could still inform further research on teachers' promotion of student metacognition about practical significance.

This study is significant in a way that the results might inform researchers about where to start enabling mathematics teachers to promote student metacognition. Profiling tools developed for this study can be used as a starting point for designing in-service training for teachers. An intervention for mathematics teachers can be arranged based on the results of the study and conducting this intervention through a research study could be a productive way forward. In addition, the developed profiling tools might be used in an intervention for mathematics teachers to help them create a learning environment where positive factors supporting promotion of metacognition are cherished and negatively influencing factors are eliminated. An intervention on dealing with factors affecting promotion of metacognition and studying the relationships among the teacher's profile in terms of factors influencing their practice and teacher's actual efforts to promote student metacognition can help researchers and teacher educators to make sense of complex issues within teaching. Use of qualitative methods and in depth analysis of rich data about teachers' considerations and their teaching can enable better understanding of issues surrounding promotion of metacognition (Dignath-van Ewijk & Van der Werf, 2012).

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Öğrencilerin Üst Bilişsel Becerilerinin Geliştirilmesini Etkileyen Faktörler Üzerine Matematik Öğretmenlerinin İncelenmesi

Öz

Bu çalışmanın amacı matematik öğretmenlerinin profillerini, profil araçları geliştirerek öğrencilerin üst bilişini teşvik etmelerini etkileyen faktörler açısından tanımlamaktır. Bu amaç doğrultusunda, Üst bilişsel Becerileri Geliştirme Amaçlı Matematik Öğretimini Çözümleme Modeli'ndeki (Framework for Analysing Mathematics Teaching for the Advancement of Metacognition –FAMTAM) dört faktör kullanılmıştır. Çalışmanın örneklemi 314 ortaokul ve lise matematik öğretmenlerinden oluşmaktadır. Bu çalışmada ilişkisel araştırma desenleri kullanılmıştır. Sonuçlar matematik öğretmenlerinin üst biliş kavramsallaştırmalarının alan yazında yaygın olarak kabul edilen kavramsallaştırmalarla paralel olduğunu göstermiştir. Ayrıca matematik öğretmenlerinin cevapları öğrencilerin özellikleri ve ihtiyaçları hakkında farkındalığa sahip olduklarını göstermektedir. Öğretmenler ayrıca matematiksel otoritenin öğrenciler tarafından kullanıldığı bir öğrenme ortamından yana olduklarını belirtmişlerdir. Öğrencilerin üst bilini teşvik etmelerini etkileyen çeşitli faktörler tarafından fazla dış baskı hissettiklerini de belirtmişlerdir.

Anahtar kelimeler: Matematik, üst biliş, üst bilişin öğretimi, üst bilişin teşvik edilmesi

Appendix

ÜST BİLİŞİN MATEMATİK SINIFINDA TEŞVİK EDİLMESİNİ ETKİLEYEN FAKTÖRLER ANKETİ

Üst biliş genel olarak düşünme hakkında düşünme şeklinde açıklanan bir kavramdır. Üst bilişsel bilgi, bilişsel süreçlerimizi nasıl gerçekleştireceğimize dair bir bilgi türüdür. Üst bilişsel bilgiler kişinin kendi özellikleri hakkındaki bilgisi, farklı bilişsel görevlerin bilgisi ve bu görevleri gerçekleştirme adına kullanılacak olan strateji bilgisi olarak tanımlanır. Üst bilişsel beceriler ise yöntemsel bilgilerdir. Üst bilişsel becerilerin kullanılması kişinin öğrenme süreçlerinin düzenlenmesi ve kontrol etmesi için gereklidir. Kontrol etme, planlama, kendini değerlendirme ve kendini gözlemleme, üst bilişsel beceriler için birer örnektir. Üst biliş ve onu oluşturan kavramlar öğretim pratiklerimizde yer alan kavramlardır. Bu çalışmanın amacı matematik sınıflarında üst bilişin teşvik edilmesini etkileyen faktörleri araştırmaktır. Katılımınız için şimdiden teşekkür ederim.

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Katılımcı Bilgi Formu

Bu formda üst bilişin matematik sınıfında teşvik edilmesini etkileyen faktörlerin farklı boyutlarda incelenmesi için katılımcı bilgileri istenmektedir.

1- **Cinsiyetiniz**:
Kadın Erkek

2- **Öğrenim durumunuz**:
Lisans Yüksek lisans Doktora

3- **Mezun olduğunuz fakülte**:
Eğitim Fakültesi Fen Edebiyat Fakültesi Diğer (*lütfen belirtiniz*): ....

4- **Mesleki deneyiminiz** (*lütfen yıl ve ay olarak belirtiniz*): .... yıl .... ay

5- **Çalıştığınız kurum türü**:
Devlet okulu Özel okul

6- **Eğitim verdiğiniz seviye**:
Ortaokul Ortaöğretim

7- **Girdiğiniz sınıf seviyeleri** (*lütfen belirtiniz*):
....

BÖLÜM I *Aşağıda öğrencilerin üst bilişsel süreçleri ile ilgili ifadeler verilmiştir. Sizden beklenen, bu ifadelerin ne derece önemli olduğuna katılma durumunuzu belirtmenizdir.*	**1-Hiç katılmıyorum**	**2-Katılmıyorum**	**3-Kararsızım**	**4-Katılıyorum**	**5-Kesinlikle katılıyorum**
1. Öğrencilerin kendi düşüncelerini planlaması	1	2	3	4	5
2. Öğrencilerin matematik ile uğraşırken kendini gözlemlemesi	1	2	3	4	5
3. Öğrencilerin gerekirse/gerektiğinde kendi yaptıklarını tekrar düzenlemesi	1	2	3	4	5
4. Öğrencilerin kendi yaptıklarını değerlendirmesi	1	2	3	4	5
5. Öğrencilerin gerekli bilgiyi seçip kullanabilmesi	1	2	3	4	5
6. Öğrencilerin kendi yaptıklarını kontrol etmesi	1	2	3	4	5
7. Öğrencilerin matematikteki uygulamalar hakkında bilgi sahibi olması	1	2	3	4	5
8. Öğrencilerin strateji bilgisine sahip olması	1	2	3	4	5
9. Öğrencilerin kendi bilişsel özelliklerini bilmesi	1	2	3	4	5

BÖLÜM II *Aşağıda üst bilişsel bilgi ve beceriler ile ilgili ifadeler verilmiştir. Sizden beklenen, bu ifadelere katılıp katılmadığınızı ilgili rakamı işaretleyerek belirtmenizdir.*	**1-Hiç katılmıyorum**	**2-Katılmıyorum**	**3-Kararsızım**	**4-Katılıyorum**	**5-Kesinlikle katılıyorum**
1. Gelişimsel süreç içinde gerçekleşir, yaş büyüdükçe onlar da gelişir.	1	2	3	4	5
2. Okul öncesi dönemden itibaren eğitimin yardımıyla gelişir.	1	2	3	4	5
3. Motivasyonu yüksek öğrencilerde daha çok görülmektedir.	1	2	3	4	5
4. Başarılı çocuklar etkin bir şekilde kullanmaktadır.	1	2	3	4	5
5. Öğretmen, problem çözme sürecinde başarılı olamayan öğrencilere bu bilgi ve becerileri kullanıp yönlendirmeler yapmalıdır.	1	2	3	4	5
6. Çeşitli öğretim yöntemleri (model olma, sesli düşünme, direkt anlatma gibi) kullanarak öğrencilerin bu bilgi ve becerilerinin geliştirilmesi sağlanmalıdır.	1	2	3	4	5

BÖLÜM III *Aşağıda matematik dersindeki sınıf ortamı ile ilgili ifadeler verilmiştir. Sizden beklenen, bu ifadelere katılıp katılmadığınızı ilgili rakamı işaretleyerek belirtmenizdir.*	**1-Hiç katılmıyorum**	**2-Katılmıyorum**	**3-Kararsızım**	**4-Katılıyorum**	**5-Kesinlikle katılıyorum**
1. Öğretmen ve öğrencilerin birlikte sorguladıkları bir sınıf ortamı oluşturulmalıdır.	1	2	3	4	5
2. Öğretmen bilmediğini göstermemelidir.	1	2	3	4	5
3. Öğrencilerin matematiksel süreçleri kendilerinin yönetebildiği bir sınıf ortamı oluşturulmalıdır.	1	2	3	4	5
4. Öğrencilerin birbirlerinin öğrenmelerine katkı sağlayabilecekleri bir sınıf ortamı teşvik edilmelidir.	1	2	3	4	5
5. Matematik sınıfında öğretmenin matematik bilgisinin sorgulanmasına izin verilmemelidir.	1	2	3	4	5
6. Öğretmen matematiği sınıfta öğrencilere sadece bilgi aktararak öğretmelidir.	1	2	3	4	5
7. Matematik sınıfında öğrenmenin gerçekleşmesinin tek yolu öğretmenin bilgiyi öğrenciye aktarmasıdır.	1	2	3	4	5
8. Öğrencilerin problem çözme strateji ve yöntemlerini kullanarak öğretmene ihtiyaç duymadan matematik yapabilmeleri sağlanmalıdır.	1	2	3	4	5
9. Öğrencilerin matematiksel süreçleri değerlendirmelerine fırsat verilmelidir.	1	2	3	4	5
10. Sınıfta matematik uygulamaları sadece öğretmen tarafından yapılmalıdır.	1	2	3	4	5

BÖLÜM IV *Aşağıda öğretim uygulamalarını etkileyebilecek faktörler ile ilgili ifadeler verilmiştir. Sizden beklenen, bu ifadelerde verilen faktörlerin sizin uygulamalarınızı ne ölçüde etkilediğini ilgili rakamı işaretleyerek belirtmenizdir.*	**1-Hiç etkilemiyor**	**2-Etkilemiyor**	**3-Kararsızım**	**4-Etkiliyor**	**5-Tamamen etkiliyor**
1. Müfredat ve öğretim yaklaşımları değişimi	1	2	3	4	5
2. Konuları yetiştirmek için zamanın kısıtlı olması	1	2	3	4	5
3. İçeriğin çocukların seviyesine ağır gelmesi	1	2	3	4	5
4. Öğrencilerin derse karşı negatif olmaları	1	2	3	4	5
5. Sınıf mevcudunun çok olması	1	2	3	4	5
6. Velilerin beklentilerinin farklı farklı olması	1	2	3	4	5
7. Okulda bunun için yeterli kaynak olmaması	1	2	3	4	5
8. Okul idaresinin öğretmen rolü dışındaki beklentileri	1	2	3	4	5
9. Genel başarı sınavları	1	2	3	4	5