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IF IN-SERVICE EDUCATION IS IMPORTANT, HOW CAN BE IT ROUTED? EVIDENCE FROM TIMSS-2015 8TH GRADE SCIENCE TEACHERS IN EUROPE

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ABSTRACT

In this study, it was aimed to determine whether the professional development activities or participation in in-service education/training of teachers has an effect on their students' science achievement or not. If such an effect exists, an attempt has been made to state which teachers should primarily participate in, or be directed to, education or such activities. The study was the survey model and TIMSS 2015 data was used. The study was conducted with the participation of 112871 students who were participated in TIMSS 2015 8th grade and their 5214 science teachers from European countries. Teachers were clustered into three groups (low, moderate and high) according to their participation in in-service training activities. The results show that the participation of teachers in in-service training makes a significant positive contribution to the success of their students. In the in-service training, "level of formal education completed", "major area of study", "years spent teaching", and "sex of teacher" are important. As the level of education increases, the teachers become aware of their deficiencies and are more inclined towards in-service training. European countries firstly are recommend in-service training for teachers with a "short-cycle tertiary or bachelor's or equivalent" level of formal education and teachers whose "major area of study" is in an "other area" and is not in "education-science" are directed.

Keywords: In-service education, professional development activities, science teachers.

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INTRODUCTION

Teachers carry out the instruction process and make decisions in this process; thus, the effectiveness of this process is based on the quality of the teachers (Eskici, 2016; Titrek, Konak, & Titrek, 2013). One of the factors that primarily determine the quality of teachers is pre-service education. However, this is not adequate alone to increase or determine the quality of the teacher. When it is considered that an individual starts teaching around the ages of 21-25 and retires at the age of 65, it is challenging for anyone to have a professional life of 40 years or more with only pre-service training. Thus, for teachers to be able to adapt to new developments, a need for education or training during their teaching period arises.

For the formation of learning societies, the significant role of teachers is great in the guidance of the individual at every stage of education, beginning from the early ages (Evin Gencel, 2013). The European Union attaches great importance to the selection and training of teachers and their professional development so that these roles can be properly implemented (Birch, Balcon, Borodankova, Ducout, & Sekhri, 2015). At the European level, "teachers' competences have been described and efforts have been made to encourage their active participation" (Theodosopoulou, 2010: 153).

Professional development is enabled thanks to participation in in-service education. In-service education can be defined as an "education which is delivered in a structured work environment and which strengthens the individual to become more efficient professionally" (Petaloti, 2009: 46). This training aims to establish the orientation of all employees, quality control, standardization of methods, development of trust, personal development, recruitment of qualified personnel and creation of a learning culture in an institution (Aydın, 2014).

The institutions which have a learning culture head towards a learning society. One of the most important institutions in society is the educational institutions. Teachers adopt a key role in the implementation of programs in educational institutions. The quality of the education in schools also depends on the quality of the teachers and there is a significant positive relationship between quality and the professional development of teachers (Borko, 2004; Fendler, 2003, Garet, Porter, Desimone, Birman, & Yoon, 2001).

The effectiveness of in-service training or professional development programs is determined through program evaluation. Evaluation is based on program design with the question "Do we have a program within our scope?"; on process with the question "Are we enough to give education service?"; on a product with the question "Are we getting the desired outputs?"; and on personnel with the question "Do employees make a direct contribution to the program as planned?" (Wiles, 2016). Studies that examined the effect of in-service training on learning outcomes of students found a positive relationship between learning outcomes of students and in-service training participation by teachers (Cho, 2002; Dildy, 1982; Fujitani, Muta, & Ota 2011; Ye, 2000).

Another program evaluation approach is to interview the participants after the activities, to watch them work together, to observe the courses after the activity and also to analyse the contents and documents. A number of studies (Akkuş & Kadayıfçı, 2007; Borghi, Ambrosis, Lunati, & Mascheretti, 2001; Carleton, Fitch, & Krockover,

2007; Demir, Böyük, & Erol, 2012; Doğan, Çakıroğlu, Çavuş, Bilican, & Arslan, 2011; Önen, Mertoğlu, Saka, & Gürdal, 2009; Önen, Mertoğlu, Saka, & Gürdal, 2010; Önen, Saka, Uzal, & Gürdal, 2008; Şenel, Çoruhlu, & Çepni, 2010; Watanabe & Nozu, 2004; Wight & Buston, 2003) revealed that there was a positive increase in the learning outcomes of learners after teachers' training programs. As a result of evaluation studies on the development and implementation of programs, it was determined that it is necessary for programs to be need-oriented (Baykan & Oktay, 2016); and in addition that some of the teachers are satisfied with the kinds of activities (Ayvacı, Bakırcı, & Yıldız, 2014; Kaya & Altuk, 2012).

In order for in-service training to be effective, the first step, which is the needs analysis, should be conducted. Needs analysis can range from individual data to big data. Needs analysis can be made by different methods. For example, survey, interview, survey and interview, or survey, interview and observation can be used in needs analysis. The results of analyses give us information about matters such as which subject needs to be learnt or who needs to undergo training. In this study, a non-traditional method was tried. A decision tree method was applied to identify teachers who need in-service education or a professional development program. For this purpose, the big data of European participants of the Trends in International Mathematics and Science Study (TIMSS) 2015 study were used. TIMSS is a worldwide appraisal of mathematics and science at the fourth and eighth grades; additionally, and inquires understudies, students' teachers, and school principals to total surveys approximately their school and classroom guidelines settings for learning mathematics and science (Mullis & Martin, 2013). Only European countries have been included in this study since the European Union supports the professional development of teachers. The European Union, for the professional development of teachers, regards in-service training in this context as an important factor for the quality of training and supports teachers to move out of the country for this purpose (European Council, 2009). From this perspective, it is necessary to have wider professional networks and collaborative projects across Europe (Day, 1997).

In this study, science teachers were selected as the representative sample. One of the main reasons for this was that the TIMSS 2015 study is related to the science and mathematics areas, and so the study collected data from science and math teachers. The second reason was that depending on the science and technological developments in the world, mostly science programs are affected. When considering that the most important actors in these programs are science teachers, in-service training for their professional development is at the forefront. Therefore, the study is limited to only science teachers.

In this study, it was aimed to determine whether the professional development activities or participation in in-service education/training of teachers has an effect on their students' science achievement or not. If such an effect exists, an attempt has been made to state which teachers should primarily participate in, or be directed to, education or such activities. This research aims to answer five fundamental questions:

Is it possible to classify 8th-grade science teachers across Europe into three groups (low-active in-service teachers; moderately-active in-service teachers; high-active in-service teachers) according to their levels of participation in in-service education for professional development as lifelong education?

If the teachers can be clustered as such, between which characteristics of these clusters is there a significant difference?

If the teachers can be clustered as such, which in-service training activities receive the most participation collectively from the teachers in these clusters?

If the teachers can be clustered as such, is there a significant difference between the achievements of the students of the teachers in these clusters?

If the teachers can be clustered as such, what are the factors ("years spent teaching," "sex of teacher," "age of teacher," "level of formal education completed" [did not complete upper secondary, upper secondary, post-secondary, non-tertiary, short-cycle tertiary, bachelor's or equivalent, master's or equivalent, doctor or equivalent], and "major area of study" [mathematics, biology, physics, chemistry, earth science, education-mathematics, education-science, education-general, and other]) that affect their affiliation with these clusters?

The first four questions in the research are related to the clustering of the teachers in terms of their receiving of in-service training and the possible effects of these clusters on success. The fifth question aims to identify the characteristics of teachers who especially are low and moderate in-service training recipients, and to determine which individuals with which characteristics can be guided towards more in-service education.

METHOD

The study was quantitative research. The study was conducted using the TIMSS 2015 data. The study represents the survey model. According to Fraenkel and Wallen (2003), the survey model interest with the existing situation and relations. The situation in this study will be defined and from there a proposal will be offered for in-service training of teachers.

Sample of Research

The TIMSS 2015 worldwide appraisal of understudy accomplishment at the fourth and eighth grades each incorporate an expansive number of mathematics and science things alongside sets of surveys that assemble data on the instructive and social settings for accomplishment (Martin, Mullis, & Foy, 2013). At the begin of the TIMSS, schools were recorded agreeing to their statistic factors, and after, schools were decided from this list utilizing the probability-proportional-to-size inspecting strategy which covered random branches were chosen from the schools (LaRoche, Joncas, & Foy, 2016). After defining the students, the questionnaires were applied to their mathematics and science teachers and school principals.

The research covers science teachers of 8th-grade science in Europe. TIMSS is actually aimed at students. Therefore, the sample of the study group is made up according to the students. In this study, the teachers of the students participating in the survey were included. For this reason, no sampling work has been done for the teachers. The TIMSS 2015 8th grade students were analysed with the participants' data, for which the study-

related information of the students was filled out completely by their teachers and with which the achievements of the students were calculated. The study was conducted with the participation of 112,871 students and 5,214 teachers.

Data Collection Tools

The research data consist of the science achievement scores of the TIMSS 2015 8th grade students and the questions directed to the teachers. TIMSS 2015 had two main data gathering tools. One of them was the Achievement Test which focused on "what the student should know", "what the student should be able to do" and "what kind of evidence best demonstrates this knowledge or ability". The data which was obtained from the test was scaled as five plausible values, and the students' science achievement scores were calculated by taking the average of five the plausible values (Cheema & Galluzzo, 2013; Gándara & Randall, 2015; House & Telese, 2008; Lay & Chandrasegaran, 2016; Tatsuoka, Corter, & Tatsuoka, 2004; Yu, Wu, & Mangan, 2015) in this study.

The other tool consisted of Context Questionnaires which covered student, home, teacher, and school questionnaires. In this study, the teacher questionnaire was used. This asked teachers to provide information about their education, experience in teaching, and professional development. Its questions directed to TIMSS 2015 8th grade teachers were used for the in-service training and professional development of teachers. In the 25th question under the heading of "Preparation to Teach Science", teachers were asked which of the following activities they had participated in during the last two years: "Science content", "Science pedagogy/instruction", "Science curriculum", "Integrating information technology into science", "Improving students' critical thinking or inquiry skills", "Science assessment" and "Addressing individual students' needs", and they were further asked "How many hours in total have you spent in formal in-service/professional development (e.g., workshops, seminars) for science?". According to the answers given to these questions, teachers were classified as low-active in-service teachers, moderately-active in-service teachers and high-active in-service teachers in terms of participation in (yes/no) in-service training.

The variables that may lead to teachers being included in these groups are thought to be "years spent teaching," "sex of teacher," "age of teacher," "level of formal education completed" (did not complete upper secondary, upper secondary, post-secondary, non-tertiary, short-cycle tertiary, bachelor's or equivalent, master's or equivalent, doctor or equivalent), and "major area of study" (mathematics, biology, physics, chemistry, earth science, education-mathematics, education-science, education-general, and other). Teachers were able to mark more than one option in the last section.

Procedure and Data Analysis

Teachers were grouped for in-service training by two-step cluster analysis. The analysis was limited to three groups. The distributions of the teachers in the groups were examined by the chi square ($\chi 2$) test. The characteristics of the teachers in different groups regarding participation in training were determined by making association rules analysis with Apriori algorithm separately for each group. Support and confidence levels were

selected as 90%. It is believed that great support and high confidence can provide this since the purpose of association rules analysis is to define strong associations (Chen, Han, & Yu, 1996). In any case, the rules at this level are accepted as strong rules (Karaibrahimoğlu, 2014). To determine whether there was a significant difference between the TIMSS achievements of the students of different groups of teachers, the score distributions were first examined. Skewness and kurtosis were used, which was sufficient for the values to be to be within ± 1 for the assumption of normality (Büyüköztürk, 2007). As a result, one-way analysis of variance (one-way ANOVA) was performed. For a meaningful outcome, the homogeneity of the variances was checked and the difference was determined by the Tamhane test, as this was not provided. For both the one-way ANOVA and the χ2 test, a .05 value was considered as the limit for significance. In the one-way ANOVA, meaningful outcomes were calculated and interpreted by the impact value (η^2), which was determined in line with the opinions of Cohen (1988); between .01 and .05 as low, between .06 and .13 as moderate, and greater than .14, as a strong effect. To identify teachers who could participate in in-service education based on the level of their participation in in-service education activities a decision tree analysis was performed by Chi-Squared Automatic Interaction Detector (CHAID) algorithm. In the interpretation, percentages were used rather than frequencies.

FINDINGS

As a result of the clustering analysis, three groups were determined at a "fair" quality level. The distribution of the groups and the group members' in-service training participation areas are presented in Tables 1-8.

Table 1. Activities Related to Science Content Teachers Have Participated in During the Past Two Years

Participation Status		Teacher Participation Level			Total	χ2
		Low	Moderate	High		
No	Number	1130	1228	87	2445	2139.71*
	% within Science Content	46.2%	50.2%	3.6%	100.0%	
	% within Teacher Level	96.4%	47.6%	5.9%	46.9%	
Yes	Number	42	1351	1376	2769	
	% within Science Content	1.5%	48.8%	49.7%	100.0%	
	% within Teacher Level	3.6%	52.4%	94.1%	53.1%	

*p<.05

Table 2. Activities Related to Science pedagogy/ instruction Teachers Have Participated in During the Past Two Years

Participation Status		Teacher Participation Level			Total	χ2
		Low	Moderate	High		
No	Number	1172	1302	65	2539	2384.87*
	% within Science pedagogy/instruction	46.2%	51.3%	2.6%	100.0%	
	% within Teacher Level	100.0%	50.5%	4.4%	48.7%	
Yes	Number	0	1277	1398	2675	
	% within Science pedagogy/instruction	0.0%	47.7%	52.3%	100.0%	
	% within Teacher Level	0.0%	49.5%	95.6%	51.3%	

*p<.05

Table 3. Activities Related to Science Curricular Teachers Have Participated in During the Past Two Years

	Participation Status	Teacher Participation Level			Total	χ2
		Low	Moderate	High		
No	Number	1111	1385	159	2655	1849.83*
	% within Science Content	41.8%	52.2%	6.0%	100.0%	
	% within Teacher Level	94.8%	53.7%	10.9%	50.9%	
Yes	Number	61	1194	1304	2559	
	% within Science Content	2.4%	46.7%	51.0%	100.0%	
	% within Teacher Level	5.2%	46.3%	89.1%	49.1%	

*p<.05

Table 4. Activities Related to Integrating Information Technology into Science Teachers Have Participated in During the Past Two Years

	Participation Status	Teacher Participation Level			Total	χ2
		Low	Moderate	High		
No	Number	1172	1188	361	2721	1556.30*
	% within Science Content	43.1%	43.7%	13.3%	100.0%	
	% within Teacher Level	100.0%	46.1%	24.7%	52.2%	
Yes	Number	0	1391	1102	2493	
	% within Science Content	0.0%	55.8%	44.2%	100.0%	
	% within Teacher Level	0.0%	53.9%	75.3%	47.8%	

*p<.05

Table 5. Activities Related to Improving Students' Critical Thinking or Inquiry Skills Teachers Have Participated in During the Past Two Years

	Participation Status	Teacher Participation Level			Total	χ2
		Low	Moderate	High		
No	Number	1097	1746	467	3310	1107.05*
	% within Science Content	33.1%	52.7%	14.1%	100.0%	
	% within Teacher Level	93.6%	67.7%	31.9%	63.5%	
Yes	Number	75	833	996	1904	
	% within Science Content	3.9%	43.8%	52.3%	100.0%	
	% within Teacher Level	6.4%	32.3%	68.1%	36.5%	

*p<.05

Table 6. Activities Related to Science Assessment Teachers Have Participated in During the Past Two Years

	Participation Status	Teacher Participation Level			Total	χ2
		Low	Moderate	High		
No	Number	1089	1655	377	3121	1260.63*
	% within Science Content	34.9%	53.0%	12.1%	100.0%	
	% within Teacher Level	92.9%	64.2%	25.8%	59.9%	
Yes	Number	83	924	1086	2093	
	% within Science Content	4.0%	44.1%	51.9%	100.0%	
	% within Teacher Level	7.1%	35.8%	74.2%	40.1%	

*p<.05

Table 7. Activities Related to Addressing Individual Students' Needs Teachers Have Participated in During the Past Two Years

	Participation Status	Teacher Participation Level			Total	χ2
		Low	Moderate	High		
No	Number	1002	1565	467	3034	780.70*
	% within Science Content	33.0%	51.6%	15.4%	100.0%	
	% within Teacher Level	85.5%	60.7%	31.9%	58.2%	
Yes	Number	170	1014	996	2180	
	% within Science Content	7.8%	46.5%	45.7%	100.0%	
	% within Teacher Level	14.5%	39.3%	68.1%	41.8%	

*p<.05

Table 8. Activities Related to Hours in In-Service/ Professional Development Teachers Have Participated in During the Past Two Years

	Participation Status	Teacher Participation Level			Total	χ2
		Low	Moderate	High		
No	Number	784	90	0	874	5851.29*
	% within Hours in in-service/professional development	89.7%	10.3%	0.0%	100.0%	
	% within Teacher Level	66.9%	3.5%	0.0%	16.8%	
Less than 6 hours	Number	364	464	0	828	
	% within Hours in in-service/professional development	44.0%	56.0%	0.0%	100.0%	
	% within Teacher Level	31.1%	18.0%	0.0%	15.9%	
6-15 hours	Number	1	1308	0	1309	
	% within Hours in in-service/professional development	0.1%	99.9%	0.0%	100.0%	
	% within Teacher Level	0.1%	50.7%	0.0%	25.1%	
	Number	0	433	571	1004	

16-35 hours	% within Hours in in-service/professional development	0.0%	43.1%	56.9%	100.0%
	% within Teacher Level	0.0%	16.8%	39.0%	19.3%
More than 35 hours	Number	23	284	892	1199
	% within Hours in in-service/professional development	1.9%	23.7%	74.4%	100.0%
	% within Teacher Level	2.0%	11.0%	61.0%	23.0%

*p<.05

As seen in Tables 1-8, teachers who had a high level of participation in in-service training were more involved and spent more time in activities. The χ2 analysis of distribution supported this outcome. The findings suggest that the teachers are properly grouped regarding their participation in in-service training and professional development activities.

Low-level teachers did not appear in certain areas, such as “science pedagogy/instruction”, “integrating information technology into science”, and “spending 16-35 hours”. Only 23 teachers from the low-level teacher group appeared in the “more than 35 hours” section. The most participated (170) activity of low-level teachers was “addressing individual students’ needs”. In the areas of “integrating information technology into science” (1391; 55.8%) and “addressing individual students’ needs” (1014; 46.5%), the participation rate and number of moderate-level teachers were higher than those of the teachers in the high-level group. High-level teachers were more involved in other areas, notwithstanding that teachers in this group spent more than 16 hours of time for development.

As a result of the analysis of participation and time spent on the activities of the teachers in the three groups, only the high-level teachers achieved the strong rule of 90% in support and confidence level (see Table 9). According to the first rule in this group of teachers, 95.28% of the teachers who participated in the training related to “science content” also participated in the training related to “science pedagogy/ instruction”. This association was seen in 94.05% of the training in this group. The second rule is the opposite of this rule, and 93.78% of the teachers participating in the “science pedagogy/instruction” also participated in the “science content” related training. This association was observed in 95.56% of the training in this group. In light of these findings, we deduced that the teachers tended towards pedagogical and content-related training.

Table 9. Characteristics of Teachers Having a High Level of In-Service Education

Consequent	Antecedent	Support %	Confidence %
Science pedagogy/instruction	Science Content	94.05	95.28
Science Content	Science pedagogy/instruction	95.56	93.78

A low level of significant difference was found between the groups as a result of the analysis to determine whether there was a significant difference between the achievement distributions of the students according to the groups in which their teachers were located (see Table 10). It can be said that the participation of the teachers

in in-service training or the improvement of themselves in the professional sense makes a significant contribution to the success of the students. As a result, such activities are considered important.

Table 10. Success of Students According to Groups of Teachers

Clusters	N	Mean	Std. Deviation	95% Confidence Interval for Mean		F	p	Difference	η2
				Lower Bound	Upper Bound				
Low	26321	513.36	82.48	512.37	514.36	526.49	.00	High > Moderate	.01
Moderate	53586	526.83	82.44	526.13	527.53			High > Low	
High	32964	535.13	78.99	534.28	535.99			Moderate > Low	

Factors leading to or contributing to the in-service training or professional development activities of the teachers were determined by the decision tree, and based on this, an attempt was made to determine which teachers could be directed to in-service training (see Table 11 and Figure 1). As a result of the analysis, an accuracy of 50.1% was found. Although this rate is not very high, it is seen as an acceptable value when considering the three groups of structures. The highest classification is for teachers in the moderate-level group. When the decision tree is examined, all nods have teachers from each group and it can be seen that the most important role in the teachers' participation in in-service education is "level of formal education completed". Other effective areas are, in order, "major area of study", "years spent teaching", and "sex of teacher".

Table 11. Classification Results

Observed	Predicted			
	Low	Moderate	High	Percent Correct
Low	184	943	45	15.7%
Moderate	177	2105	297	81.6%
High	58	1080	325	22.2%
Overall Percentage	8.0%	79.2%	12.8%	50.1%

The first level of education was "short-cycle tertiary education" at an equal or lower level. Under this node, 5% of the whole group was represented. The first important factor under this node was the "major area of study", which was biology. Mostly, those who worked in the field of biology entered the high-level group, while those who did not work in this field entered the low-level group. It is thought that teachers who have completed TIMSS-2015 the "short-cycle tertiary education or lower" level of formal education and have not received training in biology should be directed more to in-service training.

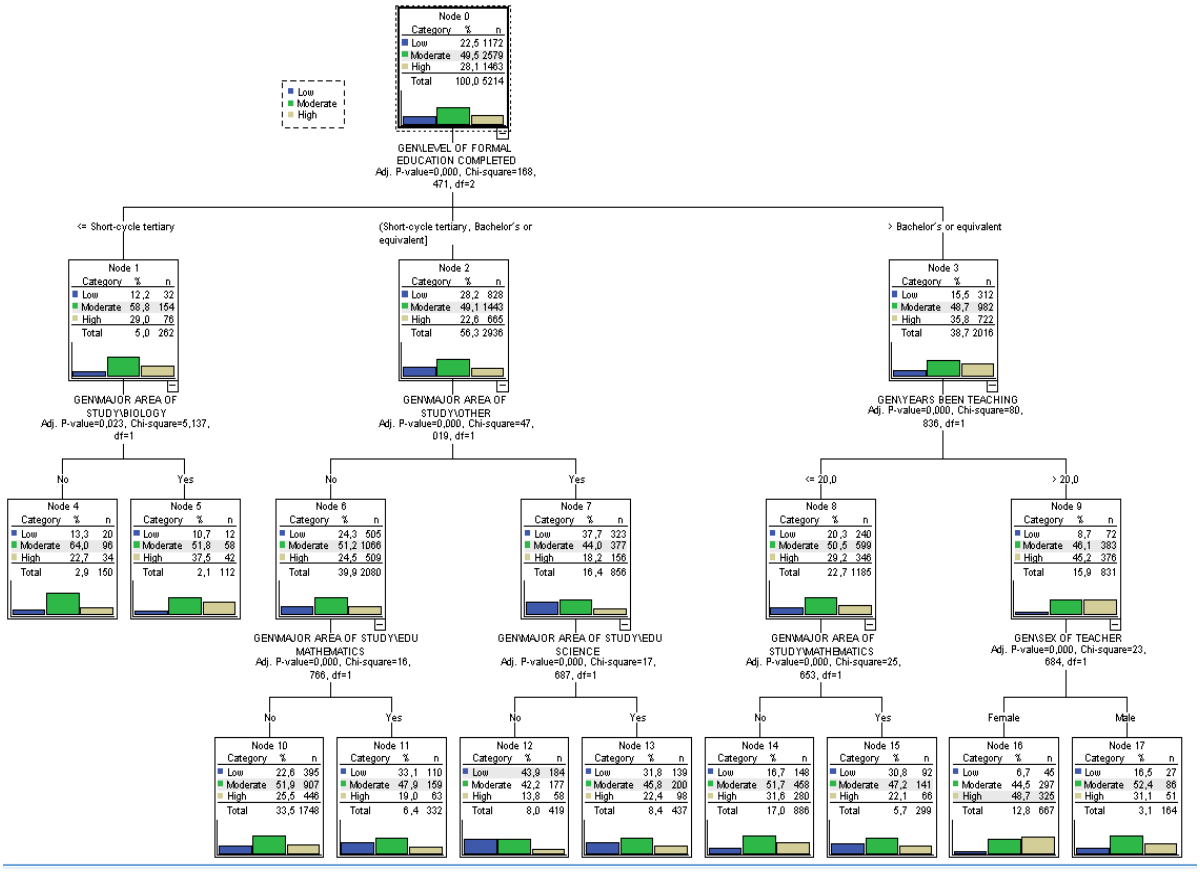

Figure 1. Decision Tree Results

The second node was the “short-cycle tertiary and bachelor’s or equivalent”. This node was also where teachers at the lowest level were the highest in number. The second factor in classifying teachers who had any of these trainings was whether the “major area of study” was considered an “other” field. Teachers who were mostly low-level were those who worked in an “other” field but did not work in the field of “education-science”. It is therefore considered that these teachers should be among the first groups to be invited to participate in activities related to in-service training and professional development. When this section is examined, conversely, the percentage of “low level” decreased and the percentage of “high level” increased in case of work in the field of “Education-Science”.

The third node was “bachelor’s or equivalent”. At the same time, this section was where the teachers in the “high-level” group were the highest in number. The first important factor in this area was “years spent teaching”, which was followed by “gender” and “major area of study/mathematics”. It is seen that female teachers who had an education above “bachelor’s or equivalent”, and who had done more than 20 years of teaching were in the “high-level” group and that at this point, there were very few “low-level” teachers. Teachers who had taught for 20 years or less and who had studied in the “major area of study/mathematics” were mostly “low-level”.

CONCLUSION and DISCUSSION

In this study, an attempt was made to discuss the effects of in-service training on student success and the factors that direct teachers to receive in-service training, and to determine the features of teachers who could be directed to in-service training. To demonstrate the effects of teachers' in-service training and professional development on students' achievement, teachers were clustered according to their participation in such activities in the last two years. Clustering is, in fact, a basic human activity, paving the road from concepts to theories (Aldenderfer & Blashfield, 1984). Clustering is also carried out to reveal the effects of teacher characteristics on their level of participation in professional development activities. Clustering can also be used for professional development by setting the instructional and teacher quality classification characteristics of the teachers (see Baker, 2013; Blazar, Litke, & Barmore, 2016; Dwyer, 2016, Koh & Chai, 2014). In this study, teachers were grouped according to their common characteristics and grouped as low-, moderate- and high-level according to their participation in in-service training activities. A two-step cluster analysis was performed and the science teachers of the 8th-grade students in Europe participating in the TIMSS 2015 study were grouped as low-, moderate-, and high-level. In studies conducted to contribute to the professional development of teachers, clustering is used both to see the deficiencies and to direct the teachers to cooperative activities. For example, Power (1992) attempted to analyze teacher beliefs and behaviours during the learning-teaching process and to shed light on teacher education by doing a cluster analysis for teachers' orientations. Christoforidou, Kyriakides, Antoniou, and Creemers (2014), who conducted a similar study of the professional development of teachers, conducted a grouping of teachers to identify the needs of "teacher's skills in assessment." The four different groups they created can classify teachers using hierarchical techniques of increasingly better assessment. Such actions make a major contribution to the developers of in-service training programs. The groups in this study, as generally expected, were increasingly inclined to participate in in-service training or professional training as they went from low to high. When the characteristics of the teacher groups were examined, the strongest association was found at a high level. This characteristic, which showed a high degree of participation in the training, had a condition of reversibility regarding participation in "science pedagogy/instruction" and "science content" activities. Participation in both activities was over 90%. From here it can be said that the teachers at the high level intensively tended towards two educational activities. Both activities –pedagogy and content– are the voice of Pedagogical Content Knowledge (PCK). Pedagogical content knowledge is defined as a "special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding" (Shulman, 1987: 8). PCK is one of the characteristic features of teachers (Baker, 2014), in that PCK determines the quality of classroom practices by teachers (Blömeke & Delaney, 2012). Quality class practices bring success. There is a positive relationship between PCK and academic achievement or student outcomes (Callingham, Carmichael, & Watson, 2016; Kanter & Konstantopoulos, 2010; Keller, Neumann, & Fischer, 2017; Lange, Kleickmann, & Möller, 2012). The findings of this study are consistent with these results. A significant difference was found between the achievements of the students of the different-level teachers attending the in-service training. Studies in the literature on in-service training or participation in professional development

activities have determined that there is an increase in the learning outcomes and achievements of students of teachers that participate in such activities (Cho, 2002; Fujitani, Muta, & Ota, 2011; Sezer, Karaoğlan Yılmaz, &Yılmaz, 2017; Ye, 2000). As a result, the findings suggest that participation in in-service training plays an important role in increasing student achievement.

The importance of participating in in-service training is expressed both in the literature and in this study. Another part of this study was how teachers would be directed to these significant trainings. In this study, unlike the traditional techniques, such as survey, observation, and document review, the teachers were directed to in-service training with the help of the decision tree. According to the results of the decision tree, for teachers to be directed towards in-service training or professional training, the important factor was the "level of formal education completed". As can be seen in the distribution of the decision tree, the section where the high-level teachers were the highest in number is above "bachelor's or equivalent". In-service training is a lifelong learning activity, and it is expressed in the literature that there is a positive relationship between the level of education and lifelong learning and perceptions of competence (Keskin & Yazar, 2015; Şahin & Arcakgök, 2014; Yaman & Yazar; 2015). The achievement averages of the students of the teachers in this area were significantly higher than those of the teachers in the other group. Other studies suggest that teachers have a positive relationship between their level of education and the success of their students (Blömeke, Olsen, & Suhl, 2016; Bolyard & Moyer-Packenham, 2008; Stols, Kriek, & Ogbonnaya, 2008). Based on this, as the level of education increased, teachers were trying to see their deficiencies and to resolve them. Other teachers were hesitant. Thus, it can be said that "ignorance is bliss".

As the study continues to examine the area of above "bachelor's or equivalent", it appears that those who had been teaching for 20 years or more participated more in in-service training or professional development activities. While no significant difference was found in some of the studies in the literature in terms of seniority and lifelong learning tendency or competence (Ayra, Köstereliоğlu, & Çelen, 2015; Özçiftçi & Çakır, 2015), in other studies, it was determined that the perceptions of competence and tendency of employees who had worked for 20 years or more generally declined (Day, Sammons, Stobart, Kington, & Gu, 2007; Keskin & Yazar, 2015; Kılıç & Ayvaz Tuncel, 2015; Şahin & Arcakgök, 2014; Yaman & Yazar; 2015). Louws, vanVeen, Meirink, and vanDriel (2017) pointed out in light of their research findings that teachers who had worked for 20 years or more showed a decline in entering professional development-oriented education or activities. The results of this study and the literature findings are not the same. In the learning of human beings, the brain can functionally tolerate the aging process (Hultsch, Hertzog, Small, & Dixon, 1999), and when considering the effect of factors such as social environment on cooperation (Vukelich & Wrenn, 1999) and motivation (Knowland & Thomas, 2014), the result of the work can be said to be harmonious for an aging Europe (Kashnitsky, deBeer & vanWissen, 2017). On the other hand, Louws et al. (2017) stated that teachers who are aged 20 or more tend to coach new teachers in their work. This evokes the "wisdom paradox" (see Goldberg, 2006). The aging brain is wisdom for mankind, not for fragmentation or analysis, but for making sense out of complex structures or processes (Canan, 2015). Based on the results of both studies, teachers who have a formal education of above "bachelor's or equivalent", who

have taught for more than 20 years, or who have participated in in-service training or professional development activities are eligible to coach for the development of freshman teachers who have recently started.

Another effective factor at the high level was the sex of the teachers. Bolam (1990) suggests that gender should be considered while in-service training activities are being organized. When the study continued to examine the area above "bachelor's or equivalent", it was seen that female teachers who had been teaching for 20 years or more were in the high level more than males. This result is consistent with previous studies (Ayra, Köstereliоğlu, & Çelen, 2015; Erdamar, Demirkan, Saraçoğlu, & Alpan, 2017; Kılıç & Ayvaz Tuncel, 2015; Ogan-Bekiroglu, 2007; Özçiftçi & Çakır, 2015; Uzunboylu & Hürsen, 2013; Yavuz Konokman & Yanpar Yelken, 2014) showing that female teachers are more likely to participate in in-service training along with lifelong learning competencies and tendencies. In addition to the basic analysis of the study, the results of the one-way ANOVA showed that the achievement of the students of high-level female teachers was significantly higher than in all other groups ($F(5, 112865) = 232.982$, $p<.05$; $\eta 2=.01$).

One thing that this study aims to emphasize is to specify the features that low-level teachers most display. Thus, experts or educational policy makers will be able to determine who firstly can be directed to in-service training. In other words, "for whom the bell tolls" can be determined. In the study results, the low-level rate was found at most in the second node, that is, the "short-cycle tertiary and bachelor's or equivalent" section. Teachers with any of these trainings are more likely to enter the low level if their "major area of study" is from the "other" area and if they are not being trained in the "education-science" area. This reveals the importance of the above-mentioned PCK and that high-level teachers are more prone to training in content and instruction; it can be stated that these teachers should be directed to in-service training or professional studies first.

Another group that can be directed to in-service training is the group educated at "short-cycle tertiary level or lower", and here teachers who had not practiced biology as a "major area of study" had a higher tendency to enter the low level. Biology topics have an important place in science programs as they are the most relevant science subjects towards life. Therefore, the lack of training in "science content" can be considered as preventing the realisation of deficiency in this area. The most important feature of the high-level teachers mentioned above was the in-service training towards "science content". This field is part of the PCK. It may be recommended that teachers who have received an education of "short-cycle tertiary level or lower" but have not practiced biology as a "major area of study" could be directed to training that may increase their PCK.

All in all, this study showed that teachers could be classified for in-service training and this classification was supported by the success of the students of the teachers. If teachers receive in-service training towards their PCK, student success also increases. In the in-service training, "level of formal education completed", "major area of study", "years spent teaching", and "sex of teacher" are important. As the level of education increases, the teachers become aware of their deficiencies and are more inclined towards in-service training. European countries or the European Union firstly recommend in-service training for teachers with a "short-cycle tertiary

and bachelor's or equivalent" level of formal education, and teachers whose "major area of study" is in an "other area" and is not in "education-science" are directed.

SUGGESTIONS

This study has several limitations. The study is limited to European countries only as a sample. Therefore, the European Union can organize in-service training programs in a broad and collaborative way. The teacher sample was not studied because of the nature of the TIMSS. The study group consisted of complete data sets of both students' achievements and teachers' knowledge. Thus, future studies should be carried out with less loss in teacher sample and data sets. In future studies, different clusters could be obtained using different clustering approaches in the classification of teachers, which shows the potential for change regarding the results. Moreover, very high levels of support and confidence have been chosen so that the characteristics of teachers in each level could be clearly seen. By lowering these values, other properties can be determined and interpreted. In this study, the variables that can direct teachers to in-service training were limited. This study could be replicated by increasing these variables, such as by including affective properties. Using different algorithms in the decision tree, this study could be replicated, and different results could be obtained.

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