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Formative Assessment, Teacher-directed Instruction and Teacher Support in Turkey: Evidence from PISA 2012

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When evaluating the students' learning process, the previous science curriculum in Turkey did not value the role of inquiry and formative assessment. But the latest policy documents clearly identify the change with a particular emphasis placed on student-centered learning and formative assessment. As an effort to understand the impact of this movement, our primary purpose with this study is to evaluate the current stance of Turkish teachers in various critical skills, including formative assessment, teacher support and teacher-directed instruction, drawing upon PISA 2012 data. To achieve this goal, we first investigated the association between students' test scores in science, and school and student related factors that influence students' assessment of teachers in those skills. Then we compared Turkish teachers with countries that are ranked usually above the average (United States), and on the top (Korea) of international rankings. The study indicated a strong positive relationship between teacher support and student science achievement. It also indicated that teachers in all countries struggle when providing formative assessment, and Turkish teachers support students' thinking and reasoning, check students' understanding more than their counterparts in USA and Korea.

Introduction

Scientific inquiry plays an important role in students' learning process, since it focuses on understanding several key concepts in all grades. National Research Council (NRC, 2012) defined these goals for students as: "ask questions of each other about the texts they read, the features of the phenomena they observe, and the conclusions they draw from their models or scientific investigations" (p. 55). As defined by NRC (2012), besides putting an emphasis on content, science education also aims to focus on creating critical thinkers in the United States.

On the other hand, the development of science education followed a different path in Turkey. Tasar, Temiz and Tan (2002) noted that the previous science curriculum failed to support students' scientific thinking. To change this trajectory, Turkish Ministry of Education made

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huge changes in the last decade to align their goals with the aims stated in other countries. Despite the fact that Turkish students are placed below average in the last Trends in International Mathematics and Science Studies (TIMMS), the average scores of 8th graders increased from 2007 to 2011 (Mullis et al., 2008; Martin, Mullis, Foy, & Stanco, 2012). After investigating evidence from PISA (The Programme for International Student Assessment) data, Gumus and Atalmis (2012) reached a similar conclusion by noting a significant increase in Turkish students' science scores from 2003 to 2009. Better scores in international tests can be linked with the changes made in the science curriculum, and Turkey continues to spend more and more to support science education. The goal of this article is to understand why Turkey still is performing below average by examining the Turkish teachers' performance in PISA results.

Before moving forward, we will examine how international documents put an emphasis on several key concepts to support science education. Later we will discuss how Turkey is aligning the science curriculum to reflect on these aspects.

Importance of Inquiry and Feedback in Science Education

Inquiry has been a crucial part of science education for decades (Bybee, 2010). The latest science education framework in the United States defined inquiry as making students involved in scientific practices (NRC, 2012). The National Research Council (NRC, 2012) defined eight practices: asking questions and defining problems; developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; developing explanations and designing solutions; engaging in argument from evidence; and obtaining, evaluating, and communicating information. All of these practices focus on making students active learners in the science education by focusing on modeling and engaging in argumentation.

Connected with the latest framework (NRC, 2012), previous policy documents in the US also underlined the importance of making students active learners by using inquiry (National Science Teacher Education Association, 1987; NRC, 1996; NRC, 2000). With a continuous focus on inquiry, the latest frameworks in the US also started to underline the importance of monitoring students' progress (National Educational Technology Plan, 2004; National Educational Technology Plan, 2010; NRC, 2012). More specifically, The National Educational Technology Plan (NETP, 2004) defined importance of providing feedback as: "Ensure that every teacher knows how to use data to personalize instruction. This is marked by the ability to interpret data to understand student progress and challenges" (p. 41). The latest plan supports this idea by noting the need as: "Actionable feedback about student learning to improve achievement and instructional practices" (NETP, 2010 p. 37). Inquiry has been an important factor of science education policy documents in the US for decades. In the last decade, the policy documents also started to focus more on providing formative feedback to students. In the next section, we will examine several policy documents and studies to define the current state of science education in Turkey.

Shifting Gears in Turkey

Despite their importance to support students, the role of inquiry and providing feedback followed a different route in Turkish policy documents. Previously, several studies reported that Turkish policy documents (Tasar, Temiz & Tan, 2002) and textbooks (Dokme, 2005) failed to make students active participants in the classroom by supporting students' scientific growth. In addition, the previous curriculum put the focus on teachers without paying too much attention to students' learning process (Gomleksiz & Bulut, 2007).

Koc, Isiksal and Bulut (2007) defined the differences in the curriculum by focusing on the changing role of the teacher as: "(1) There is more than one solution and the teacher may not know all the answers. (2) Teacher as the facilitator. (3) Teacher and students make decisions" (p. 36). Connected with these ideas, the latest policy document defined the teachers' role as being responsible for making students inquire and research in the science classrooms (Milli Eğitim Bakanlığı, 2013). The latest document also continued to underline the emphasis on formative assessment by asking teachers to monitor the progress, identify learner difficulties, and create meaningful learning environments (MEB, 2013). Similar to NRC (2012) framework, Turkish Ministry of Education's framework focus similar scientific practices without paying close attention to creating explanations. These practices highlighted as the following skills: science process skills (hypothesizing, measuring, collecting data, modeling, controlling variables, creating experiments), analytical decision making, creative thinking, innovation, communication, and team work (MEB, 2013).

The changes described above were reflected in the 2007 and 2011 TIMMS reports with an increase in students' science scores (Mullis et al., 2008; Martin et al., 2012). Connected with this growth, several scholars discussed how the new curriculum had positive impacts on teachers (Gomleksiz & Bulut, 2007) and students (Delen & Kesercioglu, 2012). When focusing on teachers' trajectory, Gomleksiz and Bulut (2007) noted that the new curriculum highlights students' scientific growth, and this helped teachers focus on students' learning process. At the same time, authors also added how changes implemented varied in different parts of the country due to lack of professional development (Gomleksiz & Bulut, 2007).

In a more recent study, Delen and Kesercioglu (2012) studied with a cohort of middle school students that were trained with the new and the old curriculum. In this study, 6th and 7th graders were educated with the new curriculum, and the 8th graders were educated with the previous curriculum. After collecting data from 290 students to measure scientific thinking, the authors found that 7th graders performed better than 6th and 8th graders, and there was a significant growth between 6th and 7th grade. Authors concluded that the new curriculum supported students' scientific growth and helped 7th grade students to outperform the 8th graders who were taught with the previous curriculum (Delen & Kesercioglu, 2012).

When evaluating the students' learning process, previous science curriculum in Turkey did not value the role of inquiry and formative assessment, but the latest policy documents clearly identify the change with a particular emphasis placed on student-centered learning and formative assessment (MEB, 2013). As an effort to understand the impact of this movement, our primary purpose with this study is to evaluate the current stance of Turkish teachers in various critical skills, including formative assessment, teacher support and teacher-directed instruction. In this process, we first investigated the association between students' test scores in science, and school and student related factors that influence students' assessment of teachers in those skills. Then we compared Turkish teachers with countries that are ranked usually above the average (United States), and on the top (Korea) of international rankings. To achieve these goals research questions in this study are as follows:

1. How teacher support, formative assessment and teacher-directed instruction are associated with student learning outcomes in science among Turkish students, controlling for the student and school characteristics?
2. How school characteristics in Turkey explain the variation in teacher support, formative assessment and teacher-directed instruction?

3. To what extent teachers in Turkey perform behaviors related to teacher support formative assessment and teacher-directed instruction, compared to developed countries, including USA and Korea?

Method

Data Source

Data employed in the current study comes from Program for International Student Assessment (PISA), a program to assess 15 years old students' skills in math, reading and science literacy internationally, organized by Organization for Economic Co-operation and Development (OECD). The data set includes a large amount of information from participant countries regarding students, schools and parents. The first PISA was administered in 2003 and since then it has been conducted once in every three years. The first time Turkey joined PISA was 2003. In this study, we utilized the latest PISA data that was collected in 2012.

Variables

Teacher Behavior. Teacher-directed instruction and formative assessment scales are categories of teacher behavior in PISA. The teacher-directed instruction scale focuses on testing following elements: "Setting clear goals, encouraging thinking and reasoning, checking student understanding, summarizing previous lessons, informing students about learning goals". Assessment item is named as "teacher-directed", but it focused on understanding how teachers support students in science classrooms, which aligns with supporting inquiry. Finally formative assessment identifies teachers' role in giving feedback, informing students about expectations and providing information to become successful.

Teacher Support. Teacher support emphasized on finding out how teachers provide extra help and opportunities, help students with learning, informs students to work hard.

Students' responses to each item in teacher directed instruction and formative assessment is based on a four point scales: 1 implies "every lesson", 2 implies "most lesson", 3 implies "some lessons", and 4 implies "never or hardly ever." Teacher support items also involve four point scale, in which 1 implies "strongly agree", 2 implies "agree", 3 implies "disagree", and 4 implies "strongly disagree."

Student characteristics

Gender. Gender is a categorical variable. We include gender in the analyses to see whether male and female students significantly differ in terms of their science achievement and responses to questions regarding teachers' practices. Gender also plays a controlling variable role in the analyses. Table 1 below displays descriptive values of gender in Turkish PISA data set.

Table 1. Descriptive Statistics for Gender

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Female	2370	48.9	48.9	48.9
Male	2478	51.1	51.1	100.0
Total	4848	100.0	100.0	

Socio-economic Status. A second variable included in the analysis as a controlling variable is socio-economic status of students (SES). In PISA data SES is designated by "index of

economic, social and cultural status (ESCS)" and it is created based on student responses to parental occupation, the highest level of parental education, and an index of home possessions related to family wealth, home educational resources and possessions related to "classical" culture in the family home. Table 2 displays descriptive statistics of SES, including frequency, minimum and maximum values in the scale, mean and standard deviation.

Table 2. Descriptive Statistics for Socio-economic Status (SES)

	N	Minimum	Maximum	Mean	SD
Index of Socio-economic Status	4806	-4.61	1.94	-1.456	1.106

School Characteristics

Public or Private. The school type (public vs. private) is school related variable included in the analyses. The purpose here is to utilize this variable to control the variation that occurs due to differences between public and private schools. This variable does not exist in the student level data, in which case we combined school and student level data sets by matching each student with school characteristics. Table 3 displays descriptive statistics for public and private schools.

Table 3. Descriptive Statistics for the School Type (Public vs. Private)

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Public	166	97.6	98.8	98.8
Private	2	1.2	1.2	100.0
Total	168	98.8	100.0	
Missing	2	1.2		
Total	170	100.0		

School Location. Table 4 demonstrates descriptive values for school location, which is employed as a controlling variable. This is a variable that is consisted of five categories, including village, small town, town, city and large city.

Table 4. Descriptive Statistics for the School Location

Location	Frequency	Percent	Valid Percent	Cumulative Percent
Village	8	4.7	4.7	4.7
Small Town	20	11.8	11.8	16.5
Town	51	30.0	30.0	46.5
City	46	27.1	27.1	73.5
Large City	45	26.5	26.5	100.0
Total	170	100.0	100.0	

Data Analyses

Inferential Statistics. The first question inquiries into the relationship between student science achievement and several teacher practices, including teacher support, formative assessment and teacher-directed instruction, while controlling for student characteristics (gender and SES) and school characteristics (public vs. private and school location). We used a multiple regression analyses to answer the question. The second question examines the relationship of each scale of teacher practices and school and student characteristics. We also conducted a multiple regression analysis for each scale by regressing teacher support,

formative assessment and teacher-directed instruction respectively on school and student characteristics.

Descriptive Statistics. The purpose of the research third question is to compare Turkey with two developed countries (USA and Korea) in regards to teacher support and behaviors (formative assessment and teacher directed instruction). We calculated descriptive values (mean and standard deviations) for each country to provide an answer to the question.

Findings

1. *How teacher support, formative assessment and teacher-directed instruction are associated with student learning outcomes in science among Turkish students, controlling for the teacher and school characteristics?*

The purpose of this question is to understand whether formative assessment, teacher directed instruction and teacher support significantly predict student science scores in PISA, controlling for gender, SES, school type and school location. A multiple regression analysis is employed to estimate the significance. Table 5 displays results from the multiple regression analyses. It shows that there is significant yet negative relationship between formative assessment and student science achievement. Specifically, one point increase in the scale of formative assessment is associated with a 9.53 decrease in students science score. Teacher support is also significantly but positively related to student science achievement: one point increase in the scale of teacher support leads to a 6.13 points increase in students science scores. However, the analyses suggested that there is no meaningful relationship between teacher-directed instruction and student science score.

Table 5 also shows significant results for school and student characteristics. Among all controlling variables in the regression analysis, gender, SES and school location are significantly associated with student test scores. Specifically, male students on average get 5.76 point less than what female students get in PISA science tests. SES is an important predictor of student learning: one point increase in SES is associated with 25.05 point increase in students' test scores. School location is also a significant but negatively related predictor of test scores. Students get 7.56 point less as the school location becomes more crowded.

Table 5. Variables Prediction Students' Science Scores

Dependent Variable: Plausible Value 1 in Science					
	B	SE	Beta	t	P-value
(Constant)	518.242	14.213		36.463	.000
Formative Assessment	-9.531	1.790	-.122	-5.323	.000
Teacher-directed Instruction	2.159	1.763	.031	1.224	.221
Teacher Support	6.132	1.831	.074	3.348	.001
Male	-5.759	2.669	-.036	-2.158	.031
Socio-economic Status (SES)	25.051	1.215	.349	20.612	.000
Private	18.376	12.441	.025	1.477	.140
School Location	-7.563	1.300	-.099	-5.818	.000

$R=0.368$, $R^2=0.135$, Adjusted $R^2=0.134$, $F(7, 3150) = 70.506$, $p<0.05$

2. *How school characteristics in Turkey explain the variation in teacher support, formative assessment and teacher-directed instruction?*

The purpose of this question is to understand underlying factors that influence students' report on their teachers' skills in teacher support, formative assessment and teacher directed instruction.

Table 6. Variables Predicting Student Perception of Teachers' Formative Assessment

Dependent Variable: Formative Assessment					
	B	SE	Beta	t	P-value
(Constant)	-.158	.193		-.819	.413
Male	.152	.036	.074	4.179	.000
Socio-economic Status	.001	.017	.002	.084	.933
Private	.376	.169	.040	2.228	.026
School Location	-.075	.018	-.076	-4.249	.000

$R=0.108$, $R^2=0.012$, Adjusted $R^2=0.010$, $F(4, 3164) = 9.301$, $p<0.05$

Table 6 displays results from a multiple regression that focus on the relationship between several characteristics of students and schools, and student report on teachers' formative assessment. The results show that students' gender, school type and school location are significant predictors of formative assessment. Specifically, female students and students from public school have more positive view of their teachers in regards to formative assessment. School location is significantly but negatively related to formative assessment ($R^2=0.012$, $F(4, 3164) = 9.301$, $p<0.05$).

Table 7. Variable Predicting Student Perception of Teacher-directed Instruction

Dependent Variable: Teacher-directed Instruction					
	B	SE	Beta	t	P-value
(Constant)	.472	.219		2.160	.031
Male	.015	.041	.007	.375	.707
Socio-economic Status	-.014	.019	-.013	-.737	.461
Private	.223	.191	.021	1.167	.243
School Location	-.097	.020	-.087	-4.850	.000

$R=0.089$, $R^2=0.008$, Adjusted $R^2=0.007$, $F(4, 3169) = 6.343$, $p<0.05$

Table 7 displays results from a multiple regression regarding the relationship between characteristics of students and schools, and student report on teacher-directed instruction. The results indicate that gender, school type and SES are not significant predictors of teacher-directed instruction. Only school location significantly related to the teacher-directed instruction scale. One point increase in the location is associated with .10 point increase in teacher directed instruction, implying that students from schools in more crowed locations have less positive view of their teachers in performing teacher-directed instruction.

Table 8. Variables Predicting Students' Perception of Teacher Support

Dependent Variable: Teacher Support					
	B	SE	Beta	t	P-value
(Constant)	.187	.182		1.029	.304
Male	-.019	.034	-.010	-.551	.581
Socio-economic Status	-.001	.016	-.002	-.094	.925
Private	.408	.160	.046	2.556	.011
School Location	-.106	.017	-.115	-6.425	.000

$R=0.119$, $R^2=0.014$, Adjusted $R^2=0.013$, $F(4, 3168) = 11.328$, $p<0.05$

Table 8 displays results from a multiple regression that focus on the association between several school and student characteristics, and student perception of teachers support. The results show that school type and school location are significant predictors of teacher support. Specifically, students from public school have more positive view of their teachers in regards to formative assessment. School location is significantly but negatively related to teacher support, meaning that schools in less crowded locations have a more positive perception of teacher support.

3. *To what extent teachers in Turkey perform behaviors related to teacher support, formative assessment, and teacher-directed instruction compared to developed countries, including USA and Korea?*

The purpose of this question is to compare Turkey with two developed countries (USA and Korea) in terms of teacher support, teacher directed instruction, and formative assessment. Descriptive values for each item are provided in Table 9. Since students' responses are reverse coded, lower means mean more frequent practices of related item.

In Table 9, means of items regarding teacher-directed instruction scale in Turkey and USA is around 2; that is, in most class teacher directed instruction is evident. On average, such type of instruction seems to be less common in Korean schools. In Turkey and USA, the most commonly performed items are "checks for understanding" and "informs about learning goals;" whereas summarizing previous lesson is relatively less commonly practiced. In Korea, teachers inform about learning goals in most classes yet they encourage thinking and reasoning in some classes.

Formative assessment seems to be problematic in all three countries. This means that teachers less commonly gave feedback to students in Turkey, USA and Korea. In Korea, however, the issue is more problematic since the mean is above 3, meaning that teachers rarely give feedback to students. The most commonly practiced formative assessment item is informing about expectations in USA and telling students how to get better in Turkey.

The means of items in relation to teacher support are relatively lower comparing to means of item in other scales, meaning that teacher support is more evident in all three countries. On average, Turkish, American and Korean students agree that their teachers let them know they have to work hard, provides extra help when needed, helps student with learning, and gives opportunity to express opinions. However, just like other scales, in Korea the means of items in the teacher support scale are higher than those in Turkey and USA, meaning that on average Korean students are less likely to agree with availability of teacher support in their schools when compared with students in Turkey and USA.

Table 9. Descriptive Statistics for Teacher-directed instruction, Formative Assessment and Teacher Support: Comparison of Turkey, USA and Korea

	Turkey			USA			Korea		
	N	X	SD	N	X	SD	N	X	SD
Teacher-Directed Instruction									
Sets Clear Goals	3173	2.04	.91	3267	1.98	.90	3355	2.31	.86
Encourages Thinking and Reasoning	3177	1.84	.87	3260	2.18	.96	3356	2.92	.87
Checks Understanding	3177	1.83	.92	3257	1.80	.86	3352	2.31	.87
Summarizes Previous Lessons	3185	2.27	1.03	3258	2.46	1.04	3355	2.50	.85
Informs about Learning	3174	1.81	.89	3257	1.70	.81	3355	1.95	.84

Goals									
Formative Assessment									
Gives Feedback	3158	3.01	.99	3259	2.57	1.02	3354	3.35	.80
Gives Feedback on Strengths and Weaknesses	3166	2.73	1.01	3261	2.88	1.00	3352	3.48	.77
Informs about Expectations	3170	2.24	1.01	3263	1.94	.90	3351	3.07	.88
Tells How to Get Better	3176	2.17	1.02	3260	2.47	1.07	3355	2.98	.94
Teacher Support									
Lets Us Know We Have to Work Hard	3182	1.56	.69	3241	1.78	.69	3347	2.10	.75
Provides Extra Help When Needed	3181	1.81	.79	3239	1.72	.74	3345	2.03	.71
Helps Students with Learning	3176	1.77	.76	3234	1.68	.70	3343	1.94	.65
Gives Opportunity to Express Opinions	3179	1.78	.82	3235	2.01	.85	3344	2.24	.77

Conclusion and Implications

Turkish Ministry of Education made significant changes in the curriculum in the past decade to underline the role of inquiry and formative assessment. These changes resulted in improvements in the previous international assessments (Mullis et al., 2008; Martin et al., 2012). In conjunction with these changes, several scholars discussed how new curriculum supported teachers (Gomleksiz & Bulut, 2007) and students (Delen & Kesercioglu, 2012). In this study, by comparing Turkey with other two nations: USA (usually ranked above average) and Korea (ranked top in international tests), our purpose was to examine how Turkish teachers perform specific tasks associated with three domain of instructional practices, including formative assessment, teacher-directed instruction and teacher support. In addition, we examined whether those domains predict student learning, as well as factors that predict teachers' practices of each domain, controlling for the role of SES, gender and school location.

Students' Science Achievement

Role of SES, gender and school location. Consistent with previous body of literature, we found that SES is significantly linked with student science test scores. The impact of SES on student achievement in all subject matters has been a common wisdom in educational literature. Literature consistently indicated that higher SES is associated with higher student learning (Caldas & Bankston, 1997; Marks, Cresswell, & Ainley, 2006; Perry, & McConney, 2010; Sirin, 2005; White, 1982). In an earlier study, Sirin (2005) conducted a meta-analysis by reviewing studies from 1990-2000 with an emphasis on SES. After reviewing 74 studies that worked with more than 100.000 students, Sirin (2005) underlined that the role of SES is dependent on the variable selection and defined the link between SES and academic achievement as "a complex relationship" (p. 438).

In this study, we found that as the school location gets crowded, students' science scores significantly decreases, controlling for SES and gender. That is, overall schools in large location are less likely to produce higher student science scores in comparison to schools located at relatively less crowded area. Research focusing on the impact of school location, on the other hand, provided contradictory results, which mostly likely to be an issue of context (Alspaugh, 1992, Fan & Chen, 1998; Young, 1998). For instance, Young (1998) investigated student achievement differences between rural and urban school in Australia and concluded that students from rural location acquire better scores in science. Fan and Chen (1998) focused on rural and urban differences in USA and found that there is not much difference between these two groups, once the effect of SES is controlled. Additional studies examining difference in school related factors, such as educational resources and the profile of academic staff, are needed, in order to explain the issue of gap between locations in Turkey (Burtless, 1996; Goldhaber & Brewer, 2000; Greenwald, Hedges, & Laine, 1996; Hanushek, 1997; Stewart, 2008; Wayne & Youngs, 2003).

In addition to the role of SES and school location, student gender is appeared as a significant predictor of ninth grade students' science scores. Female students performed better than male students according to students' overall science achievement. Literature has not reached an agreement regarding the role of gender yet. Previous studies, Delen and Kesercioglu (2012) for instance, found higher achievement in favor of male students after examining middle school students in Turkey. More comprehensive studies suggested that the issue of gender should be analyzed taking into account different branches of science education (Becker, 1989). For example, Lee and Burkam (1996) indicated that male students acquire better scores in physical science while female students get higher scores in life science. They further argued that the difference between genders is due to the laboratory experience. Increased in experimental and hands-on learning activities benefit females more than it does for male students. Weingburg (1995) explains such difference between genders through students' attitude toward science. If a student possesses a negative attitude toward science class, he/she is more likely to get lower scores in science tests and vice versa.

Role of teacher practices. We found students' test score in science increase with the increment in teacher support index, controlling for SES, gender and school location. In other words, the more support Turkish students receive from their teachers, the better science scores they gain. PISA's definition of teacher support is linked with how teachers help students in the learning process. Two decades ago, Driver, Asoko, Leach, Scott and Mortimer (1994) placed the teacher at the center of the instructional practices. Connected with this idea, previous curriculum in Turkey put the teachers at the center without putting emphasis on student learning. For instance, both authors of this study were educated in 1990s and early 2000s. Both of us only remember teachers dictating the lessons without acknowledging what we think. This is fascinating for us to find out that the teachers are making the paradigm shift happen. One of the key aspects of the curriculum change is teachers are putting students at the center of the learning process (MEB, 2013).

On the other hand, we also found that teacher directed instruction has no significant contribution to Turkish students' science achievement. Teacher-directed instruction, as defined by OECD, focuses on setting clear goals, and supporting student thinking and reasoning. Connected with these variables, supporting the reasoning and thinking is one of the most fundamental aspects of inquiry learning in US (NRC, 1996; NRC, 2000; NRC, 2012).

The missing link between teachers' support for reasoning and thinking, and student achievement raises some concerns for Turkish science education; since some scholars found a

direct link between these variables (Delen, 2014; McNeill & Krajcik, 2008). Interestingly, the current study also indicated a strong negative relationship between formative assessment and student science score. Formative assessment focuses on how teachers provide feedback to students to discuss the weaknesses and strengths.

At this stage, it is important to note that previous studies also found that teachers struggle to support students' reasoning and thinking in science classrooms (Delen, 2014; Erduran, Simon & Osborne, 2004; McNeill & Knight, 2013; McNeill & Krajcik, 2008). More specifically, several studies underlined teachers' challenges when providing feedback to students in this process (Delen, 2014; McNeill & Knight, 2013). To overcome this challenge, some studies underlined the importance of supporting teachers with providing professional development (Delen, 2014; McNeill & Knight, 2013; Simon, Erduran, & Osborne, 2006).

The lack of professional development could be one possible explanation for the missing connection for teacher-directed instruction and formative assessment. In Turkey, the inadequacy of professional development in terms of both quantity and quality is a long-term problem (Gumus, 2013). Recently, Turkish government implemented a national technology education program. After examining eleven teachers that were selected to pilot this program, Akcaoglu, Gumus, Bellibas and Boyer (2014) found inadequate training provided to teachers, and they also added that the teachers were not satisfied with the level of training provided. More than a decade ago, Guskey (2002) illustrated that professional development help teachers change their practices, which leads to change in student achievement. Thus, the lack of strong professional development would influence how teachers implement the changes envisioned by the curriculum change.

Connected with gap, our analysis indicated that school type (public vs. private) and location are significant predictors of teacher support. Specifically, there is more teacher support in private schools than public school and teacher support decreases as the school location gets more crowded. The type of school factor can be explained through the well-known accountability concept (Benveniste, Carnoy, & Rothstein, 2003). Teachers in private sector may receive more pressure from schools to spend more time on the academic development of each student. Support being larger in less crowded area could be explained through the effect of school size. For instance, teacher would be acquainted more with students if they have to serve relatively smaller number of students (Cotton, 1996).

Cross-National Comparison of Instructional Practices

In this study, the terms "teacher-directed instruction" refers how the supports students in the inquiry process. Despite the fact that, Turkey has lower scores in national tests compared to USA and Korea, we found Turkish teachers support students' thinking and reasoning, and checks students understanding more than their counterparts in USA and Korea. When we look at teachers' support, Turkish teachers push students toward working hard more than their colleagues in USA and Korea. In all categories, Turkish teachers received better scores in terms of the support they provided compared to Korean teachers. In the last decade, Turkey has been pushing teachers to implement constructivism by putting emphasis on students' learning process. This requires teachers to become facilitators of knowledge (MEB, 2013). Changing a national education system depends on significant effort, and this study is the first to empirically report Turkish teachers seem to be doing a better job compared to their colleagues in other countries.

Despite these positive findings, formative assessment seems to be challenging in all countries. Otero (2006) defined formative assessment as: "Recognizing, describing, and using students'

prior knowledge in instruction" (p. 250). As described by Otero (2006), formative assessment requires teachers to pay continuous attention to students' learning process. In the previous chapter we discussed studies that found teachers challenges in providing feedback when supporting scientific reasoning. Buck and Trauth-Nare (2009) took this idea further by noting: "few teachers understand the pedagogical implications of such scaffolding or their role in utilizing formative assessments" (p. 475). Connected with this idea, scholars are now searching for ways to support teachers in this process. For instance, Lee, Feldman, and Beatty (2012) used technology to support students and also described teachers' struggles with formative assessment. Similar to the previous body of literature, we found teachers in three countries providing low quality support with an emphasis on formative assessment. Teachers in these countries primarily focus on discussing how students can get better, but did not use formative assessment to support students' learning process.

Limitations and Future Research

In this study, our main goal was to understand the practices of Turkish teachers by analyzing student reports. After investigating a major data set, we report that the Turkish teachers are changing their viewpoint. On one hand, student reports clearly show that instructional practices of teachers have changed toward becoming more learner-centered. On the other hand, the perceived change seems to be limited, such that it does not focus on important aspects of contemporary teaching approaches, such as using formative assessment and fostering students' reasoning and thinking in science classrooms. These are critical aspects underlined by the most recent reports in Turkey (MEB, 2013) and also in other countries (NRC, 2012). We therefore suggest that the Ministry of Education in Turkey develop more rigorous in-service training that address teachers needs with respect to using formative assessment and promoting students' reasoning and thinking skills in science classrooms.

A major limitation of the current study is that it depends solely on the reports of students concerning practices of teachers, instead of real practices that are based on classroom observations. In that respect, future studies should incorporate systemic observations as a method to investigate teachers' actual classroom practices in relation to implementing student-centered ideas and formative assessment. In this way, a better understanding of the changes in instructional practices of science teachers would be possible.

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