



## Exploring the Interaction between Science Teachers' Self-efficacy Beliefs and Pedagogical Discontentment: An Attempt to Understand Why Science Education Reform Fails

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### ABSTRACT

Scientific literacy is currently one of the main purposes of science education. Science education reform efforts provide rich, comprehensive and explicit messages, ideas suggestions with teachers to promote scientific literacy through student-centered and inquiry-based instructional implementations. However, systemic change that reform aims to achieve yet to come through as most of the science teachers are still using teacher-centered lecture style science teaching rather than implementing reform initiatives. The purpose of this paper is an attempt to shed light on the existing literature to understand why science teachers would not employ reform initiatives in their classrooms. Teacher self-efficacy and pedagogical discontentment are selected to be the target constructs that the interactions between them hold promises to explore teacher averseness to reform. 130 science teachers working in public middle schools located in northern Turkey were participated in this research. The findings derived from this research provided several key interactions between self-efficacy beliefs and pedagogical discontentment in terms of the participating teachers' openness toward science education reform in Turkey. Methodological implications were also embraced.

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Self-efficacy Beliefs, Pedagogical Discontentment, Science Education Reform

### 1. Introduction

Instructional and administrative perspectives have been respectively urging and initiating educational reform aiming gradual change in educational practice across the globe over decades. Our ultimate faith in education to resolve almost all problems observed in a society and to mold a better future for all citizens is the main reason for such consistent efforts for educational reform. In his master piece with Tyack, Cuban called this ongoing reform era as "Tinkering toward Utopia" (Tyack & Cuban, 1995) as in spite of the great efforts and expectations, the reform barely alters the educational practices.

To avoid costs of earlier reform attempts in science education, classroom implementations of reform should not be taken for granted as lack of attention given to classroom practices more likely results in failure of reform. Smith and Southerland (2007) suggested that teachers should be the center of reform efforts and their beliefs about reform and teaching science in specific to ensure deeper change in classroom practices to promote scientific literacy. Highlighted by the relevant literature, beliefs that are crucial to science education

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reform consist of teachers' underlying assumptions about what to teach, how to teach, how to assess students' learning, how students learn science best and how to scaffold learning environment to promote effective learning experiences as well as their self-conception about their roles as science teachers to promote scientific literacy (Luft and Roehrig, 2007).

Beliefs are recognized to be the preeminent indicators of individuals' actions in their lives (Bandura, 2000) and "...self-efficacy refers to beliefs in one's capabilities to organize and execute the courses of action required to given attainments." (Bandura, 1997, p.3) Thus, found to be useful in examining science teachers' classroom implementations, there are different arguments across the relevant literature about how self-efficacy beliefs that teachers hold play a role in promoting teacher growth and advancing school reform as well. Some argue that to comply with immense challenges by reform's deeper change requirements on teacher shoulders, only the science teachers with high self-efficacy are more likely to facilitate and successfully implement reform-based and student-centered approaches in their classrooms compare to their counterparts (Donnel and Gettinger, 2015; Duran et al., 2009; Fogleman et al. 2011; Guskey, 1988; Hodges, Gale& Meng (2016). However, several researchers reveal that science teachers with high self-efficacy are more likely to resist new offerings of reform as they often feel lack of pedagogical discontentment over what they do in their daily base instructions and thus do not intend to change (Favre and Knight, 2016; Gregoire, 2003, Southerland et al., 2011; Wheatley, 2000, 2002).

The interrelatedness between teachers' self-efficacy and their sense of dissatisfaction lately recognized to be an important venue to explore success of science education reform. The purpose of this research is twofold; a) to explore the correlation between science teachers' self-efficacy beliefs and pedagogical discontentment and the direction of the correlations among the subscales of each construct, b) if the degree of science teachers' self of self-efficacy beliefs show any difference in the science teachers' pedagogical discontentment that provide a plausible venue to understand their receptiveness and fidelity to reform implementations. The ultimate goal of this paper is to get a glimpse of long time failure of science education reform in Turkey where reform efforts have been one of the main phenomena in education for the past two decades.

## **2. Conceptual Framework**

This section is an attempt to structure theoretical underpinnings of this research through exploring salient constructs including science education reform, teacher self-efficacy and pedagogical discontentment.

### **2.1 Science Education Reform**

Perhaps, followed by other fields, science education appears to experience the most persistent and comprehensive reform initiatives (e.g. AAS, 1990, 1993; NGSES, 2013; NRC, 1996, 2000, 2002) and suggestions offering a cohesive guidance to improve science teaching and learning as science is a field of knowledge understood to be the center of each country's ability to develop sustainably. Emphasis given the scientific literacy for all citizens through inquiry-based instruction is observed to be the primary theme of the latest science education reform recommendations urging a systemic shift and change in the purpose and methods of science education. Based on the reform suggestions, teachers were asked to adjust or change their practices to conform reform expectations by shifting from textbook-oriented, teacher-centered instruction to student-centered, inquiry-based instruction.

Indeed, substantial amount of reform investments provided science teachers with pedagogical ideas, model curricula and supplementary documents to teach science through student-centered instructions. In spite of their rich, unified and explicit nature, science education reforms are yet to yield expected results as for Berkovich (2011), teachers often resist to change. Berkovich (2011) argued that teachers who resist to reform simply find reform as unnecessary and do not agree with the reform objectives. Instead of enacting reform recommendations, science teachers surprisingly with an updated reform terminology (Saka, 2009) often tended to teach science through teacher-centered approaches by narrowing the overarching purposes of reform into classroom organization, worksheets and isolated activities mainly called by teachers as hands-on activities in their classrooms. A close look by Spillane (1999), when teachers are asked to utilize reform in their daily instructions, they left alone to make sense of new materials and ideas brought to them by reform.

For Spillane (1999), in the reform era teachers often have difficulty of turning reform initiatives into real life learning experiences in their classrooms. Drawing on their prior experiences and beliefs, teachers likely embed reforms ideas with their existing perceptions and practices failing deeper pedagogical underpinnings of reform.

## 2.2. Interaction of Self-Efficacy Beliefs and Reform

Beliefs are realized to be critical characteristics of teachers significantly influencing their instructional decisions and practices. Conceptualized by Bandura (1986), self-efficacy beliefs are individual's judgment of their abilities to organize and implement predefined tasks. Literature illustrates a close link between science teachers' self-efficacy beliefs and their classroom implementations (Miller, Ramirez and Murdock, 2017). Teachers with high self-efficacy beliefs are recognized to better orchestrate instructional activities with a greater flexibility (Gabriele & Joram, 2007) to promote student learning compare to those who have low self-efficacy (Caprara, Barbaranelli, Steca, & Malone, 2006). Malmberg, Hagger and Webster (2014) explored how teachers' self-efficacy beliefs were related to student achievement and they found that teachers with high self-efficacy beliefs performed more mastery and effort in supporting student learning by seeking and facilitating better learning experiences to respond to their students' needs. In a larger study, Fackler and Malmberg (2016) explored 14 OECD countries to understand various different factors effecting teachers' self-efficacy and student achievement. They found that teachers with high self-efficacy beliefs were able to accommodate student learning needs to foster their achievement as they were more eager to explore alternative instructional approaches compare to the teachers with low self-efficacy beliefs.

Being open to innovative and alternative ways of teaching, it is argued that teachers with high self-efficacy beliefs are more open to reform. As described by Czerniak (1990), highly efficacious teachers are more likely to adopt reform-based teaching strategies as opposed to teachers with low self-efficacy. Also, along with their pedagogical competencies and professional development experiences, Donnell and Gettinger (2015) described that self-efficacy beliefs contribute to teachers' positive perceptions of reform and amenability to change. Therefore, Fogleman, McNaill and Krajcik (2011) indicated that teacher self-efficacy is an important predictor of the successful implementation of reform efforts as teachers who believe they are able to achieve specific teaching goals, which refer to high self-efficacy, are more willing to try new approaches in their classrooms.

Although empirical research has largely supported the claim that teachers with high self-efficacy are more likely to feel ownership of reform and enhance student achievement compare to teachers with low self-efficacy are, there remain empirical evidences that high efficacious teachers are more likely to resist reform practices (Kahveci, Kahveci, Mansour and Alarfaj, 2018; Lardy & Mason, 2011; Saka, 2007; Southerland, Sowell, Blanchard and Granger, 2011; Wheatley, 2000). For instance, Favre and Knight (2016) found that teachers with high self-efficacy showing low fidelity and little dedication to reform implementations illustrate diminutive effort to create student-centered classroom environments or engage their students in reform-based practices. For Wheatley (2002), high self-efficacy restricts teachers' receptiveness of school reform as high self-efficacy limits teachers to doubt about their existing practices.

Indeed, reform initiatives demand teachers to make significant changes to their instructional decisions and actions. Teacher change literature elucidates that for teachers to make any profound change in their daily-based practices, they need to problematize their teaching through critical reflection on their own instructional practices (Southerland, Nedelson, Sowell, Saka, Kahveci and Granger, 2012). For Settlege, Sotherland, Smith and Ceglie (2009), it is seldom for efficacious teachers to reflect on their instructional practices critically; consequently they face limited dissatisfaction with their pedagogical practices. As stated by Wheatly (2002), teachers' own awareness of ineffective teaching practices where there is a significant gap between teachers' instructional goals and their student outcomes would not be possible if teachers have a high self-efficacy.

### **2.3. Interaction of Pedagogical Discontentment and Reform**

Models for teacher change aroused and fed by conceptual change literature reveal that external requests and mandates are unsuccessful to motivate teachers to fully take the ownership of reform and act accordingly (Bruce & Ross, 2008, Hollenback & Kalchman, 2013). Rather, effective results in convincing teachers to internalize and utilize reform implementations with fidelity, teachers need to recognize the gap between their beliefs, goals and practices and the student learning outcomes (Gess-Newsome, Southerland, Johnston and Woodbury, 2003) and feel dissatisfaction over what they know, believe and do in school context (Wheatly, 2002). Southerland et al. call this sense of dissatisfaction as pedagogical discontentment distinguishing it from contextual discontentment, which includes teachers' beliefs about external factors such as unsupportive administration, lack of supplies, time and space constraints and accountability measures adversely effecting teacher practices and student learning (Sowell, Southerland & Granger, 2006). Pedagogical discontentment, on the other hand, is related to teachers' beliefs about their pedagogical competencies including their ability to teach content through inquiry-based approach, to teach content for all ability level of students, to have appropriate level of science content knowledge, to be able to distinguish content issues being breadth versus depth based on student needs and to assess student learning through multiple assessment strategies based on the target skills (Southerland et al., 2012).

Research focusing teachers' pedagogical discontentment emphasizes the pedagogical competencies of teachers to successfully facilitate reform-based implementations. Being a relatively new construct, researchers often use pedagogical discontentment as a cognitive tool to explore teachers' receptiveness of reform initiatives (Kahveci et al., 2018; Olitsky, 2015) as well as their openness to areas where they realize their shortcomings to comply with reform and effective instructional outcomes (Koksal and Southerland, 2018; Saka, 2007; Sunal, Hodges, Sunal, 2010).

It is argued that openness to new ideas and suggestions, teachers' sense of pedagogical discontentment seems to be a pivotal factor as they need to feel sense of discontentment precondition for them to refine their practices through search for alternatives. Focusing on two reform-minded novice science teachers, Saka (2007) found that there is an important link between teachers' sense of pedagogical discontentment and their openness to new ideas from others as teacher with lack of discontentment rejected most of the ideas and offerings from other teachers, school administration and his college professor to help him overcome the issues that the teacher faced in his classroom. On the other hand, teacher with pedagogical discontentment appear to cooperate with his colloquies to find better ways to handle the issues that are common in the first years of teaching. Kahveci et al. (2017) also found the same link as their quantitative study with 994 science teachers illustrated that the level of pedagogical discontentment that teacher experience has a positive correlation with their attainment to reform suggestions as teachers with high pedagogical discontentment were observed to be more open to reform suggestions compare to their counterparts. Focusing on Turkish science teachers, in a qualitative study Koksal and Southerland (2018) focused on three science teachers with moderate level of pedagogical discontentment and they explored that all science teachers were willing to professional development opportunities.

### **2.4. Interrelatedness of Self-efficacy Beliefs, Pedagogical Discontentment and Reform**

Reform literature attempting to understand the failure of reform initiatives emphasized that teacher self-efficacy beliefs holding direct influence on shaping teacher practices. Most of the earlier self-efficacy literature argued that high self-efficacy is a good attribute for teachers to implement new ideas suggested by reform. However, number studies discussed earlier argued that teachers with high self-efficacy appeared to be the most reluctant group to reform as their level of comfort by the high self-efficacy restricts them to change their instructional practices. Again the reform literature also argues that in order for teachers to make any deeper change in their instructional practices, they need to feel pedagogical dissatisfaction with their instructional practices. This prerequisite would allow them to search for alternatives or better ways to

address the gap between their instructional goals and the student outcomes in their classroom. Unless they feel such discontentment, systemic change in educational system would not be possible (Settlage et al., 2009).

Drawing upon the findings of relevant literature, several combinations of teacher self-efficacy and pedagogical discontentment were idealized for teachers to successfully implement reform initiatives in their classrooms. Some argue that teachers with pedagogical discontentment and high self-efficacy are more receptive to reform initiatives (Gess-Newsome et al., 2003; Sowell et al., 2006). However, Saka (2007) found that high self-efficacy may not allow teachers to feel a sense of pedagogical discontentment that is required for them to be receptive to reform suggestions. As for Saka (2007) a science teacher with a combination of moderate level of self-efficacy and appropriate level of pedagogical discontentment allowed him to better adopt his instructional practices to reform suggestions compare to the teacher with high self-efficacy and moderate appropriate level of pedagogical discontentment. It is argued that self-efficacy plays significant role in teacher change as high self-efficacy prevents teachers to problematize their teaching and thus to prioritize change (Settlage et al., 2009). Kahveci et al. (2018) also reported that teachers with low self-efficacy and appropriate level of discontentment are more likely to take up messages of reform.

Although combination or integration of teachers' self-efficacy and pedagogical discontentment appears to be a salient one for teacher change, there is a scarcity and uncertainty of literature defining the nature of such integration. The ambiguity is the level of self-efficacy required to allow appropriate amount of pedagogical discontentment cultivating teacher change and contributing the success of reform. As an attempt to shed light on the science education reform literature, this research aims to a) explore the relationship between science teachers' self-efficacy beliefs and their sense of pedagogical discontentment and b) describe which levels of teacher self-efficacy (low, moderate or high) is more fertile to promote teacher pedagogical discontentment as a key attribute of teachers for systemic change and progress. Using Turkish context to achieve these purposes, the leading questions for this research,

1. What is the relationship between science teachers' self-efficacy beliefs and their pedagogical discontentment?
2. Is there any significant difference in science teachers' pedagogical discontentment based on different levels of self-efficacy beliefs that they hold?

### 3. Methods

To determine, at least, one reason for the unsatisfied teacher attainment to reform implications in Turkey, this study explored science teachers' self-efficacy beliefs and their pedagogical discontentment and possible relationships and interaction between them by using survey research methods. In order to ensure fidelity of the given responses, the data were collected by the researchers through face to face intercourse in participating teachers' work places during 2017-2018 academic year.

#### 3.1. Research Context

This study was carried on in a midsize city located in the northern Turkey. Turkey has been one of the countries that continuously seek out ways to improve the quality of education through educational reform for several decades. Aligned with the international trend and relevant literature, centralized science education curriculum being utilized in all public and private schools across the country was reformed four times during past 15 years by Ministry of National Education to make sure that the scientific literacy level of the population was increased through inquiry-based science education. The newest science curriculum was taken part in 2018. However, these reform initiatives barely altered the science teaching and learning practices as recent studies report that in spite of the immense efforts from Ministry of National Education, it is observed that science teachers mostly prefer teacher-centered and textbook oriented approaches to teach science (e.g. Bardak & Karamustafaoglu, 2016; Demirkan & Saraçoğlu, 2016; Uzal, Erdem & Ersoy, 2016).

### 3.2. Participants

Of the 237 science teachers working at the public school system of a city where the research was done, 130 teachers voluntarily accepted to participate in the study. All of the participants were teaching science in the middle school level from 5<sup>th</sup> to 8<sup>th</sup> grade levels. As shown in Table 1, gender distribution of the participants included 30% (n=40) male and 70% (n=90) female science teachers.

**Table 1.** Teacher demographics

(N=130)		<i>f</i>	%
<b>Gender</b>	<b>Male</b>	40	31
	<b>Female</b>	90	69
<b>Work experience</b>	<b>0-3</b>	23	18
	<b>4-10</b>	51	39
	<b>11-15</b>	25	19
	<b>16-35</b>	31	24
<b>Certification</b>	<b>Science education major</b>	103	79
	<b>Non-major (out of field)</b>	15	12
	<b>Non-education majors</b>	12	9
<b>Location of the work place</b>	<b>Urban</b>	104	80
	<b>Rural</b>	26	20

The work experience of the participants ranged from 0-3 years 18% to 16-35 years 24% mostly having teaching experience in the range of 4-10 years (39%). Based on the certification of the participants, most of them were science education majors (79%) and 12% of them were certified teachers from out of science education major and about 10% of them were non education majors. Of the 130 participants, 80% of the teachers (n=104) were working at schools located in urban areas, while 26 of them (20%) were teaching in rural area schools.

### 3.3. Data Collection

The data were collected through 2017-2018 school year by utilizing two instruments and a demographic questionnaire. To ensure the fidelity of the given responses, the data collection tools were utilized face to face manner with the consent of the science teachers. To ascertain participating science teachers' self-efficacy beliefs, Science Teachers Efficacy Beliefs Inventory (STEBI) was used. The original instrument was developed by Riggs and Enochs (1990) and widely used across the science teachers to assess science teachers' self-efficacy beliefs. The inventory was adapted to Turkish language by Erden (2007) to assess science teachers' self-efficacy beliefs through two subscales including personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE) with a total 20 5-point likert-type items. The Cronbach's Alpha values for the total scale as well as PSTE and STOE subscales were found to be 0.71, 0.78 and 0.60, respectively (Erden, 2007). In this research, however the Cronbach's Alpha values for the whole scale, PSTE and STOE were found to be 0.83, 0.78 and 0.76 respectively.

In order to gauge participating science teachers' pedagogical discontentment, developed by Southerland, Sowell, Kahveci, Granger and Geade (2006) and adopted to Turkish language by Adigözel (2012) with satisfying reliability and validity assurances the Pedagogical Discontentment instrument was administered. Using a total of 19 five-point likert-type items, the instrument measures science teachers' pedagogical discontentment divided into 5 subscales namely 1) teaching content through inquiry-based approach (IB, 3 items), 2) teaching content to all ability levels of students (AL, 6 items) 3) having appropriate level of content knowledge (SC 3 items), 4) balancing and resolving content issues being depth versus breadth based on student needs (DB, 4 items) and 5) assessing student learning through multiple assessment strategies based on the target skills (AP). The reliability of the adopted instrument was reported for the overall instrument and for its subscales' Cronbach's Alpha as 0.94, and 0.83 for the IB subscale, 0.79 for the AL subscale, 0.82 for

the SC subscale, 0.68 for the DB subscale and 0.76 for the AP subscale. In this research, reliability Cronbach's Alpha for the subscales were calculated as 0.94, 0.84, 0.92, 0.89, 0.90 respectively and 0.93 for the overall instrument.

### 3.4. Data Analysis

Analysis of the data included reporting descriptive statistics and, correlation and variance analysis. Before the analysis started, the data set was initially treated for missing values which were approximately .05% of the entire data set. To increase the sample size without significantly changing the mean scores, linear interpolation method was used to infer missing data making only a non-significant trivial change in the correlation coefficient and mean scores. Then, the results of skewness/kurtosis and Shapiro-Wilks tests ( $p > .05$ ) confirmed that the data were normally distributed for each group, therefore for the rest of the analysis parametric tests were utilized.

Correlation statistics were calculated in order to answer the first research question. Specifically, correlations between science teachers' self-efficacy beliefs and their pedagogical discontentment, mean scores and correlations between their subscales were calculated. . In order to answer the second research question, the participating science teachers' self-efficacy beliefs were categorized in into three categories as low, moderate and high based on literature. As shown in Table 3, teachers having self-efficacy z-score smaller than "-1" were coded as teachers having ) low level of self-efficacy while teachers having a z-score between -1 and +1 were coded as teachers having moderate level of self-efficacy. And the final category was identified as high self-efficacy level (coded as 3) where the standard scores of the participants' self-efficacy beliefs were greater than +1. Of 130 science teachers participating in this research, 22 science teachers (16.9%) were coded under low self-efficacy category while 85 of them (65.4%) and 23 of them (17.7%) were respectively coded as moderate and high self-efficacy categories. After defining the self-efficacy levels of the sample, finally, one-way ANOVA analysis was conducted to explore if there were any significant difference in pedagogical discontentment of teachers falling into low, medium and high level of self-efficacy categories. Significant ANOVA results were followed by Tukey's post-hoc analyses.

## 4. Findings

### 4.1. Correlation between Self-efficacy beliefs and Pedagogical Discontentment

Initially, based on univariate analyses of variance including independent-samples t-test and one-way ANOVA, between (gender and school location) and among (work experience and certification) the categories listed under each demographic characteristic of the participating science teachers, there were no significant differences found in terms of these teachers' self-efficacy beliefs and pedagogical discontentment.

The first research question was an attempt to explore the correlation between teachers' self-efficacy beliefs and their sense of pedagogical discontentment. As seen in Table 2, there was a negative and statistically significant correlation between participating science teachers' self-efficacy and pedagogical discontentment mean scores ( $r = -0.381$ ,  $p < 0.01$ ). This indicated that an increase in participating science teachers' self-efficacy mean scores was associated with a decrease in their pedagogical discontentment mean scores. Such negative and statistically significant correlations were also observed between the teachers' self-efficacy and the pedagogical discontentment subscale scores as well. Specifically, except for the correlation between teachers' self-efficacy and SC subscale ( $r = -0.212$ ,  $p < 0.05$ ), which was statistically significant at an alpha level of 0.05, all of the correlations were statistically significant at an alpha level of 0.01 ( $p < 0.01$ ). These correlation coefficients implied that if the participating science teachers' overall self-efficacy scores increase, these teachers' pedagogical discontentment scores including all subscales and the pedagogical discontentment overall mean scores decrease.

**Table 2.** Correlation coefficients between participating teachers’ self-efficacy belief scores (including self-efficacy subscales) and these teachers’ pedagogical discontentment scores (including pedagogical discontentment subscales)

Scales and Subscales	PD_AP	PD_IB	PD_DB	PD_SC	PD_AL	PD_MEAN
PSTE	-0.311**	-0.448**	-0.332**	-0.296**	-0.379**	-0.422**
STOE	-0.084	-0.168	-0.096	0.050	-0.086	-0.099
SE_MEAN	-0.286**	-0.434**	-0.309**	-0.212*	-0.341**	-0.381**

\*. Correlation is significant at the 0.05 level (2-tailed).

\*\*. Correlation is significant at the 0.01 level (2-tailed).

As far as the correlation of participating teachers’ PSTE subscale scores with their pedagogical discontentment mean and its subscale scores, similar pattern was observed. The participating science teachers’ PSTE scores illustrated negative and meaningful correlation with mean scores of AP subscale ( $r = -0.311, p < 0.01$ ), IB subscale ( $r = -0.448, p < 0.01$ ), DB subscale ( $r = -0.332, p < 0.01$ ), SC subscale ( $r = -0.296, p < 0.01$ ), AL subscale ( $r = -0.379, p < 0.01$ ) and pedagogical discontentment mean scores ( $r = -0.422, p < 0.01$ ). This finding suggests that when the efficacy of the participating teachers decreases, their pedagogical discontentment increases significantly at all subscales of pedagogical discontentment and overall pedagogical discontentment mean scores as well.

In terms of these teachers’ STOE scores, these teachers’ STOE scores were negatively correlated with the pedagogical discontentment mean scores and with all pedagogical discontentment subscales as well except for SC subscale. However, as opposed to their self-efficacy mean and PSTE subscale scores, the STOE scores of the participating science teachers’ correlation with pedagogical discontentment mean and with its subscales showed no significance. This means that with no statistical significance, the STOE of these teachers negatively affect the change in their sense of pedagogical discontentment except for SC subscale.

#### 4.2. Effect of Self-Efficacy Belief Level on Pedagogical Discontentment

For the second research question, a one-way ANOVA was conducted to compare the effect of different science teacher self-efficacy beliefs on these teachers’ sense of pedagogical discontentment as a prominent construct to assess their openness to reform initiatives. Homogeneity of variance assumption was tested by Levene’s test [ $F(2, 127) = 1.065, p = 0.348$ ] which indicated that the variance of participating teachers’ pedagogical discontentment across self-efficacy groups were not significantly different. Also, visual inspection of data showed no significant deviation from normal distribution.

Table 3 includes the descriptive statistics of participating teachers’ self-efficacy belief levels.

**Table 3.** Descriptive values of transformed self-efficacy belief categories

Self-Efficacy level	N	$\bar{X}$	SD
1 (Low) ( $z < -1$ )	22	2.5247	0.45966
2 (Moderate) ( $-1 \leq z \leq 1$ )	85	2.1542	0.62849
3 (High) ( $z > 1$ )	23	1.8860	0.76773
Total	130	2.1694	0.65432

Based on the table teachers with low self-efficacy beliefs appeared to have higher mean score (mean =  $\bar{X}$ ,  $\bar{X} = 2.5247 = 2.5247, SD = 0.45966$ ) compare to science teachers with moderate ( $\bar{X} = 2.1542, SD = 0.62849$ ) and high ( $\bar{X} = 1.8860, SD = 0.76773$ ) self-efficacy beliefs.



**Table 4.** Analysis of variance (ANOVA) for the effect of self-efficacy belief variables on pedagogical discontentment

Sources of Variance	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.645	2	2.322	5.831	0.004
Within Groups	50.584	127	0.398		
Total	55.229	129			

ANOVA results are shown in Table 4 showed that there was a significant effect of teachers' self efficacy levels on teachers' pedagogical discontentment [ $F(2, 127) = 5,831$   $p=0.004$ ]. This implies that science teachers' sense of pedagogical discontentment appeared to be significantly changing based on their self-efficacy beliefs.

In order to further explore the differences among self efficacy levels post hoc comparisons were conducted. As seen in Table 4, the results of Tukey (HSD) test showed that there was a significant difference between low self-efficacy beliefs and moderate self-efficacy beliefs ( $p = 0.041$ ) indicating that teachers having low self-efficacy beliefs felt more pedagogical discontentment than teachers with moderate self-efficacy beliefs did.

**Table 5.** Multiple comparisons between self-efficacy groups by Tukey post hoc comparisons

(I) Self-Efficacy Categories	(J) Self-Efficacy Categories	Mean Difference (I-J)	Std. Error	p	Meaningful Difference
Low	Moderate	0.37054*	0.15097	0.041	Low-Moderate, Low-High
	High	0.63876*	0.18821	0.003	
Moderate	Low	-0.37054*	0.15097	0.041	
	High	0.26821	0.14834	0.171	
High	Low	-0.63876*	0.18821	0.003	
	Moderate	-0.26821	0.14834	0.171	

\*. The mean difference is significant at the 0.05 level (2-tailed).

Similarly, the teachers with low self-efficacy beliefs also had more pedagogical discontentment compare to the teachers with high self-efficacy beliefs ( $p = 0.003$ ) did as well. However, the Tukey test results indicated that there was no a meaningful difference between the science teachers with moderate self-efficacy beliefs and the science teachers with high self-efficacy beliefs ( $p = 0.171$ ) in terms of their pedagogical discontentment. This finding implies two crucial outcomes that a) as being more receptive to reform efforts, teachers with low self-efficacy appeared to be more pedagogically discontented than teachers' with moderate and high levels of self-efficacy beliefs and b) teachers with moderate and high self-efficacy beliefs had relatively low pedagogical discontentment meaning that they appeared to be less open to reform efforts.

## 5. Discussion

Based on the findings, there was a negative and statistically significant correlation between Turkish science teachers' self-efficacy beliefs and their sense of pedagogical discontentment. As the participating teachers' self-efficacy beliefs increase their pedagogical discontentment decreases. This finding is congruent with related literature. In their study focusing on Saudi science teachers' openness to educational change through examining the interaction among science teachers' self-efficacy beliefs, pedagogical discontentment and intentions to reform, Kahveci et al. (2018) confirmed this negative correlation between science teachers' self-efficacy beliefs and their pedagogical discontentment. In another study, while exploring the initial states of applicants to professional development activity designed for science teachers; Saka (2013) explored the

negative correlation between the applicant science teachers' self-efficacy beliefs and their pedagogical discontentment.

No research was found to compare the findings of this research in terms of the correlation between the subscales of self-efficacy beliefs and pedagogical discontentment. The negative and statistically significant correlation was also observed between the self-efficacy's PSTE subscale and all subscales of pedagogical discontentment including the mean scores of the participating teachers' pedagogical discontentment. In spite of overall negative correlation except for science content knowledge subscale (SC), the correlations between participating science teachers' STOE scores and their pedagogical discontentment subscale scores including pedagogical discontentment mean scores were not statistically significant. This was attributed the nature of items used to measure efficacy beliefs (Favre and Knight, 2016) in general and outcome expectancy (Williams, 2010) in specific. Paying attention to self-efficacy as a causal determinant of behavior at the expense of expected outcomes (Bandura, 1997), Williams (2010) argued that items measuring outcome expectancy were seldom designed to clearly relate the expected behavior or result that are firmly related ones' judgments about the possibility of outcomes that yield from their behavior. Items used to measure outcome expectancy that are focusing on distal outcomes, instrumental, positive target behaviors may result in researchers to get slender glimpse of outcome expectancy. The negative but not statistically significant correlation between participating science teachers' outcome expectancies and their sense of pedagogical discontentment can be ascribed to the nature of STEBI's STOE scale items as being mostly positive (6 out of 7) and including lack of proximal and affective statements.

As an attempt to explore the relationship between science teacher self-efficacy and their pedagogical discontentment in detail, the findings of this research broadened the findings of Kahveci et al. (2018) and contradicted with results of Southerland et al. (2011). Expanding the discussion to understand which level of self-efficacy yielding pedagogical discontentment as a requirement for successful implementations of reform, findings derived from this research illustrated that teachers with low self-efficacy differed from teachers who held moderate and high level self-efficacy. As Kahveci et al. (2018) categorizing the self-efficacy levels by dividing the possible self-efficacy states into two categories, found that teachers who were more open to reform appear to be the ones with low self-efficacy.

Southerland et al. (2011) on the other hand argued that the most appropriate state of pedagogical discontentment for teachers to be open to reform was noted with the teachers who had moderate level of self-efficacy. In his earlier study Saka (2007) also argued that it is more likely that teachers with moderate level of self-efficacy tended to have greater pedagogical discontentment and thus to be more open to reform compare to their counterparts. However, contradicting with these earlier findings, this research illustrated that teachers with low self-efficacy differed from their counterparts as having greater sense of pedagogical discontentment possibly being more open to reform initiatives as opposed to the teachers with moderate and high levels of self-efficacy.

Going back to the demographics of the participating teachers in terms of the categories in self-efficacy beliefs, the number of teacher who held low self-efficacy beliefs appears to be way too short compare to the number of teachers with moderate and high self-efficacy beliefs. The overwhelming literature on preservice education constantly argued that higher self-efficacy would be a good attribute for teachers to start their teaching for many reasons such as increased student achievement. The vast amount of literature attempting to increase teacher self-efficacy beliefs seems to be successful as the number of teachers with moderate and high self-efficacy overweighs the teachers with low self-efficacy particularly in this research. This situation would be considered as a disadvantage for the sake of reform implementations as the greater amount of teachers appears to have moderate and high self-efficacy beliefs possibly feeling lack of pedagogical discontentment over their instructional practices and thus refusing to change and refuting the reform suggestions.

## 6. Implications and Further Research

To alter science education toward promoting scientific literacy, emphasis on the interaction between science teachers' self-efficacy beliefs and their sense of pedagogical discontentment is essential. Reform suggestions often urge teachers to change their existing teaching practices. Teacher change, indeed, is not an easy task. Without prioritizing deeper underpinnings of reform, teachers often prefer to draw on their existing beliefs and practices known to be the primary reason for reform to fail. Significant amount of pedagogical discontentment with their existing instructional practices appears to be a requirement for science teachers to be open to reform ideas. This research illustrated that science teachers' self-efficacy beliefs significantly interacted with their sense of pedagogical discontentment as the low self-efficacy beliefs appeared to allow teachers to problematize their teaching and feel some degree of pedagogical discontentment. It would be suggested to science teacher educators as well as teacher professional development designers to primarily focus on opportunities for teachers to explore their pedagogical shortcomings and their ineffective classroom applications to recognize their inadequacies in science teaching. Recognition of inadequate instructional practices followed by a sense of pedagogical discontentment may allocate teachers to critically question their capability of achieving effective science teaching and ensuring successful student outcomes aligned with reform. Unless they problematize their existing pedagogical competencies, it would be difficult for teacher seek for alternatives and thus to take on the reform initiatives. Mindful of this critical point, further research focusing on venues to promote teachers' reflection on their inadequacies, pedagogical contradictions and cognitive dissonances is essential. Teacher educators and teacher professional development actors ought to create opportunities for teachers to recognize the purpose of reform and how to comply with the reform through a balance between self-efficacy and pedagogical discontentment.

Another implication would be to the self-efficacy beliefs researchers to better define outcome expectancy as a construct theoretically having causal influence on individuals' self-efficacy beliefs. Instruments aiming to assess teachers' outcome expectancy should exclusively distinguish the factors effecting outcome expectancies related to ones capabilities when deciding the course of action from other contextual factors. Further research is required on developing reliable and valid tools to measure outcome expectancies as empirical evidence here in this research showed trivial relevance of outcome expectancy to teachers' self-efficacy beliefs in general.

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