



Attitudes of science teachers towards thought experiments¹

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Abstract

The purpose of this study is to examine the attitudes of science teachers towards thought experiments. One of the quantitative research methods, descriptive survey was carried out with 204 science teachers working in the public schools. Accessible sampling method was used and teachers voluntarily participated the study. Teachers' Attitudes Scale towards Thought Experiments was applied as a data collection tool. The scale was developed by the researchers before the study. The reliability coefficient Cronbach Alpha is .94. Teachers' attitudes towards thought experiments was searched due to teachers' gender, education status, teachers' status through benefiting from academic publications and professional seniority. The data was analyzed by using SPSS program with these variables. As finding of the study there was no significant difference in terms of the all variables in the attitudes of science teachers towards thought experiments. As a result, it was found that the level of attitudes of science teachers towards thought experiment is in the low level. In this context, in-depth qualitative studies can be performed to understand the reasons of this result and similar quantitative studies can be administered with different variables.

Keywords: Thought Experiments, Attitudes, Science Teachers

Introduction

In the 21st century, individuals are expected to have such skills like critical thinking, creativity, collaborative work and problem solving. This expectation is of great importance in science education as well as in other fields (Tümekaya, 2011). It is known that thought experiments are one of the necessary activities to acquire these skills (Dayı, 2011).

Thought experiments can be defined as “experiment or an event (situation) is not applied physically and is performed or visualized in the mind by contemplating”. Thought experiments are a tool that improves the internal processes of individuals by using their own experiences in their learning and ensures their active participation (Acar, 2013). It is seen that thought experiments, one of the classroom activities, are used in the development of scientific thinking, in the interpretation of thinking processes and in revealing the thinking processes of the individual (Özdemir, 2009; Dönertaş, 2011; Acar, 2013; Uyar, 2021).

There are some studies on thought experiments in the literature and their sample mainly consists of high school and university students (Bademci, 2008; Karakuyu & Tortop, 2009; Tüzün, 2010; Dayı, 2011; Acar & Gürel, 2014; Bademci & Sarı, 2014; Tüzün & Köseoğlu, 2018). There are not many studies on the secondary school level (Çetinkaya, 2019; Tüysüz & Tüzün, 2020). In these studies, subjects such as monitoring the processes of thought experiments, the place of thought experiments in problem solving, and the effects of thought experiment activities on students' conceptual learning were investigated.

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Teachers should support their own development in order to provide their students with 21st century skills. Studies show that teachers' attitudes towards Science and Science education affect students' attitudes towards Science (Morell & Lederman, 1998, cited in: Kahyaoğlu & Fire, 2007). In order for the education in science to reach the desired level, qualified teachers must be trained in this field (Kahyaoğlu & Yang, 2007). Teachers' attitudes towards thought experiments can show the teachers capabilities towards 21st century skills. So there is a need to a study to determine the science teachers' attitudes towards thought experiments and the aim of this study is to examine this kind of attitudes in terms of gender, educational status, teachers' status through benefiting from academic publications and professional seniority.

Problem Statement: What are the attitudes of science teachers towards thought experiments in terms of teachers' gender, educational status, teachers' status through benefiting from academic publications and professional seniority?

Sub Problems:

Is there a difference in the attitudes of science teachers towards thought experiments in terms of

1. Gender?
2. Educational status?
3. Teachers' status through benefiting from academic publications?
4. Professional seniority?

Method

The aim is to examine the science teachers' attitudes towards thought experiments due to different variables. For this reason, descriptive survey model was selected. It is one of the quantitative research methods. This method is performed to understand the characteristics of a group (Büyüköztürk, 2015).

Science teachers working in public schools in the 2022-2023 academic year in Turkey were participated voluntarily. 204 science teachers determined by the easily accessible sampling method. The advantage of this method is to bring speed and practicality to the researchers, so it is preferred because of that reason (Yıldırım & Şimşek, 2008). The characteristics of the participants are shown in Table 1.

Table 1. Characteristics of Participants

Variable	Group	N	%
Gender	Female	142	69,6
	Male	62	30,4
Professional seniority	1-5 year	107	52,5
	6-10 year	49	24,0
	11-15 year	23	11,3
	16 and above year	25	12,3
Educational Status	Licence	173	84,8
	Master's Degree	31	15,2
Status through benefiting from academic publications	Yes	156	76,5
	No	48	23,5
Total		204	100

The "Thought Experiments Attitude Scale" (TEAS) developed by Alp (2023) was used as a data collection tool. The scale consists of 16 items with a factor. In the interpretation of the scale options, "1.00-1.79 for Strongly Disagree, 1.80-2.59 for Disagree, 2.60-3.39 for Undecided, Agree 3.40-4.19, 4.20-5.00 for Strongly Agree" was used. Cronbach Alpha statistical procedure was used for reliability analysis in the research, it was found as .94. This values above .90 showed that the reliability of the study is high. Google forms was used to collect data by sharing in the social media groups of Science teachers.

The data were analyzed by SPSS program. First, a normal distribution was tested and not normally distributed data was determined by looking at the histogram, Kolmogorov-Smirnov, skewness and kurtosis values. For this reason, non-parametric tests were preferred in the analysis.

The Mann-Whitney U test was conducted in order to determine the attitudes of science teachers towards thought experiments in terms of gender, educational status, teachers' status through benefiting from academic publications and professional seniority. With the U test, it is determined whether there is a difference between the means of the two groups for data that do not show normal distribution (Bursal, 2017). The Kruskal Wallis Test was applied to determine whether the attitudes of science teachers towards thought experiments differ according to the level of professional seniority. With the Kruskal Wallis Test, if the number of groups is more than two, if the groups do not show a normal distribution, the difference between the averages of the groups is determined (Can, 2016). Normality test results was presented in the Table 2.

Table 2. Normality Test Result

Scale	Skewness	Standard Error (Skewness)	Kurtosis	Standard Error (Kurtosis)	Kolmogorov-Smirnov p	Shapiro-Wilk p
TEAS	-1,178	0,170	3,328	,339	,000	,000

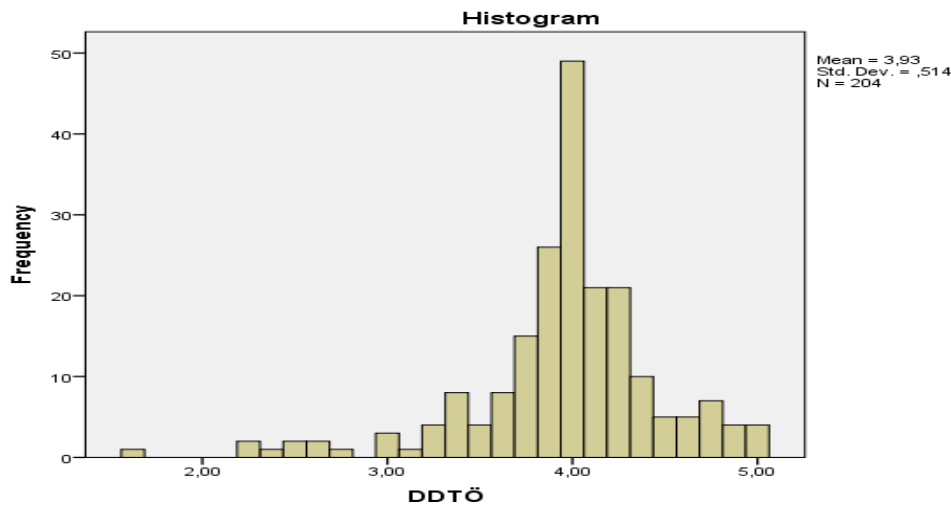


Figure 1. Normality test graph

When Table 2 and Figure 1 were examined, it was determined that the data were not normally distributed by looking at the histogram, Kolmogorov-Smirnov, skewness and kurtosis values. For this reason, non-parametric tests were used in the analysis. In the literature, the skewness and kurtosis coefficients are close to zero and an idea about normality is carried out. If the coefficient of Skewness and the coefficient of Kurtosis are divided by the standard error of the skewness and kurtosis, this distribution is considered normal if the value is between -1.96 and +1.96 (Can, 2016). Accordingly, it is seen that the values found as a result of the operations performed on the Skewness coefficient $(-1,178/0.170=-6.92)$, the kurtosis coefficient (Kurtosis) $(3.328/0.339=9.81)$ are not within the specified range. The skewness and kurtosis coefficients of the scale items are expected to be between -2 and +2 (George & Mallery, 2010). In the analysis, it is seen that the skewness coefficient is (-1,178) and the kurtosis coefficient is (3,328). Values do not have to be between -2 and +2 values. A p value greater than 0.05 in Bursal (2017), Kolmogorov-Smirnov and Shapiro-Wilk tests indicates that normality is achieved. When we look at the results of our normality test in our research, the test results prove that the data are not normally distributed, since Kolmogorov Smirnov ($p=.000$), Shapiro Wilk ($p=.000$).

Findings

In this part, descriptive statistics and the related analyses results of TAES was presented. The descriptive statistics of science teachers' attitudes towards thought experiments are presented in Table 3.

Table 3. Arithmetic mean and standard deviation values of science teachers' attitudes towards thought experiments

	N	\bar{x}	Ss
TAES	204	3,9335	,51352

As seen in Table 3, it was determined that the average thought experiment attitude score of science teachers ($\bar{x}=3.93$) was at the level of "I agree".

Science Teachers' Attitudes towards Thought Experiments in terms of Gender

The Mann-Whitney U test was used to compare the attitudes of the science teachers participating in the study towards thought experiments due to the gender variable. The obtained results are presented in Table 4.

Table 4. Mann-Whitney U Test Results for Science Teachers' Gender Variable

Gender	N	Mean Rank	Sum of Rank	U	p
Female	142	104,44	14831,00	4126,000	,475
Male	62	98,05	6079,00		

According to Table 4, the mean rank values of female science teachers' attitudes towards thought experiments is 104.44, while the mean rank values of male science teachers' scores regarding thought experiment attitudes are 98.05. Since $p=0.475 > .05$ according to U test results, there is no significant difference according to the gender variable of science teachers. According to these results, it can be said that gender is not an effective variable on science teachers' attitudes towards thought experiments. No significant difference was found in the mean scores of science teachers' attitudes towards thought experiments in terms of gender. (Mann-Whitney $U=4126,000$; $z=-.715$; $p>.05$).

Science Teachers' Attitudes towards Thought Experiments in terms of Educational Status

The U test was used to compare the attitudes of the science teachers participating in the study towards thought experiments due to the educational status variable. The obtained results are shown in Table 5.

Table 5. Mann-Whitney U Test Results for Science Teachers' Educational Status Variable

Educational Satatus	N	Mean Rank	Sum of Rank	U	p
Licence	173	99,17	17156,50	2105,500	,056
Master's Degree	31	121,08	3753,50		

According to Table 5, the mean rank of the scores of the science teachers with a bachelor's degree in thought experiment attitudes is 99.17, and the mean rank values of the scores of the science teachers with a master's degree

in thought experiment attitudes are 121.08. Since $p=0.056 > .05$ according to Mann Whitney U test results, no significant difference according to the variable of education level of science teachers. According to these results, it can be said that education level is not an effective variable on science teachers' attitudes towards thought experiments (Mann-Whitney $U=2105,500$; $z=-1.912$; $p=.056 > .05$).

Science Teachers' Attitudes towards Thought Experiments in terms of Status through benefiting from academic publications

The U test was used to compare the attitudes of the science teachers participating in the study towards thought experiments according to the Status through benefiting from academic publications variable. The obtained results are presented in Table 6.

Table 6. Mann-Whitney U Test Results for Science Teachers' Status through benefiting from academic publications Variable

Status through benefiting from academic publications	N	Mean Rank	Sum of Rank	U	p
Yes	156	105,38	16440,00	3294,000	,206
No	48	93,13	4470,00		

Due to Table 6, the mean order values of the scores of the science teachers who say that they will benefit from scientific publications for thought experiments are 105.38, and that the mean of the scores of the science teachers who say that they do not benefit from scientific publications for thought experiments is 93.13. . Since $p=0.206 > .05$ according to Mann Whitney U test results, no significant difference according to the variable of science teachers' use of scientific publications for thought experiments was found. According to these results, it can be said that the use of scientific publications for thought experiments is not an effective variable on science teachers' attitudes towards thought experiments (Mann-Whitney $U=3294,000$; $z=-1,264$; $p=.206 > .05$).

Science Teachers' Attitudes towards Thought Experiments in terms of Professional seniority

The U test, which is a non-parametric test, was used to compare the attitudes of the science teachers participating in the study towards thought experiments according to the Professional seniority variable. The obtained results are presented in Table 6.

Table 7. Mann-Whitney U Test Results for Science Teachers' Professional Seniority Variable

Professional Seniority	N	Mean Rank	sd	X ²	p
1-5 year	107	109,55	3	5,351	.148
6-10 year	48	98,19			
11-15 year	24	79,90			
16 and above year	25	102,30			

Due to Table 7 the professional seniority status of those with the highest average rank values of thought experiment scores of science teachers is "1-5 years" (109.55). It is seen that the average of the rank values of the thought experiment scores of science teachers is the lowest, while the professional seniority status is "11-15 years" (79.90). According to the results of Kruskal-Wallis analysis of variance, since $p=0.148 > .05$, science teachers' thought experiment attitudes do not show a significant difference according to the variable of professional seniority. According to these findings, it can be said that professional seniority is not an effective variable on science teachers' thought experiment attitudes.

Results, Conclusions and Recommendations

The aim of this study was to investigate the science teachers' attitudes towards thought experiments in terms of gender, educational status, teachers' status through benefiting from academic publications and professional seniority. Thought Experiments Attitude Scale which was developed by Alp (2023) was applied to 204 science teachers by using Google forms.

As a result, for gender variable, it was found that female science teachers' attitude score (104.44) is higher than male science teachers' scores (98.05). Although the females' score is bigger than males', there was no significant difference between them ($p=0.475 > .05$). So it can be concluded that female and male science teachers have similar attitudes towards thought experiments. Yeşilyurt et al., (2005) also found that gender did not have an effective effect on attitude in their study called "Development and implementation of an attitude questionnaire for primary school science laboratory". Similarly, Kaya and Büyük (2011) showed that gender has no effect on attitude in the study titled "The attitudes of primary school students towards science and technology lessons and science experiments". Differently, Yıldız et al., (2015) study named "Science teachers' attitudes towards science experiments" shows that gender affects attitudes towards science experiments and that female teachers' attitudes are significantly more positive than male teachers. However, this is not directly related to thought experiments. Research from the 1990s to the present has shown that gender plays a very minor role in attitude (Osborne, 2003; cited in Kozcu-Çakır, Şenler & Göçmen-Taşkın, 2007). The obtained result is similar to the other results in the literature about the gender variable.

As a result, for educational status variable, it was found that master's degree science teachers' mean rank score (121.08) is higher than license science teachers' scores (99.17). Although the master's degree teachers' score is bigger than license's', there was no significant difference between them ($p=0.056 > .05$).

As a result, for the variable teachers' status through benefiting from academic publications, it was found that science teacher who said that they use scientific publications about thought experiments have higher scores (105.38) than those who do not benefit these kinds of publications (93.13). It was found that there was no significant difference among these scores ($p=0.206 > .05$).

As a result, for professional seniority variable, it was found that science teacher who selected "1-5 years" seniority have higher scores (109.55) than the other seniority periods. It was also found that there was no significant difference among these scores ($p=0.148 > .05$). Differ from this result, Yıldız et al., (2015) found that the attitudes of science teachers towards science experiments differed significantly according to their professional seniority. Additionally, Keskin-Geçer, (2018) found that there was no statistically significant difference between the laboratory attitudes of science teachers according to professional seniority. However, these studies again about laboratory experiments, not about thought experiments.

In this study, the attitudes of science teachers towards thought experiments were investigated. It was obviously seen that even though the thought experiments' history is based on 1980's, newly studies to support or to not support the findings. In the new studies, it can be recommended to the researchers to test different variables or to do qualitative studies for deeply understand the effect of thought experiments.

References

- Acar, H. (2013). Fizik öğrencilerinin düşünce deneyleri ile düşünme süreçlerinin incelenmesi, Doktora tezi, *Marmara Üniversitesi, Eğitim Bilimleri Enstitüsü*, İstanbul.
- Acar, H. ve Gürel, Z. (2014). Lise ve Fizik öğretmenliği öğrencilerinin uydu hareketi ile ilgili görüşlerinin düşünce deneylerine yansımaları, *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 29 (29-2), 1-15.
- Alp, M. Ş. (2023). Fen bilimleri öğretmenlerine yönelik düşünce deneyleri tutum ölçeğinin geliştirilmesi ve uygulanması, Yüksek Lisans Tezi, *Siirt Üniversitesi, Fen Bilimleri Enstitüsü*.
- Bademci, S. (2008). Fizik problemleri çözmeye düşünce deneylerinin yeri: Birinci ve beşinci sınıf öğretmen adayları, Yüksek Lisans tezi, *Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü*, Ankara.
- Bademci, S. ve Sarı, M. (2014). Fizik problemleri çözmeye düşünce deneyleri: Fizik öğretmen adayları üzerine bir inceleme, *Eğitim ve Bilim*, 39(175), 203-215.

- Bursal, M. (2017). SPSS İle Temel Veri Analizleri (1. Baskı), *Anı Yayıncılık*, Ankara.
- Büyüköztürk, Ş. (2015). Sosyal Bilimler İçin Veri Analizi El Kitabı, *Pegem Akademi*, Ankara.
- Can, A. (2016). SPSS ile Bilimsel Araştırma Sürecinde Nicel Veri Analizi (4. Baskı), *Pegem Akademi*, Ankara.
- Çetinkaya, İ. (2019). Basit makineler ile ilgili geliştirilen düşünce deneyi etkinliklerinin 8. sınıf öğrencilerinin kavramsal anlamalarına etkisi, Yüksek Lisans tezi, *Aksaray Üniversitesi, Fen Bilimleri Enstitüsü*, Aksaray.
- Dayı, B. (2011). Kaldırma kuvveti ve basınç konusundaki problemlerin çözümünde düşünce deneylerinin yeri, yüksek lisans tezi, *Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü*, Ankara.
- Dönertaş, Ş. (2011). Role of thought experiments in solving conceptual physics problems, Yüksek Lisans tezi, *Orta Doğu Teknik Üniversitesi, Fen Bilimleri Enstitüsü*, Ankara.
- Kahyaoğlu, M. ve Yangın, S. (2007). İlköğretim sınıf öğretmenliği, fen bilgisi ve matematik öğretmen adaylarının fen bilgisi öğretimine yönelik tutumları, *Uluslararası Yönetim İktisat ve İşletme Dergisi*, 3 (6) , 203-220.
- Karakuyu, Y. ve Tortop, H. S. (2009). Düşünce deneyleriyle ilgili problem çözme etkinliğinin öğrencilerin mantıksal düşünme becerileri ve kavramsal anlama düzeylerine etkisinin araştırılması, *Bolu Abant İzzet Baysal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 9 (2) , 42-58.
- Kaya, H. (2011). İlköğretim 11. kademe öğrencilerinin fen ve teknoloji derslerine ve fen deneylerine karşı tutumları, *TÜBAV Bilim Dergisi*, 4 (2) , 120-130 .
- Keskin-Geçer, A. (2018). Fen Bilgisi Öğretmenlerinin Laboratuvar Uygulamaları ile İlgili Yeterlilikleri ve Karşılaşılan Problemler, Doktora tezi, *Fırat Üniversitesi, Eğitim Bilimleri Enstitüsü*, Elazığ.
- Kozcu Çakır, N. , Şenler, B. & Göçmen Taşkın, B. (2007). İlköğretim 11. kademe öğrencilerinin fen bilgisi dersine yönelik tutumlarının belirlenmesi. *Türk Eğitim Bilimleri Dergisi*, 5 (4) , 637-655
- Özdemir, F. Ö. (2009). Avoidance from thought experiments: fear of misconception, *International Journal of Science Education*, 31(8), 1049-1068.
- Tümekaya, S. (2011). Fen Bilimleri öğrencilerinin eleştirel düşünme eğilimleri ve öğrenme stillerinin incelenmesi, *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi*, 12 (3), 215-234.
- Tüysüz, M. ve Tüzün, Ü. N. (2020). Astronomi-kimya düşünce deneyleri temelli argümantasyonun özel yetenekli öğrencilerin eleştirel düşünme becerileri üzerine etkisi, *Erzincan Üniversitesi Eğitim Fakültesi Dergisi*, 22 (3), 818-836.
- Tüzün, Ü. (2010). Düşünce Deneyleri Kullanılarak Yapılandırılan Bilimsel Tahmin Argümanlarının Öğrencilerin Gazlar Konusunu Anlamalarına Etkisi, Yüksek Lisans tezi, *Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü*, Ankara.
- Tüzün, Ü. N. ve Köseoğlu, F. (2018). Bilim eğitiminde düşünce deneyleri temelli online argümantasyonla lise öğrencilerinin eleştirel düşünme becerilerinin geliştirilmesi, *Türkiye Kimya Derneği Dergisi Kısım C: Kimya Eğitimi* , 3 (2) , 77-98.
- Uyar, F. K. (2021). Yüksek lisans öğrenimi gören Fen Bilimleri öğretmenlerinin düşünce deneylerine ilişkin düşünme süreçlerinin analizi, Yüksek lisans tezi, *Amasya Üniversitesi, Fen Bilimleri Enstitüsü*, Amasya.
- Yeşilyurt, M., Kurt, T., Temur, A. (2005). İlköğretim fen laboratuvarı için tutum, *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, 17 (17), 21-31.
- Yıldız, E., Aydoğdu, B., Akpınar, E., Ergin, Ö. (2015). Fen bilgisi öğretmenlerinin fen deneylerine yönelik tutumları, *Boğaziçi Üniversitesi Eğitim Dergisi*, 24 (2), 71-86.

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