JOURNAL OF BALTIC SCIENCE EDUCATION

ISSN 1648-3898 /Print/
ISSN 2538-7138 /Online/

DEVELOPMENT OF AN OPTICS INTEREST AND EXPERIENCE SCALE (OIES) AND EXPLORING GENDER DIFFERENCES IN PROSPECTIVE TEACHERS' INTEREST AND EXPERIENCE

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Abstract. *In this research, the development of the Optics Interest and Experience Scale (OIES) was discussed in the first stage, and the gender differences of prospective teachers in their interest and experience were explored with OIES in the second stage. The data were collected from 228 prospective teachers from eleven universities in Turkey. For content and face validity, a theoretical framework for the OIES was established by a detailed literature review and expert opinions were consulted. For the construct validity, the principal component factor analysis was used. The final form of the scale was composed of 33 items and had two main factors namely: 'experience'and 'interest'. A reliability analysis of the instrument revealed Cronbach-Alpha coefficients of .906 for the whole scale, .886 for the experience factor, .851 for the interest factor. MANOVA analysis was conducted to explore gender differences in interest and experience scores of prospective teachers in geometrical optics. There was a statistically significant difference between males and females on the combined dependent variables. When the results for the dependent variables were considered separately, the only difference to reach statistical significance was experience such that females reported slightly higher experience in geometrical optics than males.*

Keywords: *scale development, gender differences, interest, experience, geometrical optics.*

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Introduction

Teacher education studies are important and further research in teachers' knowledge, attitudes, motivation, teaching skills that aim to encourage them to teach effectively still needed. Improving the preparation of teachers is a crucial goal of science educators. Research studies on teachers subject matter knowledge demonstrated that teachers' understanding of a topic mirror what we know about students. Therefore, teachers are believed to be a prominent factor for student performance. Optics in physics is one of the crucial topics in school science and needs further attention and investigation. There is abundant evidence in the literature that teachers do not fully conceptualize the topic of optics (Bendall, Goldberg, & Galili, 1993; Heywood, 2005; Kaltakci-Gurel, Eryilmaz, & McDermott, 2016). Teachers' interest in and experience with a subject matter affect their conceptual knowledge and instructional practice, and subsequently, student achievement. Hence, studying teachers' optics related interest and experience in detail is crucial.

Development of interest in science is one of the crucial aims of scientific literacy (Hagay et al., 2013; OECD, 2008). Many research have demonstrated that student interest in science affects their achievement (Häussler & Hoffmann, 2000; Jocz, Zhai, Tan, 2014; Krapp, 2002; Schibeci & Riley, 1986). However, science is not monolithic. Students' interest in biology, chemistry and physics have been reported to be different according to their age, gender, experience, culture and even topic of a subject (Christidou, 2006; Hagay et al., 2013). Interest is described as a content-specific person-object relationship that comes up from a person's communication with the environment (Holstermann, Grube, & Bögeholz, 2010; Krapp, 2005; Schiefele, 1991). Researchers have distinguished between two kinds of interest: individual or personal interest and situational interest (Krapp, 2002). Individual interest is a long-term intrinsic and enduring feeling toward specific activities or subjects, while situational interest is a short-term spontaneous emotional state that is evoked suddenly by external factors such as immediate environment or education. A fine developed individual interest is thought to provide students to be knowledgeable in topics they are interested in (Reinnger, 2000). Interest is believed to be content-specific (Krapp, 2005; Schiefele, 1991;1999) such that it is described as a content-specific or topic-specific motivational characteristic of personality. Krapp and Prenzel (2011) argued that the improvement of interest in various subjects (such as optical instru-

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

ments, radioactivity and electricity) varies significantly from the improvement of global interest. Additionally, in and out-of school experiences are believed to enhance individuals' interest in science (Christidou, 2006; Uitto, Juuti, Lavonen, & Meisalo, 2006).

It is widely accepted that the gender differences in science start at birth and the gap increases as students proceed through the grade levels (Kahle & Lakes, 1983; Osborne, Simon, & Collins, 2003). Regardless of worldwide endeavors to diminish the gender gap in science, this gap is as yet present (Tsai & Huang, 2018; Stewart, 1998; Zohar & Sela, 2003) especially in physics and needs further research. Girls' lower academic performance, attitudes, interest and experience in physics compared to boys has taken greater attention of researchers since many decades and many projects (e.g. WISE-Women into Science and Engineering) have been developed since then. In literature, for girls' lower performance in physics two explanations are suggested (Hasse, 2002; Sencar & Eryılmaz, 2004; Tsai & Huang, 2018). According to the first biological explanation, the differences in brain structures that are innate are responsible for the difference in the performance of girls and boys. The second mostly agreed socio-cultural explanation for the existing difference draws attention to the differences caused by the cultural and social environment in which the individual lives in. For these reasons efforts have been made to increase girls' interest and experience, hence achievement in physics by researchers (Haussler & Hoffmann, 2002; Schibeci & Riley, 1986). In general boys are reported to be more interested in science than girls (Kahle & Lakes, 1983; Lavonen, Byman, Juuti, Meisalo, & Uitto, 2005) and that difference increases with age (Jones, Howe, & Rua, 2000). Additionally, it is often reported that depending on gender students have different experiences with science in and out of school (Jones, Howe, & Rua, 2000). In those studies boys and girls were found to come to the classroom with considerable variability in their amount and nature of experiences (Joyce & Farenga, 1999; Sencar & Eryılmaz, 2004). Girls' less and diverse kind of experiences were believed to bring about lower academic achievement in science. However, some studies have criticized that gender differences depend merely on the content and context of a subject. Boys are attracted by subjects such as nuclear bombs, technology, computers, using instruments (for example batteries and microscope), while girls are mostly interested in topics about biology and human being or aesthetic dimension of a topic (e.g. rainbows) and have more experiences of observing stars, planting seeds (Christidou, 2006; Jones et al., 2000; Lavonen, Byman, Juuti, Meisalo, & Uitto, 2005). While both sexes regard topics such as space, solar system, light as equally appealing (Lavonen et al., 2005; Osborne & Collins, 2001). Research studies demonstrated that there are just few topics (such as electricity and electronics) in which the interest of females and males varies to a great extent; conversely, in plurality of distinct factual interests, no severe gender differences can be recognized (Krapp & Prenzel, 2011).

Measuring interest and experience is important to education researchers. In determining individuals' interest in or experiences with science, different measurements have been used including written-questionnaires, interviews, likert-type scales and classroom observations (Cedere, Jurgena, & Targamadze, 2018; Çiçek & Ilhan, 2017; Krapp & Prenzel, 2011). Also, individuals' self-generated questions have been utilized to find out about their interests in science (Baram-Tsabari, Sethi, Bry, & Yarden, 2006; Cakmakci, Uysal, Kole, Kavak, Sevindik, & Pektas, 2011; Yederlen-Damar & Eryilmaz, 2010). Among them Likert-type scales are the most common. However, topic-specific measurement tools are required to explore interest and experience support the assertion that interest and experience is content-specific. Therefore, in this study topic-specific instrument to measure both interest in and experience with optics was developed and used.

Significance and Aim of Research

On a detailed review of the literature, it was found that individuals had difficulty in understanding geometrical optics (Dedes & Ravanis 2009; Galili, 1996; Goldberg & McDermott, 1987; Heywood, 2005; Hubber, 2006; Kaltakci-Gurel, Eryilmaz, & McDermott, 2017). Also, there is considerable evidence that even teachers do not fully conceptualize the topic of optics (Bendall, Goldberg & Galili, 1993; Heywood, 2005; Kaltakci-Gurel, Eryilmaz, & McDermott, 2016). Physics educators have raised query concerning if teachers can successfully teach optics (McDermott, 2006) and believe the success of quality of instruction merely rely upon teachers' conceptual knowledge and instructional practice (Mumba, Mbewe, & Chabalengula, 2015). Recent studies have revealed that interest and experience are important variables in the school contexts, as they can influence individuals' achievement and the nature of current and future learning (Hidi & Renninger, 2006; Holstermann, Grube, & Bögeholz, 2010). However, hardly any studies were found in the literature analyzing prospective teachers' interests and experinces in geometrical optics and exploring them according to gender. Therefore, studies in this research are valuable because firstly they provide a valid and reliable, topic-specific interest and experience scale, and secondly they provide an insight into the comparision of male and female prospective teachers' interest in and experience with geometrical optics. Hence, the aim of the current research was to develop and validate an optics interest and experience scale, and to determine the gender differences of prospective teachers in their interest and experience in geometrical optics. In this respect, the research questions were:

1. Are prospective teachers' scores on the optics interest and experience scale (OIES) valid and reliable?
2. Do female and male prospective teachers differ in terms of their interest in and experience with geometrical optics?

Methodology of Research

Research Design

The first stage of the present research was the development of an Optics Interest and Experience Scale (OIES). The second stage of the research was a causal comparative research design. This design was used since the goal was to determine the cause or consequences of differences that already exist between group of individuals (Fraenkel & Wallen, 2000). In this research the interest and experience of prospective teachers were measured by Optics Interest and Experience Scale (OIES) developed by the researcher. Data were collected from prospective teachers registered to physics education programs of universities in different regions of Turkey during 2011-2012 academic year.

Sample of Research

Data in this research were obtained from 228 prospective teachers studying in physics education departments in Turkey who have accomplished their geometrical optics and geometrical optics laboratory courses in the academic year of the scale implementation. Each year 523 prospective teachers were placed in physics education departments by standardized placement exams. There were 13 state universities with physics education departments in the country. However, because of certain reasons not all prospective teachers reached upper grade levels or graduation so the accessible population size was lower than the targeted population as shown in Table 1. Since the related courses were at different grade levels in each university's curriculum, the scale was administered within a suitable course hour after one semester of the period in which the teacher candidates took these courses. The choice of courses was based on accessibility. The accessible population was 291 prospective teachers registered to those courses. The OIES was administered to 228 prospective teachers in 11 universities, which constituted the 44 % of the target population and 78 % of accessible population in all of these universities. Eleven candidates who did not give proper answers to the 26th item that measured whether they read the scale and honestly filled the items were removed from the analysis. A total of 217 prospective teachers (Female: 137 (% 63); Male: 80 (% 37)) were included in the analysis. The distribution of the sample group according to their university, grade level and gender is illustrated in Table 1. For ethical concerns the researcher ensured the confidentiality of the names of the prospective teachers who participated in the research.

Table 1. Distribution of the accessible population and sample according to their university, grade level and gender.

University	Grade Level	Accessible Population	Sample Size			
			Gender		Total	
			Female *(N)*	Male *(N)*	*N*	%
Atatürk U.	3	23	16	6	22	10.1
Balıkesir U.	3	38	21	13	34	15.7
Dicle U.	4	13	8	4	12	7.4
Dokuz Eylül U.	4	26	7	9	16	5.5

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

University	Grade Level	Accessible Population	Sample Size			
			Gender		Total	
			Female *(N)*	Male *(N)*	*N*	%
Gazi U.	3	40	24	7	31	14.3
Hacettepe U.	4	11	8	2	10	4.6
Karadeniz Technical U.	4	25	7	5	12	5.5
Marmara U.	5	25	7	3	10	4.6
Ondokuz Mayıs U.	3	28	8	8	16	7.4
Middle East Technical U.	3	32	15	17	32	14.7
Selçuk U.	3	30	16	6	22	10.1
	Total	**291**	**137**	**80**	**217**	**100**

Instrument and Procedures

When OIES was developed, (i) the review of the literature, (ii) setting up a pool of substances, (iii) getting expert opinions, (iv) administering draft scale to a small group and evaluating items with individual interviews, (v) administering the final scale to the described prospective teachers and making statistical analyzes were applied in sequence.

First, similar scales in the literature (Çiçek & İlhan, 2017; Sencar & Eryılmaz, 2004) were examined. Brain storms were made about the cases that were related to geometrical optics interests and experiences, and these cases were noted and a scale consisting of 35 items was prepared. Subsequently, the items were examined by five experts in a physics education program of a state university by using an expert opinion form under the headings such as readability, content suitability, and how well the interests and experiences of the subject were measured by the items. As a result of expert opinions, two items were removed from the scale and a 33-item OIES was obtained. The scale was prepared in 4-point likert type in order to determine how often (none(0)- rarely(1)- occasionally(2)- frequently(3)) each situation in the scale is performed.

Data Analysis

For the statistical analysis of the data Microsoft (MS) Excel, Item and Test Analysis Program (ITEMAN) and Statistical Package for Social Sciences (SPSS 23.0) program were used. Firstly, the data were screened out for outliers and influential data points. Also a missing data analysis was done for the preparation of the data for further analysis. Then, the validity and reliability analysis of the test scores were done. Finally, MANOVA analysis in SPSS was performed in order to check whether male and female prospective teachers differ in terms of their interest and experience in geometrical optics.

Results of Research

Results for Validity and Reliability for the OIES

For the content and face validity, first of all a theoretical framework for the OIES was established by a detailed literature review. The literature review suggested that 4-point Likert-type scale in a question format items is more suitable to measure interest and experience. Then, the OIES was examined by five experts in a physics education program of a state university by using an expert opinion form under the headings such as readability, content suitability, and how well the interests and experiences of the subject were measured by the items. As a result of expert suggestions two items were removed from the scale and other necessary minor corrections were done. A sample of ten prospective teachers were randomly selected and individual interviews were conducted with them on the final form of OIES in a think aloud process to check whether any ambiguity or misleading items present in the scale. As a result a 33-item OIES was obtained.

For construct validity, explanatory factor analysis was performed by using the SPSS 23.0 program. Kaiser-Meyer-Olkin (KMO) value was found as .854 and the Bartlett's value was 2412.126 (p=.0001) (Table 2). The fact that the value of KMO found is greater than the recommended value of .60 and that the Bartlett test is statistically significant means that factor analysis can be continued (Pallant, 2005).

Table 2. Kaiser-Meyer-Olkin (KMO) and Bartlett's test for OIES scores.

KMO Measure of sampling adequecy		.854
Bartlett's Test of Sphericity	Approx. Chi-Square	2412.126
	df	300
	Sig. (p)	.0001

As a result of the examination of the factor analysis results, seven items (1, 2, 3, 4, 6, 25, 32) that have factor loadings below .30 (Büyüköztürk, 2010) were removed from the test. Item 26 was a control item to check whether subjects filled the scale honestly and was out of analysis. As a result, a scale consisting of two factors consisting of 25 items was obtained. Two factors obtained were named 'Experience' and 'Interest'. Being 'interested in' geometrical optics means being willing to acquire new knowledge in this topic and willing to participate in activities related to this topic. Having 'experience in' geometrical optics, however, means having performed activities related to this topic previously. The factor loadings of the questions in the final form of the scale are given in Table 3.

Table 3. Factor loadings of OIES as a result of explanatory factor analysis and item-total test correlations.

Questions	Factor 1 (Experience)	Factor 2 (Interest)	Item-Total Test Correlation
12. Have you observed an image formed by a convex mirror?	.827		.719
11. Have you observed an image formed by a concave mirror?	.826		.738
14. Have you observed an image formed by a diverging lens?	.792		.720
13. Have you observed an image formed by a converging lens?	.787		.724
15. Have you observed an image formed by a hinged plane mirror?	.754		.742
10. Have you observed an image formed by a plane mirror?	.587		.555
19. Have you looked at your image formed in hinged plane mirrors in places like elevator, restaurant or shopping mall?	.575		.668
20. Have you observed an image that appears on bright surfaces such as teapot or soup spoon?	.548		.655
18. Have you looked at a mirror in the car while driving or traveling?	.533		.598
23. Have you used a camera, projector, telescope, microscope, binoculars or magnifying glass?	.483		.598
21. Have you observed an image that appears in a mirror placed for safety purposes?	.468		.665
16. Have you looked at your own image in a plane mirror?	.458		.492
22. Have you seen images of magic mirrors in an amusement park or science center?	.373		.627
17. Have you looked at your own image in a makeup or shaving mirror?	.349		.442
28. Have you opened and examined inside of an optical instrument?		.728	.620
29. Have you ever wondered about the working principles of optical instruments?		.689	.665
27. Have you interested in repairing tools related to geometrical optics or have you watched with interest when repairing?		.662	.582

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Questions	Factor 1 (Experience)	Factor 2 (Interest)	Item-Total Test Correlation
30. Have you tried to learn how to use new optical tools and instruments?		.644	.645
33. Have you interested in optic-related careers (such as astronomy, photography, etc.)?		.558	.538
7. Have you researched and studied about geometrical optics related topics and their applications in science and technology in your free time?		.556	.577
31. Have you spent your money on optics-related books or instruments?		.513	.528
24. Have you ever wanted to use optics related tools such as camera, binoculars, telescope, microscope, periscope etc.?		.466	.632
8. Have you talked to your friends about geometric optics issues or the applications of these topics in technology in your daily life?		.433	.516
5. Have you previously developed a product or project related to geometrical optics?		.397	.223
9. Have you like your friends to give you a book or instrument about geometrical optics as a gift?		.394	.494

Internal consistency coefficients and some other descriptive measures were calculated for the final form of OIES. For the total scale, the Cronbach Alpha coefficient was found to be .906. The Cronbach Alpha coefficient was found to be .886 for the subscale of experience (14 items) and .851 for the subscale of interest (11 items). The item-total test correlations ranged between .223 and .742 (Table 3). Descriptive statistics related to interest and experience scores were also shown in Table 4. Subjects' interest scores ranged from 0 to 33 and experience scores from 0 to 42, where higher scores indicate greater interest in and experience with optics. The mean score for the total OIES was 41.9 (*SD*=11.1), the mean score for the experience subscale was 30.3 (*SD*=7.63), and the mean score for the interest subscale was 11.6 (*SD*=5.66).

Table 4. Some descriptive statistics and reliability for the OIES.

	Factor 1 (Experience)	Factor 2 (Interest)	Total Scale
Number of Items	14	11	25
Max. possible score	42	33	75
Min. score	13	0	16
Max. score	42	27	67
Mean	30.3	11.6	41.9
Variance	58.3	32.1	124.4
Standard Deviation	7.63	5.66	11.1
Standard Error of Mean (SEM)	.52	.38	.76
Cronbach Alpha	.886	.851	.906

The subscales of the OIES were experience and interest as mentioned before. A medium, positive and significant Pearson correlation of .453 was found between the subscales (i.e. experience and interest) of the OIES ($p < .05$). The purpose of this correlation analysis was to obtain a sense of how much overlap there was in the measurement of the subscale constructs. If two subscales had been highly related, it would have made more sense to combine these two subscales into one factor rather than interpret the results for each subscale separately. However, this was not the case. Thus, in this research these two factors represented discriminant measures.

Results for Gender Differences in the OIES

MANOVA was performed to investigate gender differences in interest and experience scores of prospective teachers in geometrical optics. Two dependent variables were used: interest score and experience score. The independent variable was gender. Preliminary assumption testing was performed and no serious violations detected. According to MANCOVA results, there was a statistically significant difference between males and females on the combined dependent variables: $F(2, 214)=11.58$; $p=.00001 < .05$; Wilks' Lambda=.902; $\eta^2=.098$. When the results for the dependent variables were considered separately the only difference to reach statistical significance, using a Benferroni adjusted alpha level of .025, was experience ($F(1, 215)=10.12$, $p=.002$, $\eta^2=.045$) with small effect size (Cohen, 1988 as cited in Tabachnick & Fidell, 2014). An inspection of the mean scores indicated that females reported slightly higher experience in geometrical optics ($M=31.5$, $SD=7.25$) than males ($M=28.2$, $SD=7.86$). Whereas, there was no statistically significant mean difference between males and females in their interest scores (Table 5).

Table 5. Some descriptive statistics related to the prospective teachers' interest and experience according to their gender.

Sub-scales	Female (n=137)		Male (n=80)	
	Mean	*SD*	Mean	*SD*
Experience	31.5	7.25	28.2	7.86
Interest	11.1	5.40	12.6	6.00

To sum up, analysis of the research revealed that female prospective teachers tend to have slightly higher experience scores in geometrical optics than males. However, the effect size, which is an indication of practical significance, was small. There was also no significant mean difference between male and female prospective teachers in their interest scores.

Discussion

The first stage of the present research was the development of an Optics Interest and Experience Scale (OIES) to assess interest and experience of prospective teachers in geometrical optics. The validity and reliability evidences for the OIES scores were obtained through some qualitative and quantitative methods. As a result of these evidences the OIES was found to be a valid and reliable scale. By using the data collected from 228 prospective teachers, exploratory factor analysis yielded two factors (namely 'experience' and 'interest') for the OIES with 25-item 4-point Likert type scale. This scale can be used by researchers in their future studies to assess interest and experience in geometrical optics.

The results of the second stage of the research showed that females tend to have slightly higher experience scores in geometrical optics than male prospective teachers, while no significant mean difference between male and female prospective teachers in their interest scores. Several studies in science education research reported males to have higher interest and experience in physics especially in the topics of electricity and mechanics mostly in upper grade levels. That gender difference in interest and experience are believed to cause the gender gap in physics achievement between males and females and responsible for the lower academic performance of females in physics. The findings in the present research that males and females have the same interest and females have slightly higher experience with a small effect size than males are surprising, because physics is generally favored more by males than females. However, in several studies it was reported that especially in developing countries females have the same (or even more) interest or experience or achievement in physics than males (Sjoberg & Schreiner, 2005). Kahle and Meese (1994) and Simpson, Koballa, Oliver and Crawley (1994) reported that interest and achievement in science are not consistent. Topic-specific instruments are required for exploring attitudes and achievement. Therefore topic-specific tools for correctly assessing interest in and experience with physics topics are needed (Jocz, Zhai, & Tan, 2014). In the literature no other studies were met focusing on interest and experience in geometrical optics. But some researchers included interest or experience in geometrical optics topic partly in their studies. Jones, Howe and Rua (2000) found that from a sample of sixth graders in U.S more girls than boys wanted to learn about six topics (out 26) in science, two of which were rainbows and colors in optics. Lavonen, Byman, Juuti, Meisalo and Uitto (2005) reported in Finland, females' interest in school physics contexts were lower than males except the items dealing with colors in optics. The contexts where science is argued in situations of daily life and connected in some way to human being (such as 'why we can see rainbows?') were reported to be more

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

interesting for females. Hoffmann (2002) also reported that although in grade 10 in Germany, 20 % of females and 60 % of males are interested about topics examined in physics lessons, no gender difference were found in the explanation of natural phenomena (such as 'changing colors of the sky during sunset' and 'why the sky is blue?'). According to Christidou (2006) in some themes including 'light and their perception and reproduction' no significant differences were found in interests of the Greek ninth grade students in terms of their gender. In the same study all the factors related to out-of-school, science-related experiences were found to show significant gender differences. Females were found to be engaged significantly more in 'seeking information about nature' and 'using instruments and technological devices' than boys. As a result, it can be concluded that the findings from diverse studies discussing gender differences in interest or experience in physics in general are inconsistent, therefore topic-specific measures of interest and experiences are needed.

The results of this research have some implications for classroom practice. Development of such a valid and reliable scale to measure prospective teachers' interest and experience in geometrical optics specifically supports teachers to plan and develop their teaching on the topic. For one thing, the presence of an easy to administer, valid and reliable scale would enable the teachers to confidently measure students' interest and experience in geometrical optics. For another thing, once interest and experience in geometrical optics were measured, teachers might be more oriented about what to perform in their classroom. According to the results, while planning their physics lesson teachers should know that, boys and girls might be engaged in different topics in physics differently in terms of their interest and/or experience which may in turn influence their academic achievement in that specific topic. Specific topics (such as geometrical optics) that are reported in which girls are at least as interested as boys should be valued in curriculum and classroom discussions. That does not mean undervaluing the importance of other topics in physics, but many other topics can be introduced in optics related contexts that appear to be of equal interest and experience for girls and boys. Thus, if the science curriculum includes topics related to "geometrical optics", for instance discussing the topic of electricity in the context of an optical instrument like camera, it is believed that achievement in science might also be increased. In addition, placing special importance on these topics might be particularly useful for females, while this should be the case for males as well.

For future studies, the OIES may be used not only for prospective teachers but also for in-service teachers or high school students. There are limited studies on the development of interest and experience scales in physics as well as in other disciplines. Hence, it is also recommended that researchers should develop similar topic-specific scales in other disciplines and topics. Appropriate combinations of topics and experiences could help to bring up scientifically literate citizens.

Conclusions

Interest and experience are important variables in the school contexts, as they can influence individuals' academic performance as well as quality of their current and future learning. Firstly, the current research contributes to the literature with a valid and reliable, topic-specific interest and experience scale. Secondly, the findings of the research together with the previous research in the literature revealed that males' and females' interest and experience in different physics topics may alter. In this sense, it is apparent that instead of dealing with general physics interest or experience, topic-specific interest and experiences should be considered and evaluated. Female prospective teachers who participated in the present research showed slightly higher experience scores in geometrical optics than male prospective teachers and their interest scores were found to be statistically equal. These findings were valuable since physics education researchers have been trying to find contents and contexts of equal interests and experiences to reduce the gap in science achievement due to gender differences. Once specific topics of equal interest and experince (such as geometrical optics) for boys and girls are identified, teachers would be more comfortable to reach both sexes in their classroom during teaching. This is one of the most important practical implications from this research. Moreover, there is a need to widen the scope of research to investigate how males and females differ in their interest and experiences in other physics topics as well as in other disciplines.

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ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

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Received: *May 14, 2018* Accepted: *October 25, 2018*

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