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Implementing Differentiated Instruction on Pre-Service Physics Teachers: Agendas

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Abstract: The purpose of this study is to determine missing knowledge of pre-service physics teachers related to the subjects of optics, energy, force and motion and try to overcome the imperfect knowledge problem using differentiated instruction. The study was conducted with 26 pre-service physics teachers. Before intervention three different multiple choice tests (pre-tests) was implemented to pre-service physics teachers for determine their missing knowledge. After this determination, one of the researchers lectured pre-service physics teachers during eight weeks using differentiated instruction. Two weeks after instruction multiple choice tests was implemented again as post-tests. Paired sample t-test was conducted to determine whether there is a significant difference between the tests. There were significant differences in all three units in favour of post-test results. This means that the lack of knowledge of the teachers have been largely resolved.

Key Words: agendas; differentiated instruction; physics education; pre-service teachers

Fizik Öğretmen Adaylarına Farklılaştırılmış Öğretimin Uygulanması: Ajandalar

Öz: Bu araştırmanın amacı, fizik öğretmeni adaylarının, optik, enerji, kuvvet ve hareket konularındaki eksik bilgilerini belirlemek ve ardından bu eksiklikleri farklılaştırılmış öğretim kullanarak gidermeye çalışmaktır. Çalışma 26 öğretmen adayı ile gerçekleştirilmiştir. Uygulamadan önce, üç farklı çoktan seçmeli test (ön-test) öğretmen adaylarının eksik bilgilerini belirlemek amacıyla uygulanmıştır. Daha sonra, farklılaştırılmış öğretim kullanarak sekiz hafta süren uygulama yapılmıştır. Uygulamadan iki hafta sonra, çoktan seçmeli testler son-test olarak tekrar uygulanmıştır. Ön testler ile son testler arasında anlamlı farkın olup olmadığını anlamak amacıyla bağımlı gruplar t-testi yapılmıştır. Sonuç olarak, son testler lehine anlamlı bir fark çıkmıştır. Bu sonuca bakılarak, öğretmen adaylarının eksik bilgilerinin büyük ölçüde giderildiği söylenebilir.

Anahtar Kelimeler: ajandalar, farklılaştırılmış öğretim, fizik eğitimi, öğretmen adayları

1. INTRODUCTION

In regular classrooms, individual differences between students are a condition accepted by the teacher in general. Students are very different from each other in terms of readiness levels, interests, skills, and so on. In addition, the learning styles of students may also show differences. Since the same type of teaching doesn't address all the necessities of different students, differentiated instruction approach has been developed in order to make each student to achieve his/her highest level of capacity. According to Tomlinson (2001), differentiated instruction is a learning experience, in which the students can use different ways to explore the content of the program, the activities and processes are performed towards meaningful learning, and reaching their own knowledge and ideas, and students can make their own choices to show and exhibit what they learn.

Differentiated instruction is not a formula or prescription. It is also not a teaching method either. Learning and teaching is a way of thinking and a philosophy. It depends on a group of ideas (Tomlinson, 2000):

- The students in the same age group are differentiated in terms of their levels of readiness, learning styles, experiences and socio-economic statutes.
- The differences between students significantly affect their learning speed and support provided by teacher.
- Students learn better, when they are supported by teachers rather than studying on their own.
- Students learn better, when they establish a relationship between their life experiences, interests and the curriculum.
- Students learn better, when teaching activities are related to issues and problems of the life.
- Students become more involved when the classrooms become an environment, where students are respected and cared well.
- The main task of school is improving the capacity of students to the highest level possible.

Although each student learns in different ways, the basic skills and content they gain are same. Therefore, students go different ways in the same direction (Tomlinson, 1999). Teachers can make differentiation in three different items including content, process and product. Content is the knowledge taught by teachers and materials used to accomplish this. Process is the activities designed to make students use their main skills to understand their basic knowledge and opinions. Product is all learning outcomes (Tomlinson, 2014).

Many methods can be utilized to differentiate. Station, agendas, coeducation, trajectory studies, centers, access points and sequential instruction are some of these methods. In this study, agendas method was used. Agenda is a list of tasks required to complete by a specific student at a set time (Table 1). There are both same and different elements in the agendas of all students of a class. Teachers often create agendas for a student to work two or three weeks on them, then create a new agenda upon completion of the previous one (Tomlinson, 2014). The teacher checks the students when they work on their agendas during the class. In this way, the teacher has a chance to observe the improvements of his/her students and makes recommendations to them.

Table 1: Sample Agenda

First and Last Name (Student)	Start Date:	
Task	**Special Instructions**	**Signature of the teacher showing that the task is completed**
Summarize the second Law of Newton briefly	Use the textbook	
Read Newton's life and his scientific studies	Use Internet	
Design an experiment related to the second Law of Newton	Not a dangerous demonstration	

Differentiated instruction is not a one-day wonder, but a radical change, which can respond to the learning necessities showing changes of the students. However, But it is very difficult to implement differentiated instruction. It requires time and effort to be spent (Rock, Gregg, Ellis, & Gable, 2008). The teacher firstly make a decision regarding in which way the students should be differentiated depending on their individual differences. In the decision-making process, the aim should be responding to the individual differences, integrating differentiation into instruction and evaluation processes and creating regulations regarding content, product and process as they can meet the needs of students based on their pre-knowledge levels, critical thinking and expression styles (Tieso, 2003; Tomlinson, 1999). The teacher can differentiate students based on their pre-knowledge, learning capabilities and learning styles (Parsons, Dodman, & Burrowbridge, 2013).

1.1 Objective and Problems

According to many researchers, pre-service physics teachers have misconceptions or imperfect knowledge on the subjects of optics, energy, force and motion (Sahin and Yagbasan 2012; Bayraktar 2009; İngec 2009; Yalcin, Altun, Turgut, and Aggül, 2009). Pre-service physics teachers should correct these misconceptions before graduation or starting to teach the physics class. Otherwise, pre-service physics teachers may teach incorrect information to the students or they cannot be as effective as they should be. In addition, these teachers' imperfect knowledge in the subjects would result in lower self-efficacy (Sarikaya, 2004). Considering all these, it is important for teachers to overcome these knowledge issues in order to be successful in their professions. However, the physics teachers may have many missing information about the course since they take many other classes during their education. Considering that each candidate may have many missing subjects and each candidate may have different missing points of the same subject; how can it be possible to correct these issues? If a group of teachers has distinctive achievements and missing points of the same subject (chapter), it will be a serious waste of time to explain the whole chapter to all of them. In addition, teaching a subject, which is already known, to a candidate teacher will result in loss of time and it will bore the candidate. At this point, we have to consider the individual differences of pre-service teachers in terms of their knowledge about the subjects. If there is a differentiation between the candidates in terms of achievements in the physics subjects, it will be more effective to employ the method of differentiated instruction in order to recover these issues. Employing differentiated instruction in terms of prior knowledge of the pre-service teachers can lead them to complete their incomplete knowledge about the subjects. For these reasons, in this study, it is aimed to overcome teachers' imperfect knowledge with differentiated instruction. In this regard, the following questions are asked;

What are the missing knowledge of pre-service physics teachers related to the subjects of optics, energy, force and motion?

Is differentiated instruction effective to overcome the imperfect knowledge problem of pre-service physics teachers related to the subjects of optics, energy, force and motion?

2. METHOD

2.1. Sample

The study was conducted with 26 pre-service physics teachers (16 female, 10 male), at the undergraduate program of physics. The age of participants ranged from 23 to 26. All participants were in the last years of the five-year study period. After telling purpose of the study and applications to be conducted to a group of 40 pre-service teachers, they were asked to participate in the study voluntarily. 26 of these 40 pre-service physics teachers participated in the study voluntarily.

2.2. Design

Three different tests have been developed to search for answers to the research problem. These tests consisted of physics questions related to the subjects of optics, energy, force and motion. These tests were applied to pre-service physics teachers twice before and after the training. The study is a single group pre-test and post-test model. In this model, pre-knowledge of the group before the study is measured. Then the implementation of training is performed and the group is subjected to post-test to measure their knowledge. If there is a significant difference between the results of pre-test and post-test, this difference would be considered to be caused by these trainings (Schumacher & McMillan, 1993).

2.3. Measurement

In the study, three different tests were employed. All three of these tests also include multiple-choice questions with five possible answers for each question. Questions were prepared by the researchers according to the objectives of physics curriculum of high schools in Turkey. In the physics curriculum, there were 12 objectives related to optics, 7 objectives related to energy and 11 objectives related to force and motion subjects, relatively. The first test prepared was Optics Knowledge Test (OKT), which contained 36 questions of 12 objectives related to the subject of optics. There were three questions for each objective in the test. The second test prepared was Energy Knowledge Test (EKT), which contained 21 questions of seven objectives related to the subject of energy. There were three questions for each objective in the test. The third test prepared was Force and Motion Knowledge Test (FMKT), which contained 33 questions of 11 objectives related to the subject of force and motion. There were three questions for each objective in the test.

26 pre-service physics teachers were subjected to the pre-tests. Participants were given 50 minutes for each test. Analysis of tests was performed as follows:

- If a participant answers all three questions related to an objective correctly, then he/she is considered as knowing that objective.
- If a participant cannot answer at least one or more than one questions related to an objective, then he/she is considered as not knowing that objective.

As a result of the analysis of OKT, EKT and FMKT tests, it has been determined that how many objectives out of 30 objectives each participant know. In the implementation process, an individual agenda was prepared for each participant using the data obtained. Two weeks later

than completion of the implementation period, three tests were applied to the participants as post-tests.

2.4. Validity and reliability

Three different test was used in research. For provide validity of tests, two experts who have PhD level in physics education have been consulted. They checked questions with two criteria. These criteria were: "Are questions correct scientifically?" and "Do questions match with objectives correctly?". After getting feedback from experts, final versions of tests were prepared.

For provide reliability of tests, tests was implemented to different 83 pre-service physics teachers. These pre-service physics teachers had been continuing same program at different levels. Kuder-Richardson (KR-20) reliability coefficients were calculated and given in table 2. Considering the results of KR-20 analyses, we can say all three tests are reliably since reliability coefficients between 0.70 and 0.90 (Schumacher & McMillan, 1993).

Table 2: ***Kuder-Richardson reliability coefficients***

Test	KR-20 coefficient
OKT	0,79
EKT	0,71
FMKT	0,72

2.5. Intervention

Three different applications were applied to the pre-service physics teachers in order to address the lack of information on optics, energy, force and motion subjects. In the applications, differentiation was done depending on pre-knowledge of pre-service physics teachers. During the implementation period, the method of agendas, which is one of the differentiated instruction strategies, was employed. Applications related to objectives of optics, energy, force and motion subjects were performed, respectively. The implementation period took eight weeks. In each week, three hours have been spent in a row. Each lecture was 50 minutes followed by a 10 minutes break. The application done for optics took three weeks (9 hours). The application done for energy took two weeks (6 hours). The application done for force and motion took three weeks (9 hours). In the implementation period, a special agenda was prepared for each participant. These agendas were handed out to the participants at the beginning of the course. Tasks in the agendas were performed individually by the participants. A teacher, one of the researchers, has checked the participants to see whether they have completed their tasks in the classroom. In addition, he/she has helped to the participants to complete their tasks if needed. At the end of the day, agendas were collected from the participants.

As a result of OKT, it has been determined that the number of objectives known by the participants was reported between 3 and 10. In other words, the number of unknown objectives was ranged from 2 to 9. When participants were given tasks, their unknown objectives were considered. This means that those with more missing knowledge had more tasks to complete. In Table 3, the agenda of a participant, who doesn't know all three objectives, is given as an example. In Table 3, the first three tasks are related to an objective, while the following three tasks are related to another objective and the last two tasks are related to another one. It is inevitable that the participants with fewer amounts of tasks would finish their tasks earlier. In this case, additional tasks were given to these teacher participants to keep them interested.

Table 3: ***A sample agenda related to the application of optics***

First and Last Name (Student)	**Start Date:**	
Task	**Special Instructions**	**Signature of the teacher showing that the task is completed**
What is the reflection of light? What are the laws of reflection?	Use ore textbook.	
Does light act like waves or particles when it is reflected? Explain with figures.	Use either your textbook or internet.	
Solve 10 problems related to the reflection of light.	Use ore textbook.	
Explain the concepts of full reflection of the light and critical angle by figures.	Use ore textbook.	
Explain the working principle of fiber optic cables briefly.	Search internet.	
Solve 10 problems related to full reflection of the light and critical angle.	Use ore textbook.	
To what quantities the focal lengths of the lens depend on? Describe with necessary connections.	Use ore textbook.	
Solve 5 questions related to the quantities affecting the focal length of the lens.	Use ore textbook.	

After finishing the application related to optics, the tasks related to energy are given to the participants as the second application followed by the tasks related to force and motion are given to the participants as the third application, respectively. In all these practices, the content was differentiated based on pre-knowledge of the participants. Processes and products are the same. Since all participants were subjected to the method of agendas, the process was same for all. The products was not differentiated either in order to reach the same objectives for all the participants.

2.5. Data analysis

The data obtained from this study was analyzed by using SPSS 17 (Statistical Package for the Social Sciences). In the normality analyses of the data distributed, Kolmogrov-Smirnov and Shapiro-Wilk tests were used. Since the number of participants is very few (26 pre-service physics teachers), the values of kurtosis and skewness were also considered. In data analysis, p-value was 0.05 (Field, 2009). Three different tests were applied twice during the research. OKTpre, OKTpost, EKTpre, EKTpost, FMKTpre and FMKT post tests were applied before and after training period of optics, energy and force and motion subjects, respectively. As a result of these multiple-choice tests, the scores of participants were calculated (1 point for each correct answer and 0 point for each incorrect answer). Since these six tests were applied to the

same group, the pair sample t-test was performed to see whether there is a significant difference between pre-tests and post-tests. Maximum and minimum scores of participants were calculated and given at Table 4.

Table 4: ***Max and min scores***

Test	Min scores	Max scores
OKTpre	8	29
OKTpost	15	31
EKTpre	4	16
EKTpost	10	19
FMKTpre	4	22
FMKTpost	14	30

3. FINDINGS

3.1. Findings related to OKT

OKT test was performed with participants in two phases (before and after implementation period) as OKTpre and OKTpost tests, respectively. The total scores of participants and the difference between pre-test and post-test scores have been controlled to see if it is consistent with normal distribution (Table 5).

Table 5: Normality test of OKTpre and OKTpost

	Kolmogorov-Smirnov			Shapiro-Wilk			Skewness		Kurtosis	
	Statistic	df	Sig.	Statistic	df	Sig.	Statistic	Std. Error	Statistic	Std. Error
OKTpre	.14	26	.17	.92	26	.06	.88	.45	1.07	.88
OKTpost	.18	26	.02	.93	26	.10	.30	.45	.79	.88
(OKTpost-OKTpre)	.14	26	.17	.95	26	.35	-.17	.45	-.62	.88

Considering the results of Kolmogorov-Smirnov and Shapio-Wilk tests, and since the value obtained by dividing kurtosis and skewness coefficients into their standard deviations is between -1.96 and +1.96, it can be said that both OKTpre and OKTpost tests are consistent with normal distribution. In addition, the difference between OKTpre and OKTpost tests are also consistent with normal distribution. As a result of these findings, paired sample t-test was performed in order to see whether there is a significant difference between pre-test and post-test results (Table 6).

Table 6: Paired sample t-test for OKT

	Paired Differences			t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean			
OKT	9.07	3.67	.72	12.59	25	.000

3.2. Findings related to EKT

EKT test was performed with participants in two phases (before and after implementation period) as EKTpre and EKTpost tests, respectively. The total scores of participants and the difference between pre-test and post-test scores have been controlled to see if it is consistent with normal distribution. The results of normality test are given in Table 7.

Table 7: Normality test of EKTpre and EKTpost

	Kolmogorov-Smirnov			**Shapiro-Wilk**			**Skewness**		**Kurtosis**	
	Statistic	df	Sig.	Statistic	df	Sig.	Statistic	Std. Error	Statistic	Std. Error
EKTpre	.11	26	.20	.97	26	.85	-.24	.45	-.43	.88
EKTpost	.13	26	.20	.95	26	.23	.03	.45	-1.03	.88
(EKTpost-EKTpre)	.14	26	.19	.96	26	.57	-.19	.45	-.29	.88

According to Table 7, it can be said that the scores of EKTpre and EKTpost tests and difference between these tests are consistent with normal distribution. Paired sample t-test was performed in order to see whether there is a significant difference between pre-test and post-test results. Test results are given in Table 8.

Table 8: Paired sample t-test for EKT

	Paired Differences			**t**	**df**	**Sig. (2-tailed)**
	Mean	Std. Deviation	Std. Error Mean			
EKT	3.42	4.38	.85	3.98	25	.001

Since $p<0.05$, there is a significant difference between the scores of paired sample t-test. This difference is in favor of EKTpost. The average score of EKTpre was 11, whereas it was 14 in EKTpost test. In the light of these findings, it can be said that this application has positive effects on the achievement level of students.

3.3. Findings related to FMKT

FKT test was performed with participants in two phases (before and after implementation period) as FMKTpre and FMKTpost tests before the application related to force and motion subjects, respectively. The total scores of participants and the difference between pre-test and post-test scores have been controlled to see if it is consistent with normal distribution. The results of normality test are given in Table 9.

Table 9: Normality test of FMKTpre and FMKTpost

	Kolmogorov-Smirnov			**Shapiro-Wilk**			**Skewness**		**Kurtosis**	
	Statistic	df	Sig.	Statistic	df	Sig.	Statistic	Std. Error	Statistic	Std. Error
FMKTpre	.13	26	.20	.98	26	.86	.05	.45	.04	.88
FMKTpost	.15	26	.13	.92	26	.05	.80	.45	1.32	.88
(FMKTpost-FMKTpre)	.14	26	.20	.91	26	.03	-.87	.45	.46	.88

In Table 9, since significance values of Kolmogorov-Smirnow and Shapiro-Wilk tests are larger than 0.05, it can be said that the scores obtained from these tests are consistent with normal distribution. The values obtained by dividing kurtosis and skewness coefficients into their standard deviations are between -1.96 and +1.96. According to these findings, paired sample t-test may be performed performed in order to see whether there is a significant difference between pre-test and post-test results. The results of paired sample t-test, which was conducted to see whether there is a significant difference between FMKTpre and FMKTpost tests results, are given in Table 10.

Table 10: Paired sample t-test for FMKT

	Paired Differences			**t**	**Df**	**Sig. (2-tailed)**
	Mean	Std. Deviation	Std. Error Mean			
FMKT	6.88	5.72	1.12	6.12	25	.000

According to Table 10, it can be seen that $p<0.05$, which means that there is a difference in favor of FMKTpost test results. The difference between average score of pre-tests and post-tests is 7. At the end of the implementation period, it can be said that the achievement level of students has been increased.

3.4. Effect Size

A total of three paired sample t test were done at the end of each subject in order to investigate the effect of differentiated instruction to address the p-service physics teachers' missing knowledge related to the subjects of optics, energy, force and motion. The paired t-test can present the difference between two averages compared; however, it doesn't give any idea about the extent of this difference. Therefore, the effect size should also be calculated as

well as statistical significance. The effect size for paired sample t-test can be found by having the ratio of t-value calculated to the square root of the sample size (Green & Salkind, 2005). The effect size of paired sample t-tests performed for all three units is given in Table 11.

Table 11: Effect size for paired sample t tests

	t	N	D
OKT	12.59	26	2.46
EKT	3.98	26	0.78
FMKT	6.12	26	1.20

If the value of effect size is equal to 1, then it is very large, and this effect can be interpreted as large if it is equal to 0.8, moderate if it is 0.5 and small if it is equal to 0.2, respectively (Leech, Barrett, & Morgan, 2008). If these criteria are compared with the values of effect size obtained as a result of the study, it can be said that there is a large effect occurred.

4. CONCLUSION AND COMMENTS

The aim of this study was addressing the pre-service physics teachers' missing knowledge related to the subjects of optics, energy, force and motion by employing the method of agendas, which is one of the differentiated instruction methods. For this purpose, a total of 26 pre-service physics teachers were included in the study for 8 weeks. Before starting the implementation, the tests of OKTpre, EKTpre and FMKTpre were performed. Separate agendas were created for three units (optics, energy, force and motion) for 8 weeks. Special tasks were defined for each students in their agendas based on their pre-knowledge. In this way, the missing knowledge of each pre-service teacher was identified and tasks were defined in this regard. Students worked individually during practices. The pre-tests were performed again by teachers as post-tests two weeks after the completion of the training period. Paired sample t-test was conducted to determine whether there is a significant difference between the tests for these three units. There were significant differences in all three units in favor of post-test results. In addition, the effect size was also significant. This means that the lack of knowledge of the teachers have been largely resolved. Chamberlin and Powers (2010) have applied differentiated instruction in the mathematics course of the university students and determined that the achievements of the students have been increased. In another study, which have similar results with the results of Chamberlin and Powers, conducted by Dinescu, Miron and Barna (2011), it has been concluded that teaching class gas become more effective when they applied the method of differentiated instruction depending on pre-knowledge of students.

According to the results of this study, differentiated instruction can be applied on pre-service teachers in order to address their missing knowledge if it is applied depending on their pre-knowledge related to the course. This is very similar to the relationship between diagnoses and treatment in the field of medicine. Thus, the pre-tests were applied to determined (diagnosed) the teachers' imperfect knowledge and their missing knowledge was resolved by instruction (treatment). The post-tests were performed to evaluate the trainings. Because as it was told in the findings section, there was a significant difference between pre-test and post-test scores. In this way, teacher training institutions will help teachers to gain self-confidence and overcome their weak points related to the course and subjects. According to some studies conducted, imperfect knowledge causes anxiety and lack of confidence in teachers (Westerback, Gonzalez, & Primavera, 1985; Appleton & Kindt, 1999; Watters & Ginns, 1994;

McKinnon, 2010).

From another perspective, the approach of teachers, who were trained with differentiated instruction method, will be different in their professional lives when they encounter different learners. Teacher training institutions should help teachers to gain the necessary knowledge and skills to provide a better education for different learners (Goodnough, 2010). In this regard, it is believed that it is important for teachers to meet differentiated instruction methods.

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Geniş Özet

Normal sınıflarda öğrenciler arasındaki bireysel farklılıklar, genel olarak öğretmenlerin kabul ettiği bir durumdur. Öğrenciler hazırbulunuşluk seviyesi, ilgi, beceri vb. özellikler açısından birbirlerinden çok farklıdır. Ayrıca öğrencilerin öğrenme stilleri de farklılık göstermektedir. Bu kadar birbirinden farklı özelliklere sahip öğrencilere aynı tip bir öğretim ne kadar hitap eder. Her bir öğrencinin kendi kapasitesinin en üst seviyesine ulaşabilmesi için farklılaştırılmış öğretim yaklaşımı geliştirilmiştir. Farklılaştırılmış öğretim, Tomlinson (2001)'a göre, öğrencilerin programın içeriğini keşfetmeleri için, çeşitli yolların kullanıldığı, aktivitelerin ve sürecin öğrencilerin anlamlı öğrenmelerine, kendi bilgi ve fikirlerine ulaşmalarına yönelik yapıldığı ve öğrencilerin öğrendiklerini göstermek ve sergilemek için seçimlerini yapabildikleri bir öğrenme yaşantısıdır.

Her öğrenci farklı yollarla öğrenmesine rağmen kazanacakları temel beceriler ve içerik sabittir. Yani öğrenciler aynı istikamete farklı yollardan giderler (Tomlinson, 1999). Öğretmen içerik, süreç, ürün olmak üzere üç farklı öğede farklılaştırma yapabilir. Bir öğretim sürecinde bunlardan birisi de farklılaştırılabilir, herhangi ikisi veya üçü de farklılaştırılabilir. İçerik, öğretmenin öğretmek istediği bilgiler ve bunu gerçekleştirmek için kullandığı materyallerdir. Süreç, öğrencilerin temel bilgi ve fikirlerini anlamak için ana becerilerini kullanmalarını sağlamak amacıyla tasarlanmış etkinliklerdir. Ürün ise tüm öğrenme çıktılarıdır (Tomlinson, 2014).

Birçok araştırmacıya göre fizik öğretmeni adayları optik, enerji, kuvvet ve hareket konularında bilgi eksikliğine ya da kavram yanılgılarına sahiptirler (Sahin ve Yagbasan 2012, Bayraktar 2009, İngeç 2009, Yalcin, Altun, Turgut, & Aggül, 2009,). Fizik öğretmen adaylarının fakültelerden mezun olmadan ya da göreve başlamadan bu eksikliklerin giderilmesi gerekir. Aksi takdirde öğretmen adayları hizmete başladıklarında öğrencilerine yanlış bilgi aktarır veya olması gerektiği kadar verimli olamazlar. Ayrıca öğretmen adaylarındaki bilgi eksikliği onların öz yeterlilik algılarının da düşük olmasına neden olur (Sarıkaya, 2004). Tüm bunlar göz önünde bulundurulduğunda öğretmen adaylarının eksik bilgilerinin giderilmesi onların başarılı birer öğretmen olabilmesi için önem arz etmektedir. Ama eğitim süresince birçok ders alan fizik öğretmeni adaylarının birçok eksiği olabilir. Her bir adayın birden çok konuda eksik bilgi sahibi olabileceği ve her bir adayın aynı konunun farklı kazanımlarında eksik bilgi sahibi olabileceği düşünülürse bu eksiklikleri gidermek nasıl mümkün olabilir? Sadece bir üniteyi ele aldığımızda, bir grup öğretmen adayının farklı farklı kazanımlarda bilgi eksikliği olması durumunda, bu ünitenin tamamını öğretmen adaylarına anlatmak ciddi vakit kaybı doğuracaktır. Ayrıca, bir öğretmen adayına bildiği kazanımları tekrar anlatmak hem vakit kaybına neden olacaktır hem de öğretmen adayının sıkılmasına neden olacaktır. Bu noktada öğretmen adaylarının bilgi eksikliği açısından bireysel farklılıklarını göz önünde bulundurmalıyız. Her bir aday diğerinden farklı kazanımı bilmiyor ise bu adayların bilgi eksikliklerini gidermek için farklılaştırılmış öğretim kullanmak iyi bir yol olabilir. Öğretmen adaylarının ön bilgileri açısından bir farklılaştırma ile yapılan öğretim, her bir öğretmen adayının eksik bilgilerini tamamlaması sağlanabilir. Bu nedenlerden dolayı bu çalışmada farklılaştırılmış öğretim ile öğretmen adaylarının bilgi eksikliklerinin giderilmesi amaçlanmıştır. Bu amaç doğrultusunda şu problemlere cevap aranmıştır:

Fizik öğretmen adaylarının optik, enerji, kuvvet ve hareket konularındaki eksik bilgileri nelerdir?

Fizik öğretmen adaylarının optik, enerji, kuvvet ve hareket konularındaki eksik bilgilerini gidermek için farklılaştırılmış öğretim etkili midir?

Araştırma fizik eğitimi lisans programında öğrenim görmekte olan 26 (16 kız, 10 erkek) fizik öğretmeni adayı ile gerçekleştirilmiştir. Katılımcıların tamamı beş yıllık öğrenim sürelerinin son yıllarındadır. Araştırma problemine cevap aramak için üç farklı test geliştirilmiştir. Bu testler optik, enerji, kuvvet ve hareket konularıyla ilgili fizik soruları içermektedir. Bu testler örneklemdeki öğretmen adaylarına, uygulamadan önce ve sonra olmak üzere iki kez sorulmuştur. Araştırma tek grup ön test-son test modelindedir. Sorular araştırmacılar tarafından, Türkiye'de liselerdeki fizik müfredatında yer alan kazanımlara göre hazırlanmıştır. Lise fizik müfredatında optik konusu ile ilgili 12 kazanım, enerji konusu ile ilgili 7 kazanım, kuvvet ve hareket konusu ile ilgili 11 kazanım yer almaktadır. Hazırlanan ilk test Optik Bilgi Testi (OKT) olup, bu testte optik konusu ile ilgili 12 kazanıma ait 36 soru vardır. Testte her bir kazanım ile ilişkili üç soru bulunmaktadır. Hazırlanan ikinci test Enerji Bilgi Testi (EKT) olup, bu testte

enerji konusu ile ilgili 7 kazanıma ait 21 soru vardır. Testte her bir kazanım ile ilişkili üç soru bulunmaktadır. Üçüncü test Kuvvet ve Hareket Bilgi Testi (FMKT) olup, bu testte 11 kazanıma ait 33 soru yer almaktadır. Bu testte de diğer testlerdeki gibi her bir kazanım ile ilgili 3 soru yer almaktadır.

Testler uygulamadan önce 26 fizik öğretmeni adayına sorulmuştur. Katılımcılara her bir test için 50 dakika süre verilmiştir. Testlerin analizi şu şekilde yapılmıştır:

•Bir katılımcı bir kazanımla ilgili 3 soruyu da doğru cevaplamış ise katılımcı o kazanımı biliyor kabul edilmiştir.

•Bir katılımcı bir kazanımla ilgili 3 sorudan en az birini cevaplamamış ya da yanlış cevaplamış ise katılımcı o kazanımı bilmiyor kabul edilmiştir.

OKT, EKT ve FMKT testlerinin analizi sonucundan her bir katılımcının, araştırma için seçilen 30 kazanımdan kaçını bilip kaçını bilmediği açığa çıkarılmıştır. Yapılan uygulamada bu veriler kullanılarak her bir katılımcı için bireysel ajanda hazırlanmıştır. Uygulamalar bittikten iki hafta sonra, katılımcılara üç test, post test olarak tekrar uygulanmıştır. Çalışmadan elde edilen veriler SPSS 17 programı ile analiz edilmiştir. Verilerin dağılımının normallik analizinde Kolmogrov-Smirnov ve Shapiro-Wilk testleri kullanılmıştır. Ön testler ile son testler arasında anlamlı farkın olup olmadığını anlamak için bağımlı gruplar t-testi yapılmıştır. Üç ünite için de son test lehine anlamlı bir fark çıkmıştır. Ayrıca etki büyüklüğü de büyük çıkmıştır. Bunun anlamı öğretmen adaylarının bilgi eksiklikleri büyük ölçüde giderilmiştir. Benzer şekilde Chamberlin ve Powers (2010) üniversite öğrencilerinin matematik dersinde farklılaştırılmış öğretim uygulamış ve öğrencilerin matematik başarılarının arttığını belirlemişlerdir. Yine bu araştırmanın sonuçlarıyla paralellik gösteren bir başka çalışmada Dinescu, Miron and Barna, (2011) lise öğrencilerinin öğrenme profillerine göre farklılaştırılmış öğretim uyguladıklarında fizik öğretiminin daha etkili olduğu sonucuna varmışlardır.