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Physics Teacher Candidates' Opinions on Fiber Optics and New Technologies in This Field

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Factors such as innovations brought in by the developing technology, also rapidly changing social structures casted various roles to both the student and the teacher. Therefore, it is necessary to associate such knowledge acquired in courses with implications of the knowledge in our real lives and to constantly enrich course contents, namely to pursue innovations and transfer them into learning environment. The purpose of this study, physics teacher candidates' opinions on fiber optics and new technologies in the field are discussed; it is investigated how much and how new technologies are included in physics courses; teacher candidates' competence in conveying their field knowledge to real life spaces and methods they employ in pursuing scientific developments. Pursuant to qualitative research methods, the study was carried out during a semester in Waves Laboratory. At the end of the study, findings were also discussed.

Keywords: physics teachers candidates, wave laboratory, fiber optics waveguides, effective learning

INTRODUCTION

Regardless of the level of education, it is necessity of modern education that students have desire to question, wonder, investigate and learn new things by themselves, and have proficiency to do so. Therefore, it is no longer sufficient for students to learn merely the related subject. Students should understand why they learn that subject and its relation with other subjects. They should further research the subject, relate it to different subjects and be able to continue learning by themselves. Thus, students will begin to think without memorizing and more creatively. It has become increasingly important that educational concepts are discussed with their actual applications as much as possible to encourage students accordingly. Moreover, in studies where constructivist approach is employed, student model that investigates, worries, questions and actively participates in learning process should be supported. As overemphasized by Physics Course Curriculum of 2007 by Head Council of Education and Morality of the Ministry of

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Education, effectiveness of realistic education has been proven by various studies (MOE, 2007). It is possible to come across with similar studies in Chemistry Education and Physics Education (Gilbert, 2006; Taasoobshiraz, 2008). Approaching course in such sense will also contribute to easier and effective learning by students. Thus, students examine basic concepts that they try to learn, with modern applications and they realize where and how these concepts are employed, thus this both ensures permanence for acquired information and helps students with low motivation in increasing their interest and curiosity in courses. Therefore, the teaching profession today no longer requires solely the act of conveying field information onto students, but also demands monitoring of related innovations on a regular basis and sharing them with students at an appropriate level. Teachers may associate subjects to be taught with current events, and make them more realistic and more effective (Green, 2010). In this case, any people we identify as teacher must be capable of associating his/her field knowledge with innovations in that field and conveying this knowledge to students. Qualifications excepted from teachers have also changed in a way to assist students in learning more easily and permanently (Karacaoğlu, 2008). Especially, considering the fact that developments in science and technology occur quite rapidly, a distinct responsibility falls on our teachers for courses of fundamental sciences such as Physics, Chemistry, Mathematics and Biology (Meric & Tezcan, 2005). Therefore, teacher candidates especially training in areas of fundamental sciences should have increased awareness on this issue. Of course, in this case, it is becoming more important about how much courses are associated with the real life when teacher candidates training in faculties of education acquire field knowledge.

State of the literature

- Factors such as innovations brought in by the developing technology, also rapidly changing social structures casted various roles to both the student and the teacher.
- Also in studies where constructivist approach is employed, student model who investigates, wonders, question and actively participates in learning process should be supported.
- Therefore, it is necessary to associate such knowledge acquired in courses with implications of the knowledge in our lives and to constantly enrich course contents, namely to pursue innovations and transfer them into learning environment.

Contribution of this paper to the literature

- In the study, student awareness towards implementation of waves and optics course in applications in the technology has been increased.
- Conducted laboratory experiment constitutes an example of how concepts in the theory are transferred to application in technology.
- In general, it is emphasized that enriching physics course contents continuously with new applications in technology and supporting laboratory experiments with technology weighted sets as much as possible rather than classical experiment tests will contribute to education of physics teacher candidates.

In this study, subject of fiber optics is discussed as one of the most important applications of basic laws of optics and waves course in technology. The issue of fiber optics is a good example of the point reached in technology departing from basic laws in optics. In this study, physics teacher candidates' opinions on fiber optics and new technologies in the field are discussed; it is investigated how much and how new technologies are included in physics courses; teacher candidates' competence in conveying their field knowledge to real life spaces and methods they employ in pursuing scientific developments. From the point of conceptual framework, brief information related to fiber-optic systems and applications are provided.

Conceptual framework

Fiber technology, we come across in many areas of our lives, and various analysis methods in fiber optics assisting in development of this technology are actually application of the optics subject in our lives (MOE, 2008). The fact that fiber

technology is based on basic optical rules reveals the importance of concepts learned in optics and waves course.

Fiber-optic systems

Societies have to progress regularly in social, economic and scientific areas to maintain their existence. As for rapid development of society, though, transferring and sharing of knowledge are very important. A powerful communication system becomes a must for the ability to get informed instantly about an economic fluctuation occurred anywhere in the world, a new technique introduced in the medicine or a new development in military field and to take necessary measure. Fiber-optic systems have a significant place in communication networks. With applications in various fields, fiber-optic systems show a rapid development. A fiber-optic system operates briefly as such: Electrical signal received by the transmitter is converted into optical signals here. Optic signal generator on the transmitter employs uses optical energy as information carrier. This process is similar to that radio wave source produces electromagnetic energy in radio waves used as information carrier. Optical photodetector on the receiver, on the other hand, receives the optical signal and converts it into electrical signal. Transmission of signals between the transmitter and the receiver is provided by fiber-optic cable, namely by waveguide.

Characteristics of fiber-optic waveguides

Kao (1982) briefly explains them;

1. In terms of temperature, their operating range is very wide. Waveguide can operate between $-250℃$ and$500℃$.
2. Fiber-optic cables can perform information transfer in areas with high electromagnetic field without interacting with the electromagnetic field.
3. During transmission, optical wave-dimensional energy releases occurs. However, these energy releases do not affect radio frequencies.
4. Even if a few fibers cluster together, they do not constitute noise for electronic devices.

Progress of light in fiber-optic medium and mode

In fiber-optics within cylindrical structure, waveguide confines electromagnetic energy within its surface as light and ensures transmission in parallel to its axis (Keiser, 2000). In Figure 1, a fiber waveguide in cylindrical structure is shown.

There are many different structures for waveguides. However, the most common ones among them are structures with cylindrical shape that have certain radius and refractive index (Saleh and Teich, 1991). To enable transmission of wave, refractive index of the inner section should be of higher value than refractive index of the shell (Keiser, 2000). On the outermost layer, there is a protective shell. In principle, in order for light to advance in inner section, there is no need for the shell. However, the shell reduces energy losses as a result of scattering. Furthermore, it provides the fiber with mechanical strength against external influences. The shell protects inner section of the fiber from contamination that may occur on the surface. (These contaminations may result in certain absorptions in the event of contact) The shell area is generally manufactured from glass or plastic material.

Light beams should arrive between the shell and inner section with an angle greater than the critical angle. In this way, the light conducts full reverberation in inner section of the cable and advance towards the axis without refraction (Fig.2). The beam coming from a medium with an n refractive index with θ_0 angle of incidence enters into a medium denser than itself; it begins to advance in the inner section with a smaller θ angle (approaching to normal). When the beam reaches the

boundary surface between inner region and shell region, if it reaches with an angle smaller than the limiting angle, it enters into shell regions with smaller refractive index by pulling away from normal. The beam path shown by dashed lines in Fig.2 describes this process. This is actually an undesirable situation. This is because wave should be transmitted in progressive way, namely by directing to a certain direction. Therefore, while sending beams to the inner region, an incidence angle which will enable beam to reach intersection with an angle greater than the critical angle. Theoretically, this is easy to calculate. Incidence angle can be found by Snell's law if it is known from which refractive index medium to which medium the beam is transmitted or which materials are used (Griffiths, 1996).

Propagation of light through the waveguide represents a cluster of oriented electromagnetic waves which is called mode.

Purpose and importance of the study

In courses such as physics where there are abstract concepts, supporting concepts with contemporary examples is significant in terms of understanding subjects more easily. One objective of this study is to determine how much new technologies are included in physics lessons and opinions of teacher candidates on this issue, and to determine the methods by which physics teacher candidates follow developments occurring in their fields. In this study, fiber optics is discussed which is an important application of basic rules of optics and wave theory in technology. Furthermore, it can be seen as a deficiency that there are not enough studies regarding the place and importance of optics and waves subjects in the field of communication technologies. The study is conducted in Transmission of Sound experiment with Fiber-Optic Waveguide in Waves Laboratory during the period. Another purpose of the study is to determine competence of teacher candidates in conveying core knowledge acquired in waves course to a different field.

Problem status

1. How much are new technologies included in physics courses? What are the opinions of physics teacher candidates on this subject?
2. How do physics teacher candidates follow developments occurring in their fields?
3. What are the opinions of physics teacher candidates about fiber optics and new technologies implemented in this field?
4. What is the level of competence of physics teacher candidates in applying basic knowledge acquired optics and waves courses in the field of fiber optics?

METHOD

The study was conducted in accordance with qualitative research methods. In this context, detailed information about participants, data collection tools and data analysis methods are given below.

Participants

The research is conducted with twelve physics teacher candidates who are attending the department of physical education at a state university (three males, nine females). In order to conform to objectives of the study, participants are selected among teacher candidates who have passed vibration and waves courses successfully, and who are currently taking Wave Laboratory class. The research was conducted throughout the semester with two students in each lesson in Sound Transmission with Fiber-Optic Waveguide experiment.

Data collection tools

The research was conducted in two phases throughout the semester in Wave Laboratory course. In the first phase; at the beginning of semester, an event form consisting of three categories was applied to students. Regarding establishment of categories and category rankings, opinions of two field training experts were taken. Besides, for better clarity of the activity, opinions of two students (except for research participants) were also taken. The activity was applied to students during a lesson time. In the second phase; throughout the semester, while implementing Transmission of Sound with Fiber-Optic Waveguide, B and C categories in the activity form given at the beginning of semester were discussed with groups consisting of two students during face to face interviews and students' opinions were recorded. Furthermore, a source was shown as an example of new technologies in fiber optics, and consequences and importance of new methods suggested in this source were discussed (Çıldır, 2007).

Data analysis

In the first step, evaluation of applied activity forms was conducted. In this context, percentage frequencies of responses given students were calculated and evaluated. Records of semi-structured interviews that were established regarding findings obtained from this phase were used plainly to determine research results.

FINDINGS

In the first part of the study; Findings obtained from analysis of A, B and C categories included in the activity distributed to teacher candidates are provided below:

Category A

In this category, general information related to students was obtained. Accordingly, none of the students failed Vibrations and Waves course, the highest passing grade was found to be A2 (85-89) and the lowest passing grade as D1 (55-59). Thus, all the students who participated in waves laboratory were included in the study.

Category B

In this category, it was found that for the questions of;

1) *Do you agree with idea that enough information is given about modern applications of basic concepts in Physics courses?* %66.6 of physics teacher candidates think that insufficient information is given about modern applications of basic concepts and 33.3% of them are indecisive.

2) *Do you agree that enough information is given in field courses about fiber-optic technology as an application of basic laws of Vibrations and Waves subject?* 50% of physics teacher candidates disagreed or strongly disagreed with the question, 33.3% of them were indecisive, the rest agreed or strongly agreed.

3) *How much technological developments should be included in waves or other technical courses?* 16.7% of physics teacher candidates stated that 100% should be included, 58.3% of them reply as 75%, 16.7% as 50% and 8.4% of them as 25%.

4) *When you start your teaching profession, how much will you consider including technological advances in your lessons?* 16.7% of physics teacher candidates stated that it would be 100%, 75% of them reply as 16.7%, 33.4% as 50% and 16.7% of them as 25%.

5) *Which method do you mainly use to reach developments in science and technology regularly?* 58.3% of physics teacher candidates answered that they use Internet and 33.4% of them as Scientific Journals. One candidate's answer was declared null.

6) *Which source do you use most related to your profession?* 66.7% of physics teacher candidates answered as Books for their main source, 25% of them as lecture notes, and 8.4% of them as Articles.

Category C

In this category, a simple waveguide was shown on Fig.2. The goal was to determine teacher candidates' competence in applying basic concepts of optics and waves on a field such as fiber optics. After defining the Mode, questions were asked about which areas on the waveguide concepts such as waves, progressive wave and damped wave as the basic concepts of Vibrations and Waves course would represent, and they were asked to make comments. Therefore, wave functions were drawn on papers and teacher candidates were asked to only comment about where these wave functions could belong to on fiber cable. Besides, according to mod definition and again as per Figure.2, teacher candidates were asked to comment on refractive indices of mediums. Accordingly:

1) Only 25% of Physics teachers candidates gave the correct order of magnitude of refractive indices for mediums in which wave was progressing, 75% of them gave the wrong answer or gave no answers.

2) For the questions about which parts progressive and damped waves would represent, 41.6% of teacher candidates gave no answers, 16.7% replied in reverse and 41.6 of them gave the right answers.

3) 50% of Physics teacher candidates could not give any examples for application areas of fiber-optic system, and 50% of them gave the example of internet and communication systems.

4) As for the question about what the benefits of fiber-optic systems compared to other systems, 50% of teacher candidates gave the answer of "fast", 8.4% as "durable and cheap", 8.4% as "safe", and 25% of them left the question unanswered or answered as "I do not know".

In the second part of the study; some of student interviews are listed below: (R: Researcher, C: Physics Teacher Candidates).

R: Is enough information is given about new technologies in your courses related the field of Physics?

C1: *This varies based on the course and the instructor. Generally, information is given in general terms.*

C2: *Yes, but there should be more and newer examples. We are tired of hearing certain examples...*

C3: *I think interesting topics should be addressed...*

From interviews conducted, it was revealed that teacher candidates in general found examples discussed in courses as ordinary.

R: Do you think you have enough information regarding Fiber Optics or Fiber Technology?

C1: *Actually, I did not. I've only heard that it was a cable. Now, I know.*

C2: *I did not know very details, never before it was described. I've heard that it was something used in computer networks.*

C3: *For the moment, yes. Now I know where it is used and how it works.*

From the interviews, it was revealed that teacher candidates had more detailed information of fiber technology after the experiment.

R: Do you believe that, when you become teachers, will you contrite to course content with innovations in related field?

C1: *I will contribute. There is already everything on the internet.*

C2: *I will research. Even I discuss the issue with students...*

C3: *As long as I have my computer with me, yes.*

It was determined that almost all the teacher candidates wanted to enrich their course contests with modern applicants. It was revealed that teacher candidates put emphasis on this subject.

R: While preparing for the experiment, have you been able to get related resources on fiber-optic technology?

C1: *I cannot understand much since resources are in English...*

C2: *I could not even prepare fully for the experiment. I only used the experiment sheet and learned a couple of random things from the internet.*

C3: *We cannot find enough Turkish sources. In fact, it could be better to mention such issues.*

We have revealed that there is an ongoing Turkish resource shortage in this field.

As for examples of new methods in fiber optics, Mapped Galerkin Method and importance of this method in application were discoursed. Application of this method in fiber systems and its results were given. In addition, the computer program which provides a solution for solving with this method was emphasized (Çıldır, 2007). Interviews were not in the form of oral interviews for the laboratory experiment, they were mainly conducted in a way to inform students related to analysis methods in fiber optics and to receive students' opinion on the method in question. Since students express their thoughts verbally without concern for oral examination, findings became more reliable. Students' opinions on this method are given below:

R: You have learned wave equitation in Vibrations and Waves course. Can you interpret the structure of the waveguide from the wave equation given to you? (Çıldır, 2007)

$$\frac{\partial^2 E_z}{\partial r^2}+\frac{1}{r}\frac{\partial E_z}{\partial r}+\frac{1}{r^2}\frac{\partial^2 E_z}{\partial \phi^2}+q^2E_z=0$$

C1: *There are angles in the equation. There is radius. Then these are cylindrical coordinates.*

C2: *I think it is spherical or cylindrical...there is angle.*

C3: *I cannot say exactly anything...*

R: Can you calculate eigenvalues in the following matrix equation by means of methods you learned before? (Çıldır, 2007)

$$\begin{bmatrix} A^{yy} & A^{yx} \\ A^{xy} & A^{xx} \end{bmatrix}\begin{bmatrix} C^{y} \\ C^{x} \end{bmatrix}=\beta^2\begin{bmatrix} C^{y} \\ C^{x} \end{bmatrix}$$

C1: *We can acquire the result by means of mapping methods you told us earlier.*

C2: *I cannot solve. It seems difficult?*

C3: *I can try the program you have mentioned.*

R: Do you think there are advantages using this method in solving wave equitation in fiber waveguides?

C1: *More practical. But without the PC, it still cannot be solved.*

C2: *Easy, but I cannot write a computer program.*

C3: *After all, more reliable operation has error possibility.*

CONCLUSION AND RECOMMENDATIONS

According to results obtained from findings, 66% of physics teacher candidates stated that in waves course, information on current applications were provided. The results retrieved from interviews in general; can be grouped into two as current sampling in the courses depends on the course and training supervisor, and know samples are given in courses. In these interviews, students stated that they expected more interesting examples in physics courses. In this case, following technological developments in these courses will also bring along more active participation of students in the learning process. As stated by Wieman and Perkins in their work, we should involve rapidly changing technology to physics courses. In this way, more interesting current examples will take place of routine examples.

It was revealed that teacher candidates prefer using the Internet more for following scientific developments and secondly scientific journals. Regarding field course, teacher candidates mainly prefer books and then lecture notes. Only one student was found to read the article. In interviews, students stated that source books suggested by the instructor in notation with lecture notes facilitated their learning experience.

All teacher candidates are willing to include certain amount of technological developments in their career. Most teacher candidates stated that they would research on the internet for their courses and follow the latest developments. One candidate stated that it would be possible to discuss technological developments with students by giving them assignments. In interviews, it was revealed that teacher candidates placed emphasis on this issue. In this case, teachers should be assisted more on this subject, and their awareness about more reliable resources than internet should be increased and regular usage of these resource should be encouraged.

50% of teacher candidates stated that fiber optics subject was not mentioned in the Waves course. Interviews also support this fact. Most students know fiber-optic as a cable, a few students associate it with internet networks and computers. Students could not establish the relationship between information transmission with fiber-optic and optic and electromagnetic wave. However, the end of the experiment, they were able to make such associations.

According to findings in C category conducted with a view to determined teacher candidates' competence in implementing the basic concepts in different subjects, the majority of teachers could not line up refractive indices of mediums correctly. In interviews conducted with students, it was revealed that they could make the definition of full reflection law but could not consider in on the shape. Teacher candidates failed in applying their knowledge in a different field and they acted by rote. Similarly, even though they were later able to express progressive and damped waves, they could not think of it on fiber cable. Although students knew the definition of Mode, they could not associate it with progressive wave graphic. In this case, we can say that effective learning does not take place. In such cases where information is not internalized, student experience difficulty in using their acquired knowledge in their daily lives and business fields (Basaran, 2004). At the end of the experiment, when these graphics were handled again, they all managed to give meaningful answers. In this context, we can say that Transmission of Sound with Fiber-Optic Waveguide experiment is informative for physics teacher candidates in this field. Furthermore, teacher candidates find new analysis method in fiber optics more reliable and practical, but they state that the included software is too difficult for students to prepare by them.

Another consequence obtained from findings is that the students find the number of Turkish sources about fiber optics insufficient. In this sense, students can benefit from the internet more. In this case, they are advised to read especially abstracts of Turkish thesis and articles in Turkish. Difficulties in this area can be solved by adding sections about Optics and Waves for new books to be published in Turkish.

In conclusion, teacher candidates have failed in conveying basic concepts of optics and waves to information transmission with fiber-optic cable as one of applications in technology. Our expectation in an effective learning is not only to know the definitions and rules solely, but also to convey these definitions and rules in different application fields. In this sense, we can infer that transmission of sound with fiber-optic experiment is highly effective in eliminating this detected deficiency in teacher candidates. However, enriching physics course contents continuously with new applications in technology and supporting laboratory experiments with technology weighted sets as much as possible rather than classical experiment tests will contribute to education of physics teacher candidates.

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