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The Turkish Physics Teachers' Views of the 'Radiation' Subject in the Current Textbooks

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ABSTRACT

Radiation has become an important issue due to an increase in human-made radiation sources and a rapid improvement in technology. The aim of this study is to elicit the Turkish physics teachers' views of the 'radiation' subject in the current textbooks. To collect data, semi-structured interviews were conducted with twelve teachers working in different high schools. The data were presented using tables with quatotions. The findings showed that the teachers were mostly familiar with the 'radiation' subject in the textbooks. They stated that the curriculum insufficiently involved the 'radiation' subject. Further, they addressed that the textbooks minimally referred to the subject since the university entrance examination does not cover the radiation-related questions. Teachers also depicted that they had limited subject matter knowledge of radiation and found it difficult for teaching their students. Moreover, they thought that integrating more radiation subjects into the current textbooks would be beneficial for them and their students. The current study suggests that the scope of the 'radiation' subject in the textbooks should be extended. Furthermore, a new physics curriculum ought to be interactively developed by the help of the teachers.

Keyworlds: Radiation, textbooks, Turkish physics teachers, views.

INTRODUCTION

A rapid development in science calls for an updated curriculum that keeps up with technology at all educational levels. The qualified education highly depends on the applied curriculum (Erden, 1998). Any curriculum is reviewed and revised to meet the needs/demands of advancements in the globalized world. Hence, many studies have purposed to improve the quality of education. These studies have mostly focused on curriculum development, possible

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opportunities for schools to effectively manage these curricula and appropriate teaching methods (Aydın, 2004; Millar & Gill 1996; Neumann & Hopf, 2012; Millar, Klaassen & Eijkelhof, 1990; Rego & Perelta, 2006).

Because teachers have a pivotal role in carrying out educational and instructional activities, teacher-student interactions are very important in school learning (Ahmed, Shaharim & Abdullah, 2017). That is, their duties and responsibilities cover not only to teach, but also follow guidance and current situations (Özer &Gelen, 2008). Teachers should be aware of the issues in the curriculum (Öner, 2010). Although the school curriculum is well-prepared, it needs to be correctly implemented by teachers. A triangulation amongst student, teacher and curriculum is crucial to achive the goals of any science curriculum (i.e., the nature of science, conceptual understanding and inquirying new knowledge) (Aydın, 2004).

Radiation has naturally been available everywhere since the creation of the Earth. Natural radiation occurs without any anthropogenic contribution and emits from the atmosphere and inner structure of the earth to its surface. Artificial radiation, which is anthropogenic, is used in many sectors (medicine, industry, agriculture, etc.). After the disasters 'Chernobyl and Fukushima Daiichi', interest in radiation has greatly increased in mass media and society. Also, radiation acts as a significant agenda in that it may negatively affect human health. These issues increases need to learn accurate knowledge about radiation day by day.Students can learn the 'radiation' subject in two ways (formal education in schools and informal education in mass media, e.g., television, internet, newspapers)(Colclough, Lock & Soares, 2010; Cooper, Yeo, & Zadnik 2003; Lucas, 1987). Of course, formal education is more reliable to obtain accurate and effective knowledge. Tada (1999) stated that the scientific definition of radiation was important for schools in formal education. In addition, teachers have great responsibilities for formal education. In fact, how to instruct radiation is a common problem in many countries. As seen from Table 1, some researches from different countries have challenged radiation education. For instance; Pilakouta (2011) reported that Greek science curricula had difficulties in explaining the subject of radiation. In Russia, government prepared textbooks related to radiation education after the Chernobyl disaster and organized seminars for teachers. Fukushima Daiichi nuclear disaster has increased radiation education in Japan even though it has been done for many years (Tsubokura, Kitamura&Yoshida, 2018).

Table 1. *Some researches challenging radiation education in different countries.*

Countries	Researches
Portugal	Rego and Peralta (2006). Portuguese students' knowledge of radiation physics *Physics Education*, 41(3), 259.
Russia and Japan	Tsubokura, M., Kitamura, and Yoshida, M.(2018) Post-Fukushima radiation education for Japanese high school students in affected areas and its positive effects on their radiation literacy. *Journal of Radiation Research*, 59(2), 65-74.
England	Millar, R., & Gill, J. S. (1996). School students' understanding of processes involving radioactive substances and ionizing radiation. *Physics Education*, *31*(1), 27-33.
Greece	Pilakouta, M. (2011). *TEI Piraeus students' knowledge on the beneficial applications of nuclear physics.* Paper presented at the International Scientific Conference, The Conference for the contribution of Information Technology to Science, Economy, Society and Education, Piraeus-, Greece.
Australia	Cooper, S., Yeo, S., and Zadnik, M., (2003). Australian students' views on nuclear issues: Does teaching alter prior beliefs. *Physics Education, 38* (2), 123-129

Mork (2008) who, examined the learning processes of radiation in schools, found that the ‘radiation’ subject was firstly introduced with atom, nucleons, half-life, alpha, beta and gamma radiation, activity, nuclear fission, and nuclear fusion. As a result, such a very complex structure makes it difficult for children. Several studies of radiation and radioactivity have suggested that students have difficulties at understanding these issues and hold many misconceptions (Eijkelhof, 1996; Henriksen & Jorde, 2001; Ince, Sesen & Kirbaslar, 2012; Nakiboğlu & Tekin, 2006; Prather, 2005). Millar, Klaassen and Eijkelhof (1990) found that students had pitfalls at differentiating radiation and radioactivity from each other. Millar and Gill (1996) addressed that students could not distinguish radiation transmission nor understand how radiation is absorbed. Rego and Perelta (2006) revealed that most students did not know natural radiation. They also implied that the subjects ‘radiation types, ionizing radiation and non-ionizing radiation’ were unknown issues.

Yalçın and Kılıç (2005) and Morgül, Yılmaz and Uludağ (2004) concluded that there was not enough time for learning radiation and its importance in schools. They also emphasized that majority of the society including students and teachers did not have a sound understanding of radiation. Tortop et al. (2009) believed that research-based radiation education could improve radiation literacy at secondary and high schools. Molu, Kahyaoğlu and Köksal (2016) offered to use a variety of instructional/conceptual models to explain the ‘radioactivity’ subject.

The related literature indicates that very few studies have involved physics teachers' views of the ‘radiation’ subject in the textbooks. The aim of this study is to elicit the Turkish physics teachers’ views of the ‘radiation’ subject in the current textbooks. Hence, given the teachers’ views, the ‘radiation’ subject may be enriched for the existing physics/science curricula.

The following research questions guided the current study.

1. What doTurkish physics teachers think about the ‘radiation’ subject in the current textbooks?
2. What are the physics teachers’ views of the ‘radiation’ subject in the curriculum?
3. Does physics teachers think it is difficult to explain the subject of 'radiation' to students?

METHODS

In view of Patton (2002), this study conducted semi-structured interviews with physics teachers, who accepted the interview form prepared by the researchers. A group of experts (three physics educators) checked the interview questions. Further, the researchers validated their findinds with quotes from the interview sessions (Altunisik, Coskun, Bayraktaroglu, & Yildirim, 2005).

The interview form included two parts on demographic information (gender, age, type of school where teachers work, experience, postgraduate education status) and the ‘radiation’ subject. The interview form comprised of 3 open-ended questions and follow-up ones if necessary. The research group consisted of 12 physics teachers working at different schools (i.e., Science High School, Anatolian High School, Anatolian Teacher High School, Girls High School, and Vocational High School). The interviewees were chosen in regard to gender, age, work experience and school type. Hence, the maximum diversity method was followed for purposive sampling method (Yıldırım & Şimşek, 2008). Interview records were transcribed in verbatim to implement descriptive analysis method (Miles, & Huberman, 1994; Patton, 2002; Robson, 2001). Because of ethical issues, the teachers’ names were coded by enumerating.

As shown in Table 2, the teachers were coded as ' T1-T12'.6 females (F) and 6 males (M) , who held PhD (one teacher), master degree (six teachers) and bachelor degree (five teachers), participated in the study. Their average age was 37.25 years, while their average professional experience was 13.16 years.

Table 2. *The interviewees' demographic features of gender, age, school type, work experience, and postgraduate education status*

Teachers	Gender	Age	School type	Work experiance	Postgraduateeducation status
T1	M	36	Science High School	14 years	PhD
T2	M	43	Science High School	21 years	Master
T3	F	46	Anatolian High School	24 years	-
T4	M	32	Anatolian High School	6 years	Master
T5	F	37	Anatolian Teacher High School	10 years	-
T6	M	42	Anatolian Teacher High School	17 years	Master
T7	F	28	Anatolian Teacher High School	5 years	-
T8	F	29	Girls High School	2 years	Master
T9	M	41	Girls High School	18 years	-
T10	F	48	Girls High School	25 years	Master
T11	F	26	Vocational High School	3 years	-
T12	E	39	Vocational High School	13 years	Master

FINDINGS

Three open-ended interview questions were asked to the physics teachers:

1. '*Have you ever come across the 'radiation' subject in the textbooks?*'
2. *'Do you think that the 'radiation' subject is sufficiently involved in the curriculum?'*
3. '*Do you think the 'radiation' subject is difficult to teach?'*

If necessary, the researchers asked follow-up questions to elaborate their views.

Their responses to these interview questions are presented in Tables 3-5.

Table 3. *Their responses to the first principal interview question*

Responses	Teacher Codes
Yes, the 'radioactivity' subject in the 12th-grade textbook covers it.	T2,T3,T5,T8,
Yes the 11th-grade textbook and some reading parts embrace it.	T4,T6,T7,T11
Yes, I've come across the radiation in the 11th and 12th grade textbooks.	T1,T9
No, I haven't seen the radiation title in the textbooks.	T10,T12

As seen from Table 3, ten teachers answered *yes,* whilst only two teachers responded *no.*

Table 4. *Their responses to the second principal interview question*

Responses	Teacher Codes
Yes, I think that the 'radiation' subject is sufficiently involved in the curriculum	T1,T6
No, the 'radiation' subject is insufficiently involved in the curriculum	T2-T5, T7-T12

As observed in Table 4, only two teachers said that the 'radiation' subject was sufficiently involved in the curriculum. Ten teachers implied that the 'radiation' subject was insufficiently involved.

Table 5. *Their responses to the third principal interview question*

Responses	Teacher Codes
Yes, it is difficult to teach	T1-T12

As seen from Table 4, all teachers stated that the 'radiation' subject was difficult to teach.

Some quotations are as follows:

Interviewer: *"...Have you ever come across the 'radiation' subject in the textbooks?"*

Teacher 1: *"...Yes, I encountered it at 11th and 12nd textbooks."*

Interviewer: *"...Do you think that the 'radiation' subject is sufficiently involved in the curriculum?"*

Teacher 1: *"...Yes, I think it's enough."*

Interviewer: *"...Can you explain your reason(s)?"*

Teacher 1: *"...All physics subjects is already divided into very few sections. Until the end of the semester, we are having difficulty finishing important issues.I think enough. In fact, many new topics have been added into the curriculum after any change in physics curriculum. Now, the use of radiation is explained by reading texts."*

Interviewer: *"...Do you think the 'radiation' subject is difficult to teach? "*

Teacher 1: *"...Yes, I think so. In fact, it is difficult to explain most of the physics subjects to the students. The 'radiation' subject is also one of them. Of course, the teacher has a milestone to explain the 'radiation' subject. If the teacher explains the subject with the current examples, the student will understand better.*

Interviewer: *"...Have you ever come across the 'radiation' subject in the textbooks?"*

Teacher 6: *"...Yes, I came across it at a reading text in the 11th grade."*

Interviewer:: *"...Do you think that the 'radiation' subject is sufficiently involved in the curriculum?"*

Teacher 6: *"...No. The 'radiation' subject should be extensively handled within the textbooks. Students do not know much information about radiation. They do not know its benefits and damages. In fact, teachers do not know much about the 'radiation' subject too. Radiation is actually of interest in chemistry curriculum, not in the physics subjects. Since University Entrance Examination does not include any question about the 'radiation' subject, I think much attention to the 'radiation' subject is not given.*

Interviewer: *"...Do you think the 'radiation' subject is difficult to teach?"*

Teacher 6: *"...Yes. It is necessary to know the subject in order to explain it well. Therefore, radiation is not a well-known subject. It is difficult to teach.*

Interviewer: *"...Have you ever come across the 'radiation' subject in the textbooks?"*

Teacher 12: *"...No, I have not seen the radiation title in textbooks."*

Interviewer: *"...Do you think that the 'radiation' subject is sufficiently involved in the curriculum?"*

Teacher 12: *"...No, not enough. If the 'radiation' subject had been sufficiently included in the textbooks, I would have already remembered its details. It may be mentioned in very few sub-headings. Of course, there is a need to include the 'radiation' subject into the physics curriculum because we are constantly exposed to radiation, e.g., computer or mobile phones. For example, although I am a teacher, I do not know much knowledge about radiation."*

Interviewer: *"...Do you think the the 'radiation' subject is difficult to teach? "*

Teacher 12: *"...Yes. It is always difficult to describe abstract concepts.*

DISCUSSION and CONCLUSIONS

The present study found that majority of the physics teachers encountered the *'radiation'* subject in the current textbooks. Only two physics teachers stated that they could not recall a radiation topic in the current textbooks. The teachers generally stated that the *'radiation'* subject was insufficiently included in the textbooks. This is consistent with Yalçın and Kılıç's (2005) result of the Turkish textbooks. Rego and Perelta (2006) depicted that the Portuguese secondary school curriculum embraced very few information/knowledge about the *'radiation'* subject. They also implied that teachers had difficulties in explaining the *'radiation'* subject. These difficulties in learning and teaching radiation may stem from its abstract features (Usta, 2011; Pratner 2005; Hefele, 2011). As a matter of fact, all teachers found the *'radiation'* subject difficult to teach to the students. Similary, Rego and Perelta (2006) determined that the *'radiation'* subject was one of the difficult subjects to teach to the students.

This study indicated that the teachers did not have much knowledge about radiation. This finding is a parallel to the findings of earlier studies. Colclough, Lock, and Soares (2010) found the teachers' knowledge of radiation and radioactivity insufficient. Eijkelhof, Kortland and Loo (1984) addressed that teachers needed teaching tools/methods if they were forced to explain the 'radiation' subject. Fukutoku (2010) stated that teachers had insufficient radiation literacy and difficulties in understanding and explaining the 'radiation' subject. Libarkin, Asghar, Crockett andSadler (2011) revealed that many teachers did not understand the 'radiation' subject. Balta (2018) reported that the high school physics teachers did not have strong subject-matter knowledge of the 'radiation' topic. Morgül, Yılmaz and Uludağ (2004) implied that teachers could not talk more about radiation in their lessons. Nishina (1999) argued that teachers working in primary and secondary schools needed to be supported about radiation education.

This study indicated that a lack of any question in the university entrance examination restricted to sufficiently include the 'radiation' subject in the physics curriculum. Similarly, Yalçın and Kılıç (2005) and Taşaoğlu and Bakaç (2011) determined that the textbooks did not contain much more information about the 'radiation' subject since it was not handled within the university entrance examination. Taşoğlu, Ateş and Bakaç (2015) suggested that pre-service physics teachers would need new teaching and information processes to provide more useful learning environments about radiation and radioactivity.

People are constantly exposed to radiation and its positive/negative aspects in their daily lives. Such subjects as the definition and use of radiation, its effects, andthe protection ways from its harmful effects should be presented in the existing physics/science curricula. Indeed, how to teach the importance of radiation education in the schools has been discussed over years (Tsubokura, Kitamura & Yoshida, 2018).

Teachers hesitate to discuss and handle any subject if they have limited or incomplete subject matter knowledge. For this reason, an abstract subject like radiation should firstly be conceptualized at the textbooks, which are an important guide for the teachers. Future studies should unveil subject-specific teachers' (i.e., physics teachers, science teachers, biology teachers and chemistry teachers) views of this subject and compare them with each other .

Finally, the 'radiation' subject , which constantly and inevitably appears in our lives, has increased its own importance and coverage in the school textbooks. Teachers should pay more attention to the radiation subject in their lessons. In-service radiation education should be well-organized and well planned for phsyics teachers. New learning models for radiation education are supposed to be developed and tested. Rather than radiation disasters-based education, fundamental radiation concepts, effect(s) of radiation, types of radiation and protection methods from radiation should be prioritized. The current study recommends that further studies focus on evidence-based radiation researches by taking teachers' views into account.

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