Radiation knowledge and awareness: Evaluation from the perspective of high school students

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Abstract. This study aimed to determine the knowledge and awareness levels of students studying in the 12th grade of secondary education about the concept of radiation. In line with the purpose of the study, the phenomenological approach, one of the qualitative research methods, was used. The study participants comprised 28 students who studied the subject of 'Introduction to Atomic Physics and Radioactivity' in the 12th-grade curriculum of secondary physics courses in secondary education institutions affiliated with the Ministry of National Education in the 2023-2024 academic year. The study used seven open-ended questions developed by the researchers as data collection tools. The data obtained from the interviews were subjected to content analysis. As a result of the research, it was determined that the students defined radiation as a harmful ray at most. At the same time, it was determined that the students primarily associated radiation with electronic devices and thought radiation could be transmitted from human to human. Considering the data obtained, it was concluded that the students had incomplete and erroneous information about radiation; therefore, their awareness of radiation was not high.

1 Introduction

Radiation, in the most basic sense, is defined as 'energy traveling from its source in a material or space environment'. The excess energy carried in the form of fast particles and electromagnetic waves released by natural or artificial radioactive nuclei to pass into a stable structure is called 'radiation'. Radiation, in more general terms, occurs through the disintegration of radioactive atomic nuclei and the emission of alpha (α), beta (β), and gamma (γ) rays to the environment while transforming into a new atomic nucleus. This energy, emitted by energy packages called waves, particles, or photons, is always considered a phenomenon that exists in nature and that we live with [1].

In 1896, Wilhelm Röntgen's discovery of X-rays and in 1896, Henri Becquerel's discovery that uranium salt emits invisible rays, radiation has become a part of our daily life with its use in medicine, communication, and industry, which has become increasingly widespread until today [2]. Especially the rapid increase in the use of communication tools

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has increased the possibility of people being exposed to radiation. As a result of these developments, the adverse effects of electromagnetic field-generating devices on human health have started to be discussed [3]. While we benefit from radiation in almost every field, from agriculture to the health sector, communication to energy resources, it should be realized that there will be harm when used more than necessary. Because there is a reaction against radioactivity in a large part of society along with health concerns. For these discussions to be healthy and obtain positive results, it is thought that individuals should have sufficient knowledge about radiation and be able to distinguish its benefits and harms [4]. In this context, since it is known that the world population continues to increase rapidly, it comes to mind that these measures should be taken by states to ensure economic and social development. With sustainable development, it is necessary to meet the needs of today and to shape the country's policies with an understanding that considers the needs of future generations. The concept of need here refers to very basic needs such as food, drink, and shelter, as well as situations such as the provision of health services and social security, and sometimes goods such as cars, dishwashers and televisions. To make these needs affordable for all the people of the world, World Leaders have agreed on 17 Global Goals (https://www.kureselamaclar.org/) to end extreme poverty, combat inequality and injustice, and address climate change by 2030 [5]. At this point, radiation comes to the agenda within the technological and scientific developments experienced worldwide, especially in the need for health and safety. Because we live in a world where radiation is naturally present everywhere. For example, light and heat from nuclear reactions in the sun are necessary for our existence. People are constantly exposed to natural radiation from the sun and space. There are radioactive substances in the structures that make up the earth's crust, in food, in the water we drink, and even in the air we breathe. In short, all life on Earth has developed in the presence of radiation [6]. In addition to these, people are exposed to radiation by self-made radiation sources other than natural radiation sources [7]. There are still many debates about the existence and effects of radiation, both in nuclear energy and in the use of technological devices in daily life. In this context, acquiring the correct concepts and facts about the concept of radiation, which we are exposed to every moment in daily life, seems to be very important for ensuring socially conscious development [8].

In the 2018 secondary physics curriculum, the subject of radiation is included under the title of 'Introduction to Atomic Physics and Radioactivity'. Students who complete this unit are expected to be able to explain the effects of radiation on living things. Under this title, it was aimed to share the concepts and facts about radiation sources in living spaces, ways of protection from radiation, and radiation safety. In addition, ionizing radiation is mentioned and the areas where it is used, and its biological effects are mentioned [9]. At this point, the knowledge and awareness levels of the students who have learned the subject of radiation are of interest in the current situation with the place of sustainable development goals on the agenda. Because, when the literature is examined, it is emphasized that students have many wrong or incomplete information about radiation [10-12]. For example, [13], one of these studies, conducted research on students' understanding of radioactivity, radiation, and radiation risk. He found that most of the students could not distinguish between the sources of ionizing radiation and other environmental hazards and that nuclear power plants and submarines were the most feared sources of radiation. In this context, this study was carried out with the idea that students who will shape the future should gain environmental awareness from primary school years and that their ability to correctly understand and discuss the issues/concepts that concern their daily lives will constitute one of the cornerstones of social development and progress. From this point of view, the study aimed to determine the level of knowledge and awareness of 12th grade secondary school students about the concept of radiation. For this purpose, answers to the following questions were sought:

Which properties of radiation do the students define radiation by focusing on?

What are the awareness of the students about the indicators of radiation, its spread, the population it affects, and the ways of protection from radiation?

2 Method

2.1 Research design

In this study, since it was aimed to determine the knowledge and awareness levels of high school students about the concept of radiation, the phenomenological approach, one of the qualitative research methods, was used. Because in the study, it was aimed to determine students' knowledge and awareness of the concept of radiation within the framework of experiences [14].

2.2 Study group

The research was conducted in 2023-2024 and the participants in the research were determined by the criterion sampling technique of the purposeful sampling method [14]. In this context, interviews were conducted with 28 students who had studied the subject of 'Introduction to Atomic Physics and Radioactivity' in the 12th-grade curriculum of secondary physics courses in secondary education institutions affiliated with the Ministry of National Education in the 2023-2024 academic year.

2.3 Data collection tool and application

The researchers developed seven open-ended questions in the study to examine the student's knowledge and awareness of radiation. The first draft of the interview questions was prepared by reviewing the literature. Three field experts (with a doctorate in physics education) were consulted for the questions, and the questions were rearranged and finalized in line with the feedback.

Interviews were conducted face-to-face and outside of class hours within the principle of volunteerism. Each interview lasted approximately 10-15 minutes. The researchers noted the answers of the participants during the interviews. All students and parents were informed about the study before the study and the necessary consent forms were signed.

2.4 Data analysis

The data obtained from the interviews were subjected to content analysis. MAXQDA 24 program was used in content analysis.

The data were analyzed by inductive analysis technique. With content analysis, it is aimed to bring together similar codes within the framework of specific categories and to interpret them by organizing them in a way that readers can understand [15]. The analyses were carried out within the framework of the research questions, and seven categories were formed. The frequencies of the codes within each category are stated in detail. To ensure coding reliability in the data coding process, the data were coded separately by another researcher and the codes were compared. The reliability of the research was calculated using [16] formula by determining the number of 'agreement' and 'disagreement' for each code made by both researchers. The reliability of the research was found to be 90%. The percentage of agreement between the experts regarding the coding of the interview data being 70% and above is considered sufficient in terms of the reliability of the data analysis [15]. For disagreements, the researchers came together to discuss the relevant code and category

and reached a consensus with the support of literature. The process continued until the agreement between the researchers was 100%.

3 Findings

The study aimed to determine high school students' knowledge and awareness of radiation.

For this purpose, the students' responses were expressed under seven categories within the framework of the questions. These categories and codes under the categories are explained in detail below.

3.1 Category 1: Definition of radiation

Radiation was defined mainly by the students as a harmful ray (11), a form of energy (5), and an electromagnetic wave (5). At the same time, students expressed radiation as a radioactive substance (4) and a disruption in the atomic structure (2).

It is revealed that the students see radiation as a type of energy released due to the disintegration of the atom and harms living health.

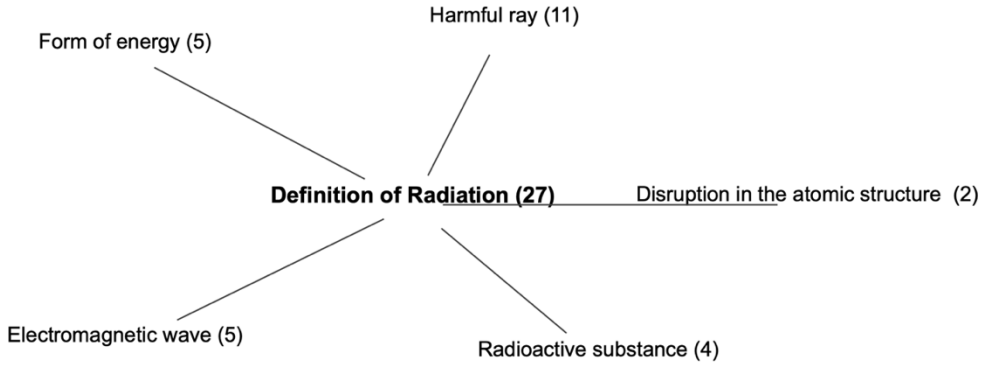

Fig. 1. Student expressions related to the definition of radiation.

3.2 Category 2: Concepts connoting radiation

Among the concepts evoking radiation, students used the expression electronic devices (17) the most. This concept is followed by mutation (8).

These concepts expressed by the students represent various radiation sources and effects and traces from daily life.

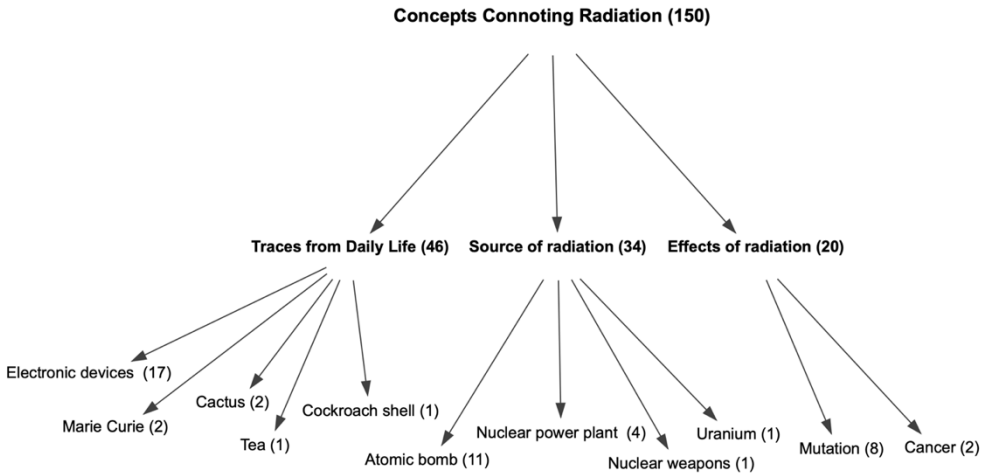

Fig. 2. Student expressions related to the concepts connoting radiation.

3.3 Category 3: Propagation of radiation

In the study, it was determined that students thought that radiation was emitted from various electronic devices (14), disruptions in the atomic structure (8), nuclear energy sources (5) and sun rays (3).

It was determined that the students mostly thought that radiation emission increased with the use of electronic devices and the use of X-ray generating devices increased with the disruption of the atomic structure of matter.

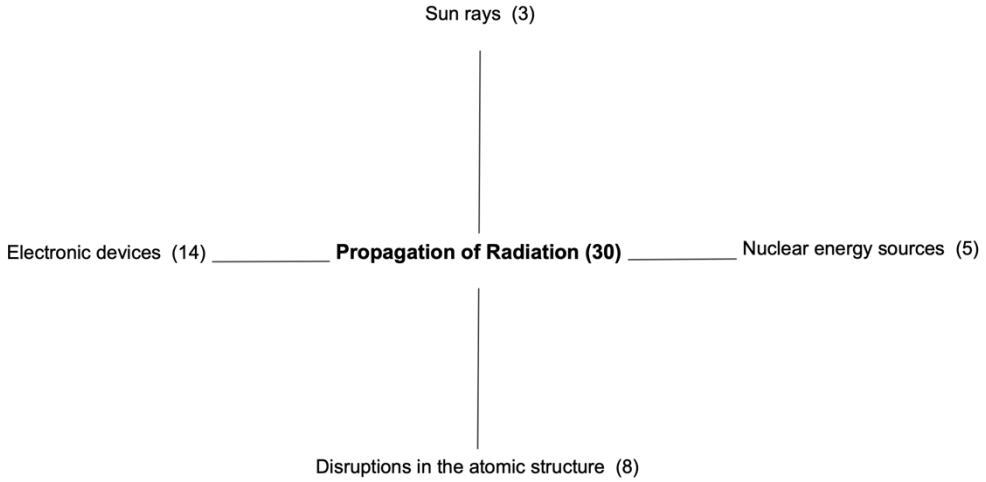

Fig. 3. Student expressions related to the propagation of radiation.

3.4 Category 4: Signaling the presence of radiation in an environment

Students stated that they could recognize the presence of radiation in an environment mainly through the radiation detector indicator (14). They also noted that environmental radiation would cause physical symptoms (9). As a result of radiation exposure, they said that people most often experience headaches (6).

It is concluded from the student statements that the presence of radiation cannot be understood with the naked eye. Therefore, it is essential to measure radiation and take necessary precautions.

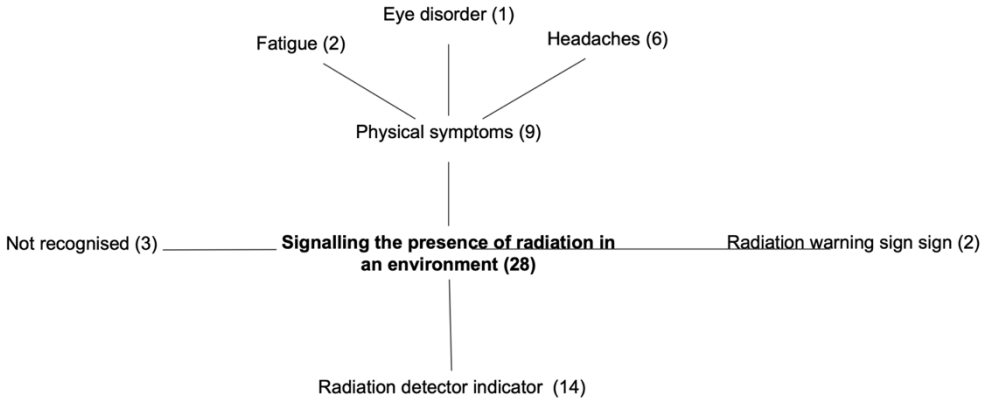

Fig. 4. Student expressions about the sign of the presence of radiation in an environment.

3.5 Category 5: Human-to-human transmission of radiation

Students thought that radiation is transmitted from person to person (17). The idea that people exposed to radiation can transfer radiation to other people came to the fore.

In addition, the number of students who thought radiation was not transmitted from person to person (11) was not less.

3.6 Category 6: Age group most affected by radiation

The study determined that students thought that children (9) were most affected by radiation. Following this age group, students believed that the elderly (8), 0-18 age group (8), and infants (5) were affected.

These students' statements reveal that individuals in other age groups, except infants, are thought to be affected more.

Fig. 5. Student statements about the age group most affected by radiation.

3.7 Category 7: Radiation protection methods

The study determined that the students thought distance control (14) should be provided the most to protect them from radiation.

In addition, it was determined that the students included the expressions of unique protection clothes (8) and lead (4). In addition, students stated that applying sunscreen (2), using plants such as cactus (2), and using steel (1) are some of the effective methods.

At this point, it is revealed that the most effective method to protect from radiation is distance control.

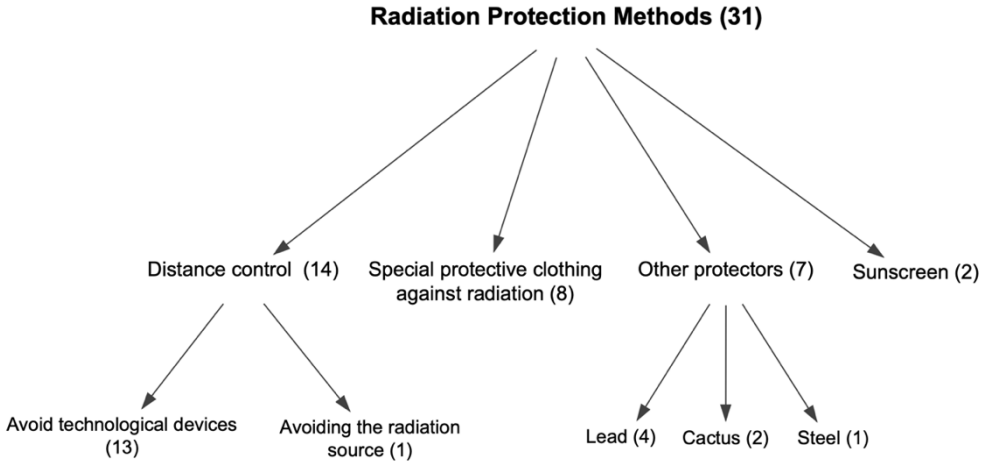

Fig. 6. Student statements about radiation protection methods.

4 Discussion, conclusion and suggestions

This study tried to determine the level of knowledge of high school students about the concept of radiation and their awareness of the source, existence indicator, propagation, effects, and radiation protection methods.

Firstly, when the students' statements about the definition of radiation were analyzed, it was concluded that they primarily defined radiation as a harmful ray. In addition, it was also observed that some students defined radiation as a form of energy, an electromagnetic wave, a radioactive substance, and a disruption in the atomic structure. When the definition of radiation given in the textbook provided by the Ministry of National Education for 12th grades is examined, it is seen that 'The event in which atomic nuclei in an unstable state become stable by emitting particles or electromagnetic rays is called radioactivity in general terms. The emergence of energy through radiation is called radioactive radiation or radiation [17]. It can be said that the student's definition of radiation as a harmful ray is not based on this definition [18]. When the other concepts that students associated with radiation were analyzed, it was found that radiation was primarily related to electronic devices. In addition, the fact that atomic bombs, nuclear weapons, mutation, and cancer were associated with radiation explains the expression 'harmful ray' used by the students in the definition of radiation. In support of this situation, it is emphasized that many people have radiation phobia [19]. When the students' responses to the existence of radiation are analyzed, it is seen that they mainly stated that they could benefit from the radiation detector indicator. Again, in support of the view that radiation is harmful, which emerged in the first research question, the presence of radiation was associated with symptoms such as fatigue, headache, and eye disorder. [20] also emphasized that radiation poses a health hazard in their study. However, it is known that these symptoms will occur due to prolonged exposure to radiation above a specific dose. According to another finding, most students stated that radiation can be transmitted from person to person. Although this view is partially correct, it is known that radiation is not directly transmitted from person to person. Still, in some cases, when a person is exposed to radiation or contaminated with radioactive materials, radiation can indirectly affect others [19]. When asked which age range individuals are most affected by radiation, the students answered that radiation affects children, 0-18 and the elderly. Here, it was a striking result that a few students believed radiation affects infants the most. Because when

the literature is examined, it is stated that radiation primarily affects fetus, newborns, children, and adolescents respectively. The elderly are the group least affected by radiation because the cell division rate slows down [11]. Finally, students' opinions on ways to protect themselves from radiation were analyzed. According to the data obtained, it was determined that students emphasized distance control the most. [21] also reached similar statements with this research result. In addition, it was determined that students emphasized using unique protective clothing and other materials such as lead. However, it was concluded that other protection methods in the literature such as keeping the time of exposure to radiation short, shielding radiation sources, and applying decontamination procedures [22] were not mentioned in the study.

When the data obtained in general are analyzed, it is determined that although the students have studied the subject of 'Introduction to Atomic Physics and Radioactivity' in 12th grade, they have incomplete and erroneous information, and therefore, their awareness of radiation is not high. This situation indicates that the content and teaching-learning processes of the 12th-grade physics curriculum should be revised so that students can acquire these concepts and phenomena in a more qualified way. In addition, it can be said that teachers who build a bridge between students and curricula have essential duties in eliminating the deficiencies related to these concepts and phenomena. At the same time, to raise future generations consciously and increase their awareness of this issue, teachers must keep close to technological developments and thus develop conscious usage behaviors in students. From this point of view, it can be stated that pre-service and in-service teacher training should include topics on these issues that directly affect public health.

Considering the 'Health and Quality Life' target expected to be reached in 2030 within the framework of Sustainable Development, developing students' knowledge and awareness to strengthen this target is a critical starting point for our country. It should not be forgotten that the goal of 'Health and Quality of Life', which puts people at the center, constitutes a critical element of our social development, especially economic progress [23].

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