Literacy of students of the Department of Primary Education regarding radioactivity

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Abstract

In the present work, the literacy of students of the Pedagogical Department of Primary Education is investigated for phenomena related to radioactivity. The alternative ideas that students have in this subject are also detected. The progression of the perceptions that students have from year to year of their study was also studied. The results of the research led to the conclusion that students have misconceptions, some of which have been published in other papers and some are being identified for the first time. Research on how students' misunderstandings change within their study, has shown that they remain unchanged throughout their studies. This result means that their studies do not change any misunderstandings on this topic. This finding leads also to the conclusion that the students of the pedagogical departments should have courses with modern physics that touch on everyday problems of the modern life.

Key words: Misconceptions, literacy, natural sciences, radioactivity, students.

Introduction

Radioactivity is a phenomenon that has been extensively studied by scientists in terms of its nature, effects and usefulness to humans and the environment. In recent decades humanity has made radioactivity part of its daily life, as it is used for various purposes, such as food preservation (Olszyna-Marzys, 1992), medical exams and treatment (Cherry, Sorenson, & Phelps, 2012) and energy production and use. Even though radioactivity is a useful resource, it has many drawbacks. It can cause serious health problems to humans (Ainsley et al., 2011; Nagataki & Takamura, 2016), either in the form of serious diseases or mutations in DNA and have devastating effects on the environment. All the above show that it is necessary for an active citizen to have basic knowledge regarding radioactivity. This necessity becomes even greater when it comes to future educators, who will pass on the right knowledge or misconceptions about radioactivity to their students.

There are many studies regarding the perceptions, knowledge and misconceptions that pupils, students and teachers have on various environmental issues and most of them show the existence of common misconceptions between the three groups, with radioactivity being no exception (Khalid, 2003; Morales, & Tuz'on, 2020). Usually, misconceptions come from the lack of coverage of radioactivity in the curriculum at all levels of education and misinformation from various sources, such as the media and the internet (Sesen and Ince E, 2010). It is important to note that pupils and/or students tend to be disinterested in finding suitable sources (Linjse et al., 1990) for information on environmental issues and show indifference to the impact of these issues on their daily live.

In most studies, teachers, students and pupils fail to define radioactivity. They tend to believe that it is either the emission of particles or the emission of electromagnetic radiation from the nucleus of some elements, but not both, and in some cases neither of the above two options (Nakiboğlu , & Tekin, 2006). There is also confusion between the terms radioactivity,

radiation and radioactive sources (Tsaparlis, Hartzavalos, & Nakiboglu, 2013), with many people confusing them, specifically the terms of radioactivity and radiation. In 1987, Kaczmarek, Bednarek and Wong published that medical students believed that objects in an X-ray room could become radioactive after a diagnostic test. In addition to misconceptions about the definition of radioactivity, there are also misconceptions about the nature of radioactivity. Because radioactivity is dangerous to living organisms it has led to the belief that any radiation is just as dangerous (Robin and Singh, 1996). It is often considered extremely destructive and dangerous (Sesen & Ince 2010), harmful to humans (Millar, & Gill, 1996), while many believe that radioactivity is an artificial creation (Neumann & Hopf 2012) produced at nuclear power plants. There is a prevailing thought that the term radiation is synonymous with the term infection (Millar & Gill, 1996). There is also the false perception that irradiated bodies become radioactive (Plotz, 2016). Also, if a body is irradiated it will remain radioactive forever, thus giving a principle of conservation of radioactivity (Robin et al, 1990). All of the misconceptions presented above show a significant lack of knowledge about the nature and uses of radioactivity, especially for medical and energy purposes. Furthermore, there is the perception that radioactivity contributes negatively to the greenhouse effect and is one of the causes of the decrease in the thickness of the ozone layer (Boyes & Stanisstreet, 1994; Neumann, & Hopf, 2012). In addition, radioactive radiation is often mixed with non-ionizing radiation, resulting those students believe that all electrical devices emit destructive radiation (Neumann, & Hopf, 2012).

Therefore, it is interesting to find out whether the students of a Department of Primary Education, future teachers, have misconceptions about radioactivity, since they can transfer them to their students. Equally interesting is the answer to the question whether their misconceptions change during their studies.

Research

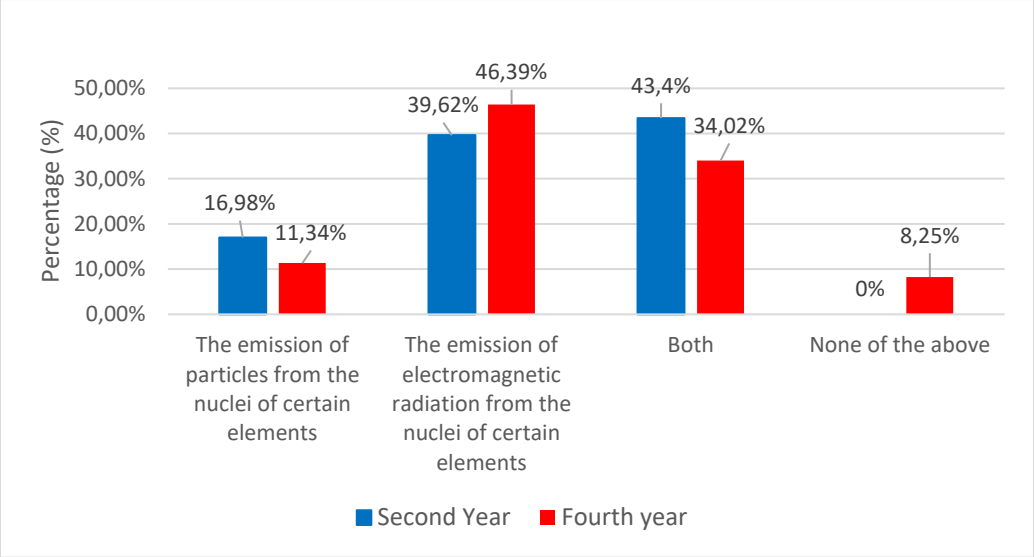
The main purpose of this study is to record and examine the perceptions of students of the Department of Primary Education about radioactivity and to determine their literacy in this field. A second objective was to determine whether there was a change in their misconceptions from year to year of study. 150 students took part in the research, with 25 (16,67%) of them being male and 125 (83,33%) females. From the 150 participants, 53 (35,33%) were in their second year of study and 97 (64,67%) were in their fourth year of study.

The questionnaire used in the research consisted of closed-ended questions and had two distinct parts. In the first part demographic information was requested from the participants, through four questions. In the second part, the participants' perceptions on radioactivity were examined. The nine questions of the second part were about the definition, use and effect of radioactivity, which were multiple choice with only one correct answer.

The results of the research were processed with the use of IBM SPSS Statistics 22, with the questions corresponding to qualitative variables. Independent samples t tests (chi-square) were conducted between the variables. The variables were transformed into right-wrong questions, so that the independent samples t tests were done correctly.

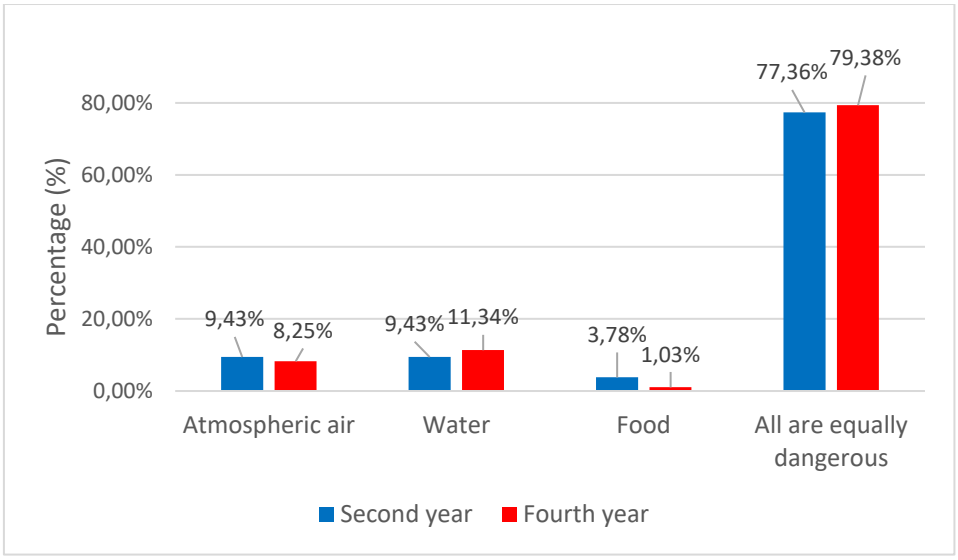
Results

Graph 1 shows the distribution of students' answers in relation to the year of study regarding question 1 "Radioactivity is:". 23(43,4%) of the 53 second-year students and 33(34,02%) of the 97 fourth-year students answered correctly that both are correct definitions of radioactivity. The application of independent t-test (x^2=1,288, df=3, p=0,256) showed that the variables are independent, and that the year of study is not a statistically significant factor.



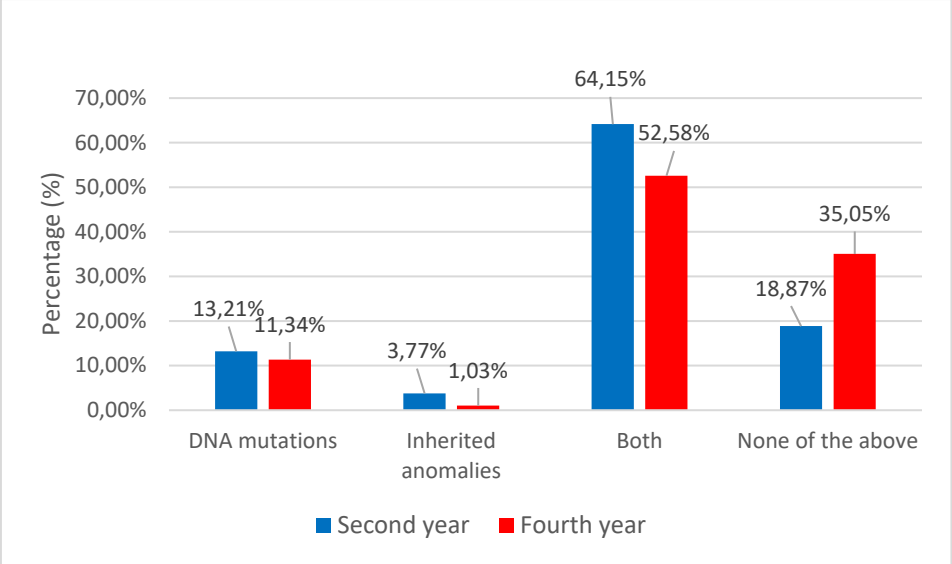
Graph 1. The bar graph of students' answers, in relation to the year of study, for question 1: "Radioactivity is:"

Graph 2 shows the distribution of students' answers in relation to the year of study regarding question 2 "Which is more dangerous if its effected by radioactive pollution?".



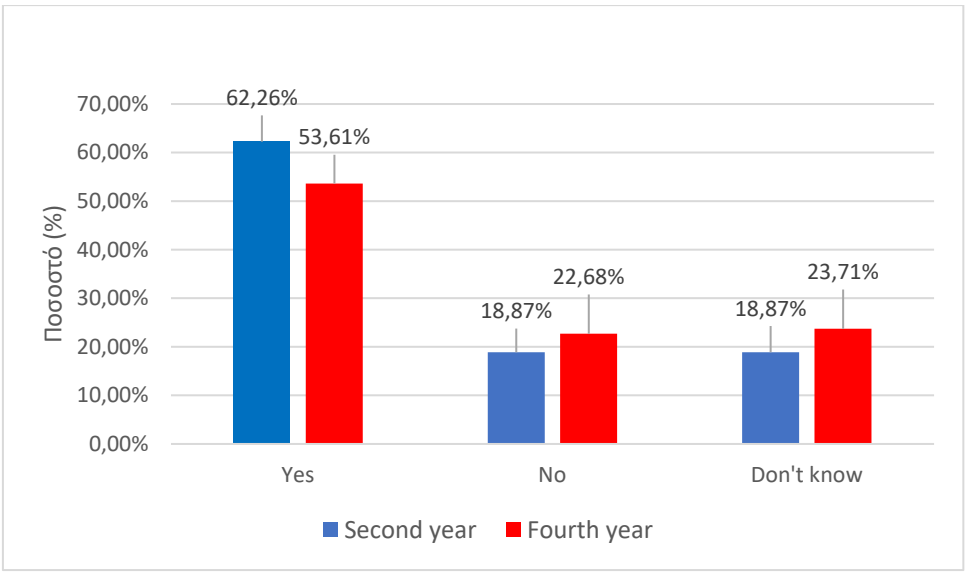
Graph 2. The bar graph of students' answers, in relation to the year of study, for question 2: "Which is more dangerous if it's effected by radioactive pollution?"

5(9,434%) of the 53 second-year students and 8(8,247%) of the 97 fourth-year students answered correctly that the atmospheric air is more dangerous. The application of the independent t-test (x2=0,061, df=3, p=0,805) showed that the variables are independent, and that the year of study is not a statistically significant factor.



Graph 3. The bar graph of students' answers, in relation to the year of study, for question 3: "Significant amounts of radioactive radiation can cause:"

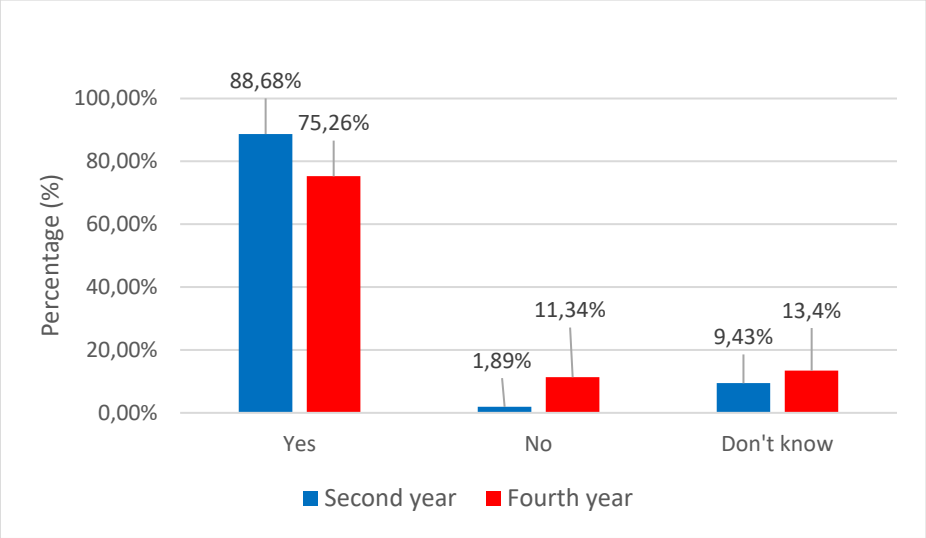
Graph 3 shows the distribution of students' answers in relation to the year of study regarding question 3 "Significant amounts of radioactive radiation can cause:". 34(64,15%) of the 53 second-year students and 51(52,58%) of the 97 fourth-year students answered correctly that both, DNA mutations and inherited anomalies, can be caused by large amounts of radioactive radiation. The application of the independent t-test (x2=1,870, df=3, p=0,172) showed that the variables are independent, and that the year of study is not a statistically significant factor.



Graph 4. The bar graph of students' answers, in relation to the year of study, for question 4: "Do we use radioactive sources to produce energy?"

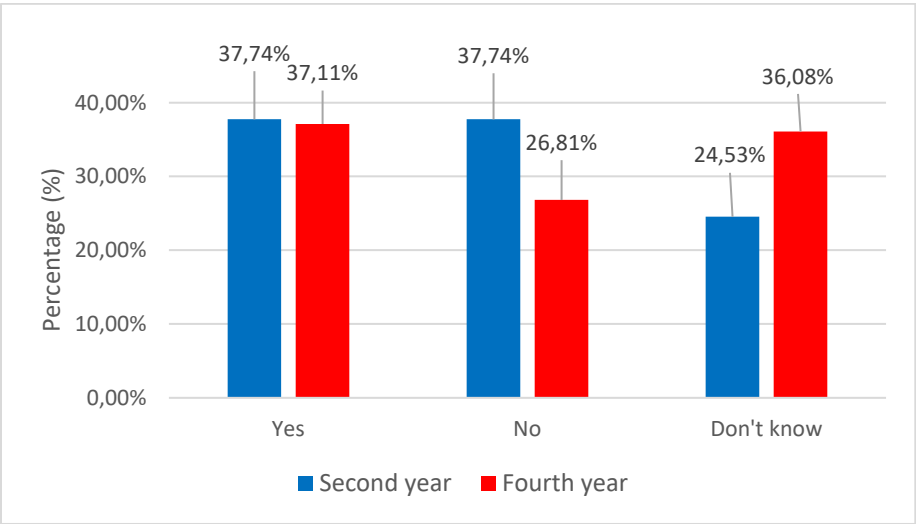
Graph 4 shows the distribution of students' answers in relation to the year of study regarding question 4 "Do we use radioactive sources to produce energy?". 33(62,26%) of the 53 second-year students and 52(53,61%) of the 97 fourth-year students answered correctly that radioactive sources are used for energy production. The application of the independent

t-test (x2=1,046, df=2, p=0,306) showed that the variables are independent, and that the year of study is not a statistically significant factor.



Graph 5. The bar graph of students' answers, in relation to the year of study, for question 5: "Do we use radioactive sources for medical purposes?"

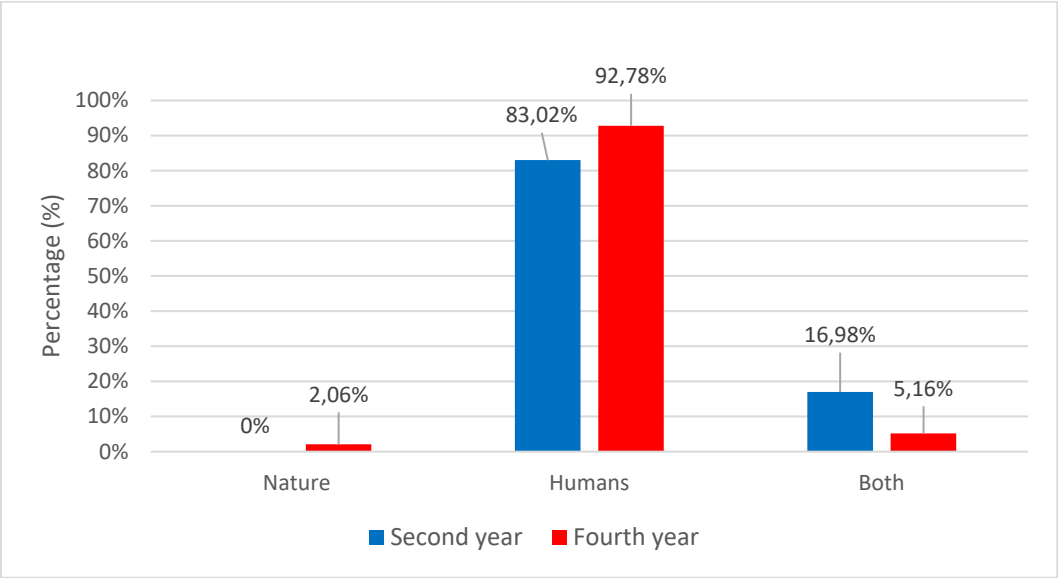
Graph 5 shows the distribution of students' answers in relation to the year of study regarding question 5 "Do we use radioactive sources for medical purposes?". 47(88,68%) of the 53 second-year students and 73(75,26%) of the 97 fourth-year students answered correctly that radioactive sources are used for medical purposes. The application of the independent t-test (x2=3,859, df=2, p=0,049) showed that the variables are not independent, and that the year of study is a statistically significant factor.



Graph 6. The bar graph of students' answers, in relation to the year of study, for question 6: "Do we use radioactive sources for food preservation?"

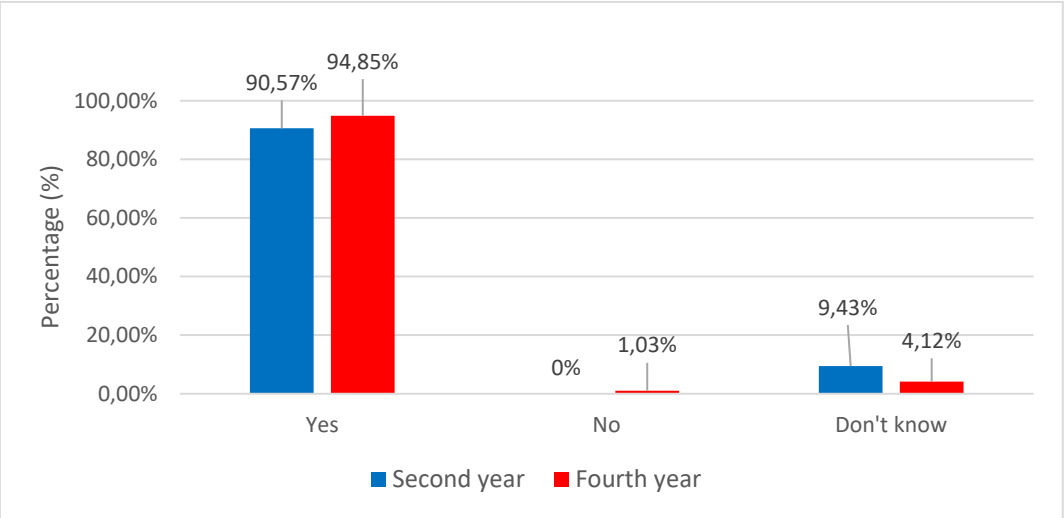
Graph 6 shows the distribution of students' answers in relation to the year of study regarding question 6 "Do we use radioactive sources for food preservation?". 20(37,74%) of the 53 second-year students and 36(37,11%) of the 97 fourth-year students answered correctly that radioactive sources are used for food preservation. The application of the

independent t-test (x2=0,006, df=2, p=0,940) showed that the variables are independent, and that the year of study is not a statistically significant factor.



Graph 7. The bar graph of students' answers, in relation to the year of study, for question 7: "Who is responsible for radioactive waste?"

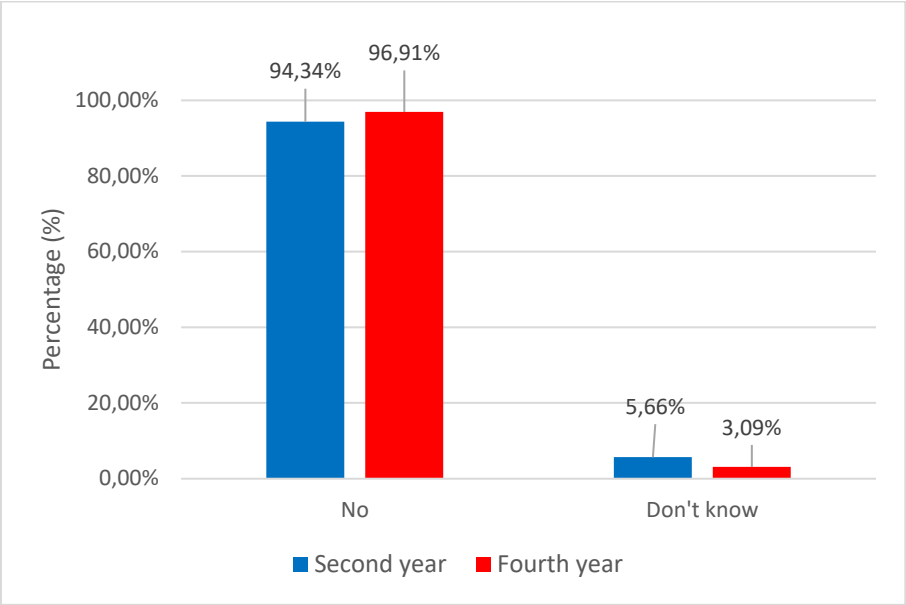
Graph 7 shows the distribution of students' answers in relation to the year of study regarding question 7 "Who is responsible for radioactive waste?". 44(83,02%) of the 53 second-year students and 90(92,78%) of the 97 fourth-year students answered correctly that humans are responsible for radioactive waste. The application of the independent t-test (x^2=3,429, df=2, p=0,064) showed that the variables are independent, and that the year of study is not a statistically significant factor.



Graph 8. The bar graph of students' answers, in relation to the year of study, for question 8: "Do radioactive waste contain radioactive material?"

Graph 8 shows the distribution of students' answers in relation to the year of study regarding question 8 "Do radioactive waste contain radioactive material?". 48(90,57%) of the 53 second-year students and 92(94,85%) of the 97 fourth-year students answered correctly

that radioactive waste contains radioactive material. The application of the independent t-test (x^2=1,009, df=2, p=0,315) showed that the variables are independent, and that the year of study is not a statistically significant factor.



Graph 9. The bar graph of students' answers, in relation to the year of study, for question 9: "Can we easily destroy radioactive waste?"

Graph 9 shows the distribution of students' answers in relation to the year of study regarding question 9 "Can we easily destroy radioactive waste?". 50(94,34%) of the 53 second-year students and 94(96,91%) of the 97 fourth-year students answered correctly that radioactive waste is not easily destroyed. The application of the independent t-test (x^2=0,588, df=2, p=0,443) showed that the variables are independent, and that the year of study is not a statistically significant factor.

Table 1 shows the results of the independent t-tests between the nine questions and the year of study. The tests show that the year of study is not a statistically significant factor for the eight of the nine questions answered by future teachers.

Table 1. Correlation table of students' answers and the year of study

Question	X^2	p	Difference
1	1,288	0,256	Random distribution
2	0,061	0,805	Random distribution
3	1,870	0,172	Random distribution
4	1,046	0,306	Random distribution
5	3,859	0,049	Statistical significant
6	0,006	0,940	Random distribution
7	3,429	0,064	Random distribution
8	1,009	0,315	Random distribution

9	0,588	0,443	Random distribution

Furthermore, the score of the students' correct answers to each question and per year of their studies was determined. The data are presented in Table 2, which shows the percentages of students who gave correct answers to the nine questions according to their year of study, as well as the average of the correct answers to the nine questions in total.

Table 2. The percentages of correct answers of students per question and per year of study

Question	Second year	Fourth year
1	43,4%	34,02%
2	9,43%	8,25%
3	64,15%	52,58%
4	62,26%	53,61%
5	88,68%	75,26%
6	37,74%	37,11%
7	83,02%	92,78%
8	90,57%	94,85%
9	94,34%	96,91%
Average	**63,73%**	**60,6%**

The data from Table 2 show that a second-year student answers correctly on average 5.7 questions out of 9, while for a fourth-year student the average is 5.5 questions out of 9. This analysis also shows that the students do not change their perceptions at all with their year of study and keep their perceptions.

Results

Six misconceptions were identified by this study, which examined the literacy of students of the Department of Primary Education regarding radioactivity.

- Radioactivity is only the emission of electromagnetic radiation from the nuclei of certain elements or only the emission of particles from the nuclei of certain elements. These specific perceptions have been documented in the international literature through the work of Nakiboğlu, & Tekin in 2006.
- Atmospheric air, food and water are just as dangerous if they are affected by radioactive pollution.
- DNA mutations and inherited anomalies cannot be caused by large amounts of radioactive radiation. This perception is odd, because while students consider radiation in general to be extremely dangerous, a significant portion of them do not know exactly what it is dangerous for.
- Radioactive sources are not used to produce energy.
- radioactive sources are not used for medical purposes.
- Radioactive sources are not used for food preservation. Because they consider radiation dangerous, a significant portion of students do not believe it can be used for food preservation. A similar view has been documented by Plotz in 2016, that when bodies are irradiated, they become radioactive.

The independent t-tests showed that the year of study is not a significant factor and does not affect students' responses. The year of study is a statistically significant factor for only one of the nine questions and specifically for the question: "Do we use radioactive sources for

medical purposes?". All the above show that the misconceptions of the participants have not changed during their studies at the university, and they essentially keep their misconceptions. This finding leads to the necessity that the students of the pedagogical departments should have courses with modern physics that touch on everyday problems of the modern life, in order to handle the misconceptions of their students on the same topics.

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