

Analyzing the Energy Awareness of Pre-Service Teachers Using the Word Association Method

Virág Fehér

University of Debrecen, Debrecen, Hungary

Balázs Czékmán

<https://orcid.org/0000-0002-1515-7129>

Puskás Ferenc Primary School, Budapest, Hungary

Magdolna Chrappán

<https://orcid.org/0000-0001-6129-2965>

University of Debrecen, Debrecen, Hungary

Gyula Lakatos

University of Debrecen, Debrecen, Hungary

Ibolya Markóczi-Revák

<https://orcid.org/0009-0000-4331-5289>

University of Debrecen, Debrecen, Hungary

Abstract

Energy awareness education as part of sustainability education is the joint task of schools and society as a whole. However, only teachers who themselves possess this competence can educate students in energy awareness. Accordingly, the aim of the research was to examine the energy awareness of pre-service teachers. To achieve the aim, the research attempted to find answers to the questions of what kind of knowledge about energy awareness the pre-service teachers in the sample had, whether students showed the interdisciplinary characteristics of sustainability in their knowledge, and what relationships could be observed in this knowledge system. The research was conducted in the autumn of 2021 at three universities in the North-East region of Hungary with 272 pre-service teachers participating voluntarily. The word association method was used for the study. Greatest association frequency was measured. The analysis of association fields proved the interdisciplinary nature of the students' knowledge of energy awareness. The highest association frequency was measured in the area of renewable energy sources and their use, while the least association frequency was measured in the area of empathy. The association graphs showed no meaningful difference in relationships between the studied student groups. The results showed definitive, unrelated knowledge.

Keywords: Energy awareness, field of association, pre-service teachers, word association.

Introduction

The energy crisis is a global problem culminating at the economic level resulting from energy disruption to production, distribution and consumption. The incredible pace of economic development of various countries is due to the fossil fuels of industrial civilization achieved in the 19th and 20th centuries, which are cheap to extract and process, have a high energy density and are easy to transport. This approach, however, is not sustainable due to the climate change effect of greenhouse gases generated by the combustion of coal, oil and gas, and because the known reserves of these energy resources are finite and if they are exhausted, millions of years are required for regeneration (Szalóczy, 2023). Therefore, attention has to be focused on renewable energy sources, the exploitation, sensible and economical utilization of which require educating the energy-conscious citizens.

Energy awareness (EA) education as part of education for sustainability is an interdisciplinary task that has social, economic, political and ecological implications in addition to school education. It is a responsible task in which students are educated to use energy correctly and efficiently. This requires to have teachers who are themselves energy-conscious in their knowledge, attitude, approach and behavior (Liarakou et al., 2009; Genc & Akilli, 2019). Only those who are purposefully educated from an early age at all levels of education can become energy-conscious teachers. The question is what the outcome of this process is among pre-service teachers entering and leaving higher education. In this paper, we present the differences in the knowledge of energy awareness among first-year and final-year pre-service teachers, taking into account its interdisciplinary aspects. The word association method is applied in the analysis, which presents the students' knowledge about energy consciousness in the context, in a relationship network that also reveals where the gaps are in the understanding and interdisciplinary interpretation of knowledge about EA.

Theoretical Background

Research in Relation to the Energy Awareness of Pre-service Teachers

The majority of research on the EA of pre-service teachers focuses on knowledge and attitudes towards renewable energy. In terms of knowledge, Zyadin et al. (2014) reported a limited level of knowledge of renewable energy among teachers and pre-service teachers, which in their opinion was a problem because it was reflected in teaching practice, which put students at a disadvantage in terms of EA. Saraç and Bedir (2014) obtained similar results. According to their results, the teachers surveyed not only had low quality knowledge about renewable energy (RE), but also had several misconceptions. This is dangerous because not only gaps but also erroneous views can develop in the knowledge of RE among students taught. The low level of knowledge of renewable energy among pre-service teachers was also confirmed by Cirit (2017), who studied students of different grades and found no significant differences between grades in terms of knowledge about RE.

Another group of research measured not only knowledge about renewable energy, but also the level of attitudes towards it (Bilen et al., 2013; Çelik, 2021; Liarakou et al., 2009, Emlik & Ercan, 2017). In addition to the low levels of knowledge on RE, these studies found positive attitudes towards RE. Stylos et al. (2023) investigated energy literacy of pre-service primary school teachers in Greece. Their results also showed low to medium levels of knowledge about RE, while satisfactory levels of emotions and behavior were found. Pre-service teachers are cautious about the costs of using renewable energy resources, which makes the transition from fossil fuels difficult for them. The study of Stylos et al. (2023) also looked at gender differences and found that female students performed better in the affective and behavioral dimensions of their empowering leadership questionnaire. Science pre-service teachers were ahead in the cognitive and affective dimensions compared to arts pre-service teachers.

Similar to the study of Stylos et al. (2023), Bialynicki-Birula et al. (2022) demonstrated that the attitudes of women towards energy saving and the environment were significantly better than those of men, while men provided higher levels of knowledge in renewable energy. A similar conclusion was reached by Martins et al. (2021) when measuring the energy literacy levels of Portuguese university students. They found that the women's knowledge levels of RE were lower than those of men, while their behavior and attitude towards energy were more positive. Studying gender differences, presumably women's more caring nature and sensitivity to problems caused a more responsible attitude and approach to sustainability issues, including energy awareness. Further gender studies may confirm the advantage of women in environmental and energy behavior, which supports a concern about the increased development of these qualities of male pre-service teachers and the methodology of such development.

In their, Cebesoy and Karisan (2017) analyzed the knowledge and attitudes of pre-service science teachers about RE as a function of economic, political, technical, socioeconomic and geographical background factors using the qualitative case study method. They found that the level of knowledge was low in all cases, regardless of background factors, while there were differences in attitudes depending on the influencing factors studied.

In the third group of studies, in addition to measuring knowledge and attitudes, the analysis of awareness about RE also appears. Guven and Sulun (2017) examined the knowledge and awareness of RE by final-year pre-service teachers trained for different levels and majors of education using their proprietary Renewable Energy Knowledge Level Test (REKLT) and the Renewable Energy Awareness Scale (REAS) developed by Morgil et al. (2006). The scale of Morgil et al. (2006) related to renewable energy interprets awareness primarily as an attitude and includes 50 statements about knowledge, perception, and emotional attitudes about renewable energy. It lacks behavioral statements, which are important elements of EA. In this study, Guven and Sulun (2017) found differences between pre-service teachers of different training levels and majors only in terms of knowledge about RE, but not in terms of awareness. Aisli Celik (2021) gave a broader understanding of the concept of renewable EA. The awareness of RE among primary school mathematics pre-service teachers and those learning science was measured using the Attitude Scale Towards Renewable Energy Resources test developed by Güneş et al. (2013), in which they also discussed the need for the application of renewable energy, the importance of education, the interest of individual countries and environmental awareness. This interdisciplinary understanding of EA is already consistent with the understanding of sustainability as a

system of relations between economic, social, political, natural and ecological dimensions. The attitude of students towards RE was found being positive. In this study, Aisli Celik (2021) used the metaphor collection form method to interpret the attitude of students towards RE, which, similarly to the word association method, also revealed what the concept of renewable energy meant for the person studied, leaving room for the free expression of a larger number of associations and thoughts.

Measuring energy awareness, although it does not apply to pre-service teachers, an interesting and more complete picture was provided in the study by Zyadin et al. (2012), who analyzed the tenth grade students' attitudes and awareness of RE. Knowledge of RE was not satisfactory, while attitudes and awareness varied between town and non-town students. Interestingly, in addition to the attitude test, the study also used a set of self-assessment questions to measure awareness, in which students had to judge how good their knowledge of RE was. When judging the state of some knowledge, metacognitive abilities are used, including conditioning knowledge. Metacognition is about awareness, so its application in judging energy consciousness in addition to attitude and knowledge tests further increases the accuracy of judging EA.

One common finding related to the research projects discussed above focusing on the measurement of the knowledge, attitudes and awareness of pre-service teachers related to renewable energy is that pre-service teachers have an unsatisfactory level of knowledge of RE, while in most cases their attitudes are positive. At the same time, research carried out at various levels of education has shown that the level of environmental and energy-conscious behavior is lower than the level of knowledge about the environment and EA (Tayci & Usual, 2012; Kónya, 2018; Fehér & Revákné, 2021). Energy-conscious behavior is an integral part of the attitude towards energy awareness. Thus, when the research projects mentioned above confirmed the positive attitude of pre-service teachers towards renewable energy, the question arises as to how correct this statement is. This problem is due to the fact that environmental attitudes and measurement tools, including those related to RE, are still fragmented.

The other general statement is the interpretation of EA. As can be seen, some of the research mentioned above perceives consciousness primarily as an attitude or part of it. At the same time, research projects also emerge which, starting from the interdisciplinary nature of sustainability, examine EA along several disciplines. In our research, when examining EA, we also start from its interdisciplinary nature.

The third lesson from the above-mentioned research is the methods of measuring EA. There are qualitative, content-based and quantitative studies using questionnaires and the method of metaphor collection form. Among these, the metaphor collection form method is a novel method proving a deeper and interconnected knowledge structure. In our research, efforts were made to reveal not only the acquired definitive knowledge, but also its interdisciplinary nature and the attitude elements related to the knowledge when measuring the EA of pre-service teachers, for which the word association method, which is similar to the metaphor collection form method, was applied.

Energy Awareness and Sustainability

The United Nations 2015 framework defined 17 Sustainable Development Goals (SDGs). The seventh goal of this system is the production of and access to affordable and clean energy pushing the exploitation and use of fossil energy resources into the background and enhancing the utilization of renewable energy resources. Achievement

of this goal without educating energy-conscious citizens is very difficult. Consequently, education has the responsibility to shape students, in terms of EA, into active individuals committed to sustainability (Guirao et al., 2022; Olsson et al., 2022). Since shaping the approach of sustainability and thus EA is a complex, interdisciplinary task, it is inevitable that teachers give students the opportunity to become aware of and understand the complex relationships between the social, economic, ecological and political aspects of EA (Andić & Vorkapić, 2017; Hofman-Bergholm, 2018; Veisson & Kabaday, 2018; Sahakian & Seyfang, 2018; Guirao et al., 2022). Only teachers who think and act in this way in relation to sustainability and EA can make their students see this complex context.

In EA education, teachers are expected to be energy-conscious themselves and to be able to convey this to their students. It is important that teachers, regardless of their specialization and the given school level (kindergarten, primary or secondary school, higher education), are proficient in education for sustainability, authentically represent the value system of sustainability, as well as know and apply the methods of transferring attitudes related to environmental awareness, including EA. They should have knowledge of the concept and principles of sustainability appropriate to their field of expertise and should try to incorporate them into their everyday pedagogical activities (Educational Authority, 2013). In other words, EA education is the task of all teachers, regardless of their specialization, and of the whole school education. It is a pedagogical activity within the possibilities of the given content of any subject, both inside and outside the classroom. Mostly this is possible within science subjects, but it can also be included in, for example, an English language class (Bell, 2016; Alghamdi & El-hassan, 2019).

Consequently, education for sustainability, including EA, is a very important task of higher education, including teachers' training. Moreover, it includes both formal and non-formal activities (Jonāne & Salītis, 2009). Formal education cannot be limited to the fact that, for example, natural or environmental science pre-service teachers study sustainability-related subjects directly, while the teachers of social sciences, humanities or even language or music have little or no access to such subjects. For the latter, it would be equally important to include such subjects in their training. The professional part of the training should be complemented with the non-formal, extracurricular educational and sustainability activities of the operator of the institute network that can be transformed into the education of sustainability and EA in higher education, which serve as true and active examples for pre-service teachers to follow and are organically integrated into their sustainability value system.

Research Problem and Questions

Since EA is an important pillar of sustainability, it is to be expected that teachers educating future generations in EA should have complex knowledge and attitudes towards energy awareness already as pre-service teachers (Jonāne & Salītis, 2009; Veisson & Kabaday, 2018; Guirao et al., 2022). They should see its dimensional network of relationships and be able to effectively convey it to their students in the midst of the goals, requirements and opportunities of the given education system as influencing factors. They should have attitudes towards EA, including energy-conscious behavioral elements (Tayci & Usual, 2012; Fehér & Revák, 2021). In this research, the knowledge of pre-service teachers related to EA, its interconnections and interdisciplinary nature were studied.

The main questions of the research were the following:

- (1) What knowledge do the studied pre-service teachers have in relation to EA?
- (2) How does interdisciplinarity appear in the knowledge of the studied students in relation to EA?
- (3) What interconnections can be detected in the knowledge structure of the studied students regarding EA?
- (4) In terms of the main questions of the research, what are the differences between the beginner and the final-year pre-service teachers?
- (5) How does the specialization of the pre-service teachers (arts or science) influence the knowledge structure related to EA?

Methodology

Participants

The research involved students studying (N = 272) at three universities – University of Debrecen, University of Nyíregyháza and Eszterházy Károly Catholic University – in Hungary’s North-East Region in September 2021. The above universities are long-standing teachers’ training institutions in Hungary. They were selected because the population of the North-East Region of Hungary was studied in relation to the knowledge of and attitude towards RE in the course of a former project (“The Role of Social Learning Regarding Renewable Energy Resources in the Eastern Region of Hungary” project, supported by the NKFIH, K 116595 application in Hungary, 2016–2019). As a follow-up, we were interested in finding out what attitudes and knowledge pre-service teachers at the universities in the region had with which they arrived at their future schools, where their task was, among other things, to educate students to become energy-conscious citizens.

In order to show whether there was a change in knowledge about EA during the higher education years, both first-year and final-year students were studied. To explore the interconnections, both students of the Faculty of Arts and Humanities (Literature, English, French, Italian, German, Russian, History, Ethnography pre-service teachers) and those of the Faculty of Natural Sciences (Biology, Chemistry, Physics, Mathematics, Geography pre-service teachers) were studied (Table 1).

Table 1

Participants of the Study

	Faculty of Arts and Humanities	Faculty of Natural Sciences	Σ Students
First-year students	115	46	161
Final-year students	49	62	111
Σ Students	164	108	272

Considering the number of the respondents, it can be seen that the number of students majoring in science is lower. This can be explained by the fact that in Hungary, compared to humanities programs, fewer and fewer students choose science teachers’ training programs for higher education. The selection of students for the study was not random. We contacted the directors of teachers’ training at the three higher education

institutions of the North-Eastern Region, who allowed and helped select pre-service teachers at the given institutions. Among the students contacted, the volunteers were involved in the study.

Instrument and Data Analysis

The basic method of the research was the word association test, which had been used in psychological and linguistic research for more than a century. Word association has been applied to explore the knowledge structure and its changes primarily in the field of natural sciences since the 1980s (Hovardas & Korfiatis, 2006; Kostova & Radoynovska, 2008, Czékman et al., 2017). Five to six stimulus words are required for the practical application of word association testing. Within a set time (usually one minute) for each stimulus word, students write down (or tell) the associations (words or phrases, short sentences) that come to mind in relation to that particular stimulus word. Then comes the analysis of the obtained data, which can be used to determine the Garskof-Houston relationship coefficient (RC) on the one hand, and, on the other hand, to map the associations given to a particular stimulus word by calculating simple frequency. The value of the relationship coefficient between two stimulus words is greater if they contain more common associations.

The time taken to conduct the study can be shortened with the help of ICT tools. The software, developed by Kovács (2009), automatically calculates the value of the relationship coefficients between stimulus words after entering the associations given to the stimulus words per student, based on which the networks of relationships between the stimulus words can be constructed.

The frequency of associations given to stimulus words can be determined using Excel or SPSS statistical analysis software. However, the wordcounter.com application is simpler and faster for counting words in a given text (Czékman et al. 2017).

In this paper, the networks of relationships illustrating the relationship coefficients between stimulus words are not analyzed separately. Only the networks of associations, which include the associations, are presented, as they show in detail the nature and strength of the relationship between the individual stimulus words.

In the course of the research, the knowledge of concepts and knowledge related to EA were analyzed. The most important key concepts related to energy awareness include energy conservation, energy efficiency, conscious energy use, energy crisis, renewable energy. These key concepts were used as stimulus words.

Since the survey was conducted during the COVID19 pandemic, it was conducted online. Students were contacted via Zoom and Messenger and asked to tell any associations they could think of regarding the given stimulus word within one minute. Since five stimulus words were applied, the survey of one student lasted five minutes.

The associations received from the students were sorted in a table. A given student received 1 point for each association they mentioned. However, there were some associations that the student did not mention, but the others did. Such an association, which they did not mention, was awarded 0 points.

Then, the number of associations per stimulus word was counted for first-year and final-year students and the per capita average of the occurrence of each association was obtained. Then the associations were grouped based on the answers of students. It was possible to distinguish twelve fields of association in relation to both the first-year and the final-year students.

- (1) Renewable energy resources and their application (e.g., water, wind, wind energy, water power plant, solar panels, etc.);
- (2) Fossil fuels and their application (e.g., coal, crude oil, natural gas, gas heating, etc.);
- (3) Economy (e.g., saving, financial risk, increase of natural gas);
- (4) Politics (e.g., energy policy of the EU, energy policy of the Hungarian government, carbon neutrality, etc.);
- (5) Science (e.g., physics, geography, research, science, scientists, etc.);
- (6) Education (e.g., education to think, school education, change of view, learning, forming awareness, etc.);
- (7) Environmental protection (e.g., environmentally friendly, supporting environmental protection, green energy, green environment, etc.);
- (8) Future (e.g., future, sustainability, future vision, ecological footprint, future of the Earth, etc.);
- (9) Energy-conscious behavior (e.g., switching off lights, do the washing with a small amount of water; wash a full amount of clothes, etc.);
- (10) Energy conserving solutions (e.g., electric car, maintaining a constant temperature, passive houses, insulation, LED bulbs, etc.);
- (11) Empathy (e.g., worry, anxiety, uncertainty, discontent, feeling of being threatened, sad, etc.);
- (12) Other (e.g., underdeveloped, fatal, concepts, process, error, shortage, chaos, etc.).

Then the relative frequency (total actual occurrences/maximum possible occurrences) of all actual occurrences was determined in the given field of association and the differences between first-year and final-year students were detected.

The analysis of the association fields did not show clearly which associations appeared in relation to several stimulus words. These associations are important because they represent the connection, the relationship between two or more stimulus words. In the course of this more in-depth relationship analysis, the average per capita of each association ($N = 2894$) (words, phrases) was calculated in each association field, then the association networks were constructed applying the Gephi network analysis and representation software package. The networks of the first-year and final-year students were analyzed separately, as well as, for deeper analysis, those of the students majoring in arts and science. Association networks contain only associations with occurrence frequency above 5 %. During the analysis, the pattern of the networks, the Garskof-Houston relationship coefficient (RC), which indicates the strength of the relationship between stimulus words and the characteristic associations, were studied.

The significance analysis of the results of first-year and final-year pre-service teachers was carried out using the software SPSS 26.0. After performing the Kolmogorov-Smirnov test, the Friedman test was applied to examine the differences between relative frequencies within the groups of first-year and final-year students in the case of the association fields, while the Mann-Whitney U test was applied to compare first-year and final-year frequencies. In each case, effect sizes were also studied. In the case of the Friedman test the value of 'r', while in the case of the Mann-Whitney U test the value of 'd' were determined. When analyzing association networks, the ANOVA test was used to examine the significance between RC values.

Results

Considering the first two questions of the research, we examined what knowledge the studied pre-service teachers had in relation to EA, and how interdisciplinarity appeared in this knowledge system. Partly the fourth research question was also answered, because during the study the differences between first-year and final-year pre-service teachers were also studied.

First, the number of associations per stimulus word and the average per capita for first-year and final-year students were determined (Table 2). The difference between the averages per capita was determined using the Mann-Whitney U test and no significant difference was found between them ($U = 5.000$; $p = .117$).

Table 2

Number of Associations Occurring in Each Association Field and Their Average per Capita

		Renewable energy	Energy conservation	Conscious energy use	Energy crisis	Energy efficiency	Total (Σ)
First-year students (n = 161)	Number of associations	202	356	386	458	431	1833
	Average per capita	1.25	2.21	2.39	2.84	2.67	11.38
Final-year students (n = 111)	Number of associations	115	228	237	235	246	1061
	Average per capita	1.03	2.05	2.13	2.11	2.26	9.56

In order to further analyze the knowledge of first-year (n = 161) and final-year (n = 111) pre-service teachers related to EA, the relative frequency of the associations actually occurring in each association field was determined (Table 3).

For the renewable energy stimulus word (Table 3), higher relative frequency values occurred in the fields of renewable energy resources and their use, economy, environmental protection, fossil energy resources and their use and other. A significant difference between the two groups of students was found in the fields of renewable energy resources and their use, economy, energy-conserving solutions and empathy, where final-year students gave more associations, and also in the fields of politics and other, where first-year students mentioned more concepts.

In the case of energy conservation, the relative frequency of associations in the field of renewable energy resources and their use was also in the first place. This was followed by economy, environmental protection, energy-conscious behavior and energy-conserving solutions. Between the relative frequency of associations of first-year and final-year students, the Mann-Whitney U test indicated significant differences in favor of final-year students in the fields of education, energy-conscious behavior, and other.

Among the fields of the stimulus word of conscious energy use (very similar to energy conservation), the students mentioned the relatively highest number of associations again in the field of renewable energy resources and their use, followed by economy, education, environmental protection, future vision, environmental-conscious behavior and energy-conserving solutions. There was no significant difference between the relative frequency values of the two groups of students.

Stimulus word	Conscious energy use		Energy crisis	
	First-year	Final-year	U	p
Renewable energy resources and their application	.022	.020	8582.5	.000
Fossil energy resources and their application	.007	.000	8491.5	.000
Economy	.013	.024	8533.0	.006
Politics	.006	.000	8547.0	.000
Science	.000	.000	8769.0	.000
Education	.013	.019	8203.0	.013
Environmental protection	.012	.017	8673.0	.012
Future	.012	.017	8394.0	.012
Energy-conscious behavior	.013	.025	7975.5	.013
Energy conserving solution	.011	.016	8256.0	.011
Empathy	.000	.000	8769.0	.000
Other	.009	.014	7996.0	.009
χ^2	371.28	238.17		11
df	11	11		11
p	.000	.000		.000
Effect size ϕ	1.518	1.123		1.401
	Large	Large		Large

Considering the stimulus word of the energy crisis, students mentioned several associations in the fields of fossil energy, economy, renewable energy resources and their use, as well as politics and future vision. Similarly, significant differences were in these fields between the two groups of students. Final-year students showed greater relative frequency of associations in the fields of economics, politics, education, environmental protection and other.

In relation to the stimulus word energy efficiency, students had the most associations in the fields of renewable energy resources and their use, economy, environmental protection, future vision and education. There were significant differences between the two groups of students in relative frequencies in the fields of education (where the frequency of mentions by first-year students was higher), environmental protection and other. In the case of the latter two, final-year students gave relatively more concepts.

Overall, the Friedmann test showed significant differences between the relative frequencies of associations occurring in all association fields regardless of stimulus words and student groups. The effect size was also large in all cases, which indicated that each association field had a strong influence on the frequency of associations there. The relative frequency of the actually mentioned associations of the studied students was highest in the fields of renewable energy resources and their use, followed by economy, fossil energy resources and their use, education, environmental protection, future vision and energy-conscious behavior. Examining the difference between first-year and final-year students (Table 3), with the exception of environmental protection, future vision, energy-conserving solutions and other fields, the relative frequency values were higher for final-year students in all cases.

The relationships that can be observed in the knowledge structure of pre-service teachers related to EA (research question 3) was studied by analyzing the association networks (Figures 1–6). Here we went deeper and looked at the differences between pre-service teachers studying at the Faculty of Arts and Science for first-year and final-year students (assuming that students at the Faculty of Science have a more complex network, since they have direct sustainability subjects, while students at the Faculty of Arts do not).

The pattern of the association networks was analyzed first. Figures 1–6 show similarities between the studied pre-service teachers' groups. The stimulus words of renewable energy and energy crisis are separate units of the networks, with few links into the network. At the same time, associations related to the stimulus word appeared with the highest frequency in relation to the stimulus word of renewable energy. The other striking feature is the connection of stimulus words of energy conservation and conscious energy with most associations in the networks.

To support the pattern, we looked at the values of the Garskof–Houston relationship coefficient (RC) directly proportional to the number of associations connecting stimulus word pairs (Table 4). The highest number of connecting (common) associations occur between conscious energy use and energy conservation (Table 4), while the smallest number can be observed in the case of conscious energy use – energy crisis, energy crisis – energy efficiency and energy conservation – energy crisis. Low RC values are also typical when renewable energy is connected with another stimulus word. The RC values therefore confirmed the pattern. The strongest connection occurs between the stimulus words of EA and conscious energy use. The weakest links were found between renewable energy and the energy crisis in all groups. According to the

ANOVA analysis, the difference in RC values between stimulus word pairs (for all groups studied) was significant ($F = 21.38$; $df = 9$; $p = .000$).

Figure 1
Association Network of First-year Pre-service Teachers

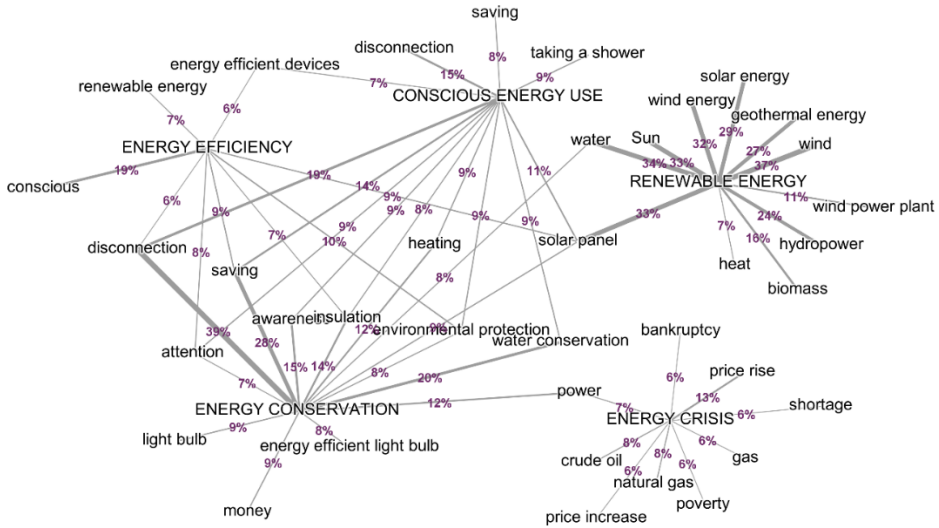


Figure 2
Association Network of Final-year Pre-service Teachers

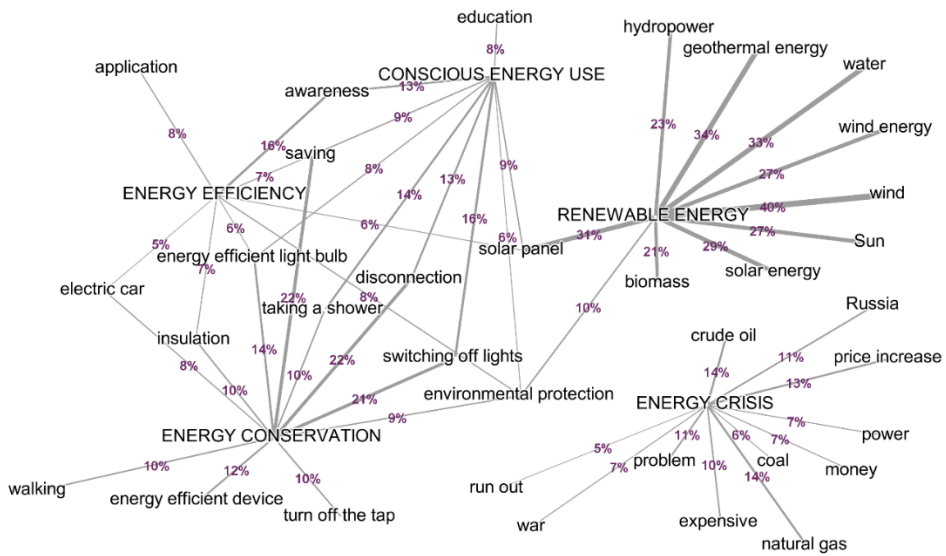


Table 4

Garskof–Houston’s Relationship Coefficient (RC) Values by Stimulus Words in the Studied Pre-service Teacher Groups

	RE- EC	RE-CE	RE- ECR	RE- EE	EC- CE	EC- ECR	EC- EE	CE- ECR	CE-EE	ECR- EE	Average
First-year total	6.07	7.14	3.17	6.86	14.74	2.40	10.10	1.24	9.32	1.34	6.23
Final-year total	5.02	1.93	0.62	3.73	12.21	1.02	5.31	0.77	6.54	1.23	4.12
First-year FoA	5.19	6.98	1.96	5.35	14.31	1.65	9.60	0.73	9.48	0.86	5.61
First-year FoS	8.27	5.80	5.35	10.49	16.63	4.67	9.76	2.92	10.08	3.09	7.70
Final-year FoA	5.51	2.72	0.74	2.55	12.30	1.07	2.88	0.78	4.44	0.41	4.69
Final-year FoS	5.83	1.82	0.68	4.81	14.07	0.77	7.07	0.34	7.59	2.16	4.41

RE: Renewable energy; EC: energy conservation; CE: conscious energy use; ECR: energy crisis; EE: energy efficiency

Third, the typical associations were analyzed in each net. As with the pattern, similarities were found here as well. Associations with renewable energy are mentioned in the highest number. A concept with a frequency of 7 %, heat, was found solely in the network of first-year pre-service teachers, while in all other networks associations with a frequency of 20 % or more were found. These include water, wind, geothermal energy, solar energy, Sun, etc. A typical association with other stimulus words is solar cells (for conscious energy use and energy conservation), but environmental protection and water also appear as connecting words.

Most of the connecting associations were found between energy conservation and conscious energy use, i.e., typically, 8–25% mentions. The most common connecting (common) association that occurs similarly in all networks is disconnection, saving, electricity conservation, water conservation, turning off electricity, etc.

Based on the RC values in Table 4, the RC values of the energy efficiency – conscious energy use and energy conservation – energy efficiency stimulus words also show the presence of several connecting associations. The networks reveal that most of the common associations between the stimulus word pairs of energy conservation – conscious energy use have a third branch towards energy efficiency. Such associations include saving, water conservation, disconnection, environmental protection. A characteristic association of energy efficiency is awareness.

The energy crisis is a separate unit in the relationship network. Its typical associations include crude oil, natural gas, expensive, price increase, money, war. Some connecting associations occur (e.g., water, electricity, money), but in the network of final-year pre-service teachers (all studied students together) it shows no connection at all; it is completely separate.

If we look for differences between the groups studied, overall significant differences cannot be found in relation to the individual stimulus words ($F = 0.92$; $df = 9$; $p = .474$). If the total average of connections between stimulus word pairs by groups is analyzed, the highest number of connections between stimulus words can be found among first-year students at the Faculty of Science followed by first-year students together and the first-year students at the Faculty of Arts (Table 4). The RC values of final-year students in the association networks, although lower in Table 4, do not differ significantly from those of the first-year students. Based on the analysis of the association networks, no recognizable differences were found between the studied pre-service teacher groups in terms of their patterns, connections between stimulus words and typical associations.

Discussion and Conclusions

The aim of the research was to study the EA of pre-service teachers. For this purpose, the characteristics of the knowledge and knowledge structure of first-year and final-year students regarding EA were compared. Considering the interdisciplinary nature of sustainability (Andić & Vorkapić, 2017; Hofman-Bergholm, 2018; Veisson & Kabaday, 2018; Sahakian & Seyfang, 2018; Guirao et al., 2022), the extent to which the students' knowledge of EA corresponds to this interdisciplinary character was also examined. The main method of the study was the word association method, since with its help relationships could be revealed that were not revealed during the description of the definitions of concepts. With regard to EA, the key concepts – renewable energy, energy conservation, conscious energy use, energy crisis and energy efficiency – were used per stimulus word, and correlations were established between them in the student groups examined.

Regarding the first question of the research, we analyzed what knowledge the students had about EA and how interdisciplinary that knowledge was. First, we looked at how many associations the first-year and the final-year pre-service teachers made. No significant differences in associations per capita were found between the two groups. One reason may be that there is no such significant impact on the students at any higher education institution resulting in a broader knowledge of EA among final-year students. Another reason is that final-year students gave more thoughtful answers, with fewer irrelevant associations. A third possible reason is that first-year students had a stronger compulsion to comply when answering, i.e., they gave associations to stimulus words more conscientiously, making the most of themselves.

In relation to the first research question, twelve association areas were created based on the answers of the students (renewable energy resources and their use, fossil energy resources and their use, economy, politics, science, education, environmental protection, future vision, environmentally conscious behavior, energy-conserving solutions, empathy, other). For each stimulus word, we calculated the differences in the relative frequency of associations in each field within and between groups of first-year and final-year pre-service teachers. Within the groups, there were significant differences ($p = .000$) between the relative frequency of associations of each field for both the first-year and final-year students, and the effect size always indicated a strong effect. The frequency with which students mentioned an association within a given stimulus word depended to a large extent on the association field. The highest number of mentions was found in the fields of renewable energy resources and their use followed by economy, fossil energy resources and their use, education, environmental

protection, future vision and environmentally conscious behavior in both the first-year and the final-year student groups.

The result is not surprising, since nowadays most students hear and learn about renewable energy and related concepts (water, wind, wind energy, Sun, solar energy, etc.) both in and outside school. Moreover, this is a field that has become part of everyday life both socially and economically. There is no coincidence that the relative frequency values of associations in the fields of fossil energy resources and their use and economy come in second place, since in the course of discussions about renewable energy resources and their use, it is inevitable to contrast them with fossil energy resources and to constantly emphasize the economic aspects of renewable energy resources. This is what students learn, see and hear through various sources of information (school education, media, internet, etc.). These students hear more and more about the role of sustainability for the future of the Earth and the importance of environmental protection, which they were able to incorporate into their knowledge system about EA.

Although the aim to evaluate the components of attitude, behavior and empathy related to EA was not included in this study, it did emerge through analyzing the association fields. Both final-year and first-year students mentioned concepts for both energy-conscious behavior and empathy. The relative frequency of mentions in the empathy field was small compared to other areas. The fields of education, politics and science were also less involved in discussions.

In terms of differences between first-year and final-year students, the latter had the higher frequency of mentioning associations in most fields (in all fields except for environmental protection, future vision, energy-conserving solutions). However, based on the values of effect sizes, either the two groups of students examined had no effect on the relative frequency values of the associations, or, in one or two cases, medium effect sizes were observed. This shows that whether pre-service teachers are first-year or final-year students, they do not have a significant impact on the assessment of EA knowledge. Overall, however, it can be seen that the role of politics, science and education in relation to EA is also given more emphasis in the thinking of final-year students. Broader thinking focuses on the factors that can be decisive in the development of EA.

The examination of each association field also provided an answer to the question that the examined pre-service teachers are capable of an interdisciplinary interpretation of energy consciousness. However, shortcomings were also revealed, such as shaping a future vision that included sustainability, or empathy, which played a significant role in making responsible decisions about our environment, in this case energy use, or the components, tasks and importance of education in EA education. These are all shortcomings without which teachers would be less effective in developing the energy awareness of their students. To eliminate these gaps, strengthening these fields of teachers' training should be given greater emphasis in the future in the education and sustainability programs and strategies of the institutions included in the study. It should also be a more important task of the society as a whole. Therefore, there is an increasingly urgent need to include the pedagogy of education for sustainability as a new dimension of training, regardless of teacher specialization, and to teach it as a separate course for students.

Considering the third question of the research, we looked for relationships in the knowledge of pre-service teachers. The association networks of first-year and final-year pre-service teachers were created and compared, as well as those studying at the

faculties of arts and science. Based on the pattern of the networks, no significant differences were found. Among the stimulus words, renewable energy and the energy crisis are isolated from the stimulus words of energy conservation, conscious energy use and energy efficiency, which are connected with several common associations. This result was supported by the values of the Garskof–Houston relationship coefficient (RC).

Analyzing the associations connecting the stimulus words, we found that connecting associations with a frequency above 5 % (average of all mentions of a given association per person) were similar in all networks (e.g., between energy conservation and conscious energy use saving, hydropower, electricity, disconnection, switching off lights). Considering several common associations connecting energy conservation and conscious energy use, as well as energy efficiency, it raised the question of whether the studied students correctly interpreted the given stimulus words and saw the differences between them. A greater number of associations between these stimulus words can also be explained by that they mentioned behaviors related to energy conservation and energy-conserving solutions that came up every day from some sources of information or in connection with an authentic problem (e.g., switching off electricity at home because it costs a lot). Therefore, these associations are among the first automatically made by the students. However, a teacher needs to interpret energy awareness more broadly, understanding its global context. This is the only way to be able to educate the students into complex-minded, energy-conscious individuals. The development of a global mindset requires a fundamental change of attitude in the education and training of pre-service teachers. This means a new form of education both in its approach and methodology: 1) interdisciplinary, contextual transfer of professional knowledge; 2) the dominance of students' independent knowledge acquisition, for example, through collaborative, cooperative project activities, during which they solve problems relevant in everyday life together via a multifaceted approach; 3) as an external practice, they can gain insight into the sustainability-related problem-solving process of various units of the economic and social sphere (companies, corporations, agricultural units, municipal and government offices, etc.).

The associations of the stimulus word of renewable energy were the most frequent (> 15 %) including wind, water, hydropower, geothermal energy, Sun, solar energy, solar panel. These are the most ingrained concepts of the studied students about renewable energy and its use. The common associations include energy-conserving behavior and energy-conserving solutions (e.g., saving, switching off lights, energy-conserving light bulbs, taking a shower, etc.), together with environmental protection, as well as some terms related to economics and politics. In the association network, where the most frequently mentioned associations are included, in addition to associations related to renewable energy resources and their use, energy-conserving behavior and solutions, terms from other association fields were found in a much smaller proportion. The concept of sustainability, concepts related to education, associations with the role of science or words about empathy were not encountered in the networks. This confirms once again the shortcomings that were visible in the evaluation of the association fields.

Regarding the groups of students, no significant difference was found in the relationship between stimulus words. However, taking into account the lack of significant differences, the network of the first-year pre-service teachers studying at the Faculty of Science was the most complex. In the networks of final-year students, fewer connections were observed compared to the first-year students. Therefore, there was

no recognizable difference between first-year and final-year students or between students majoring in arts and science in terms of the relationship with EA. Renewable energy is a separate concept for them, not linked to other stimulus words. The same can be seen in the case of the energy crisis as well. Closely related concepts in their knowledge were energy conservation, conscious energy use and energy efficiency, most often interpreted as energy-conscious behavior. All this refers to isolated, definitive knowledge, which means that this knowledge is most encountered at the conceptual level, both inside and outside school. There is a lack of attitudinal, correlative educational methods at different levels of education, and the society does not pay enough attention either to enlightenment and awareness-raising that takes into account all aspects of EA.

Our results revealed that the interdisciplinary knowledge of the studied pre-service teachers related to energy awareness was unbalanced. As a result of the combined effect of society and education, their knowledge is dominated by behavioral elements related to everyday life. Their knowledge is definitive, they often do not connect well-known concepts, or do not see the relationship between them. This fundamentally weakens global thinking and approach that teachers have to possess in order to educate their students to be energy-conscious citizens. These results, in accordance with previous research (Fernández et al., 2023; Dimenäs & Alexandersson, 2012), demonstrate that there are shortcomings in the interdisciplinary approach to sustainability in terms of energy awareness in the studied institutions. Eliminating this shortcoming requires a completely new approach. There is a need for curricula that serve interdisciplinary knowledge both in content and teaching methods regardless of teacher discipline (Pegalajar-Palomino, 2021). On the other hand, the interpretation of sustainability as an interdisciplinary system is the result of a longer development process, the prerequisite of which is that the person has the ability to think globally and see the complexity, in possession of which the connections between disciplines can be realized in order to understand and solve phenomena and problems in a holistic way. This is why we can agree with the statement of Dimenäs and Alexandersson (2012) and also Fernández et al. (2023) that in order to effectively address the problems of sustainability, there is an urgent need to teach not only sustainability, but also the natural and social science disciplines necessary for it, emphasizing an interdisciplinary approach to natural and social phenomena, thus developing a personality with a global mindset and a much better ability to see connections. The combined application of pedagogical and psychological methods also plays a significant role in the formation and development of this ability, i.e., education for sustainability is an interdisciplinary task not only in terms of content but also in terms of education.

School and higher education play a significant role in the process by which students eventually become energy-conscious teachers. In this process, great responsibility lies with education policy, education regulators, educational documents, school environment, teaching methods and, last but not least, the knowledge, preparedness and attitude of teachers in relation to sustainability.

The study showed no appreciable difference in EA between pre-service teachers preparing to teach different disciplines. In our case, this is a problem because science pre-service teachers study several sustainability-related courses. The question is: To what extent does this give procedural knowledge? Moreover, greater emphasis on sustainability education is also needed in the case of humanities students. On the other hand, sustainability knowledge should also be incorporated into the courses for students at the Faculty of Arts in different disciplines. Universities should provide more

opportunities for projects and events dealing with sustainability, where students can participate in sustainability-related tasks interactively, regardless of their specialization. As sustainability-related issues and problems multiply day by day, sooner or later it will become necessary to include content and attitudes related to sustainability goals in courses specifically designed for this purpose. For example, the energy issue, like climate change (Fernández et al., 2023), has grown so that it requires courses designed for it. In the future, higher education institutions should consider incorporating such courses into curricula, especially in teacher training (any teacher specialization), which would be a progress in developing sustainable education (Salite et al., 2021).

It does not matter what the major of an educator is and where they teach. Education for sustainability, including EA, is a common task of all teachers, regardless of their major. They must be able to transfer their knowledge and attitude to their students, highlighting the relationships without which the problems of sustainability and the future of the Earth cannot be understood and managed.

References

- Aisli Celik, S. (2021). Pre-service teachers' attitudes and metaphoric perceptions towards renewable energy resources. *International Online Journal of Education and Teaching (IOJET)*, 8(4), 2334–2352. <https://eric.ed.gov/?id=EJ1318716>
- Alghamdi, A. K. H., & El-Hassan, W. S. (2019). Raising Saudi students (energy) sustainability awareness through ESL – teachers' thoughts. *Journal of Teacher Education for Sustainability*, 21(1), 137–154. <https://doi.org/10.2478/jtes-2019-0011>
- Andić, D., & Vorkapić, S. T. (2017). Teacher education for sustainability: The awareness and responsibility for sustainability problems. *Journal of Teacher Education for Sustainability*, 19(2), 121–137. <https://doi.org/10.1515/jtes-2017-0018>
- Bell, D. V. J. (2016). Twenty-first century education: Transformative education for sustainability and responsible citizenship. *Journal of Teacher Education for Sustainability*, 18(1), 48–56. <https://doi.org/10.1515/jtes-2016-0004>
- Bialynicki-Birula P., Makiela, K., & Mamica, L. (2022). Energy literacy and its determinants among students within the context of public intervention in Poland. *Energies*, 15(15), 53–68. <https://doi.org/10.3390/en15155368>
- Bilen, K., Özel, M., & Sürücü, A. (2013). Fen bilgisi öğretmen adaylarının yenilenebilir enerjiye yönelik tutumları [Pre-service sciences teachers' awareness about renewable energy]. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi*, (36), 101–111. <https://dergipark.org.tr/en/download/article-file/55862>
- Cebesoy, Ü. B., & Karisan, D. (2017). Investigation of preservice science teachers' knowledge, teaching efficacy perceptions and attitude towards renewable energy sources. *YYU Journal of Education Faculty*, 14(1), 1377–1415. <http://dx.doi.org/10.23891/efdyyu.2017.49>
- Çelik, S. (2021). Pre-service teachers' attitudes and metaphoric perceptions towards renewable energy resources. *International Online Journal of Education and Teaching (IOJET)*, 8(4), 2334–2352. <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://files.eric.ed.gov/fulltext/EJ1318716.pdf>
- Czékman, B., Kiss, J., & Tóth, Z. (2017). Tudásszerkezet-vizsgálat online szóasszociációs teszttel [Research of knowledge structure through online word association tests]. *Iskolakultúra*, 27(1–12), 56–65. <https://doi.org/10.17543/ISKKULT.2017.1-12.56>

- Cirit, D. K. (2017). Fen bilgesi öğretmen adaylarının yenilenebilir enerji kaynaklarına ilişkin bilgileri [Pre-service science teachers' (PST) knowledge involving the topic of renewable energy]. *Turkish Journal of Educational Studies*, 4(3), 21–43. <https://dergipark.org.tr/en/download/article-file/403126>
- Dimenäs, J., & Alexandersson, M. (2012). Crossing disciplinary borders: Perspectives on learning about sustainable development. *Journal of Teacher Education for Sustainability*, 14(1), 5–19. <https://doi.org/10.2478/v10099-012-0001-0>
- Educational Authority. (2013). *Útmutató a pedagógusok minősítési rendszerében [Guidance in the teachers' rating system]*. https://www.oktatas.hu/pub_bin/dload/unios_projektek/kiadvanyok/utmutato_a_pedagogusok_minositesi_rendszereben_6.pdf
- Emlik, H., & Ercan, O. (2017). Öğretmen adaylarının yenilenebilir enerji kaynaklarına karşı tutumları ile enerjinin etkin kullanımı ve teknolojik kirlilik farkındalıkları arasındaki ilişkinin incelenmesi [Examination of the relationship between prospective teachers' attitudes towards renewable energy sources their awareness related to efficient use of energy and technological pollution]. *Kahramanmaraş Sütcü İmam Üniversitesi Sosyal Bilimler Dergisi*, 19(3), 1194–1210. <https://doi.org/10.33437/ksusbd.878687>
- Fehér, V., & Revák, M. I. (2021). Az energiatudatosságra vonatkozó fogalmak megjelenése és azok sajátosságai általános- és középiskolai természettudományos tankönyvekben [Occurance of concepts related to energy awareness and their distinctive in features in science textbooks used in elementary and secondary school]. In D. Cseresznyés & C. Király (Eds.), *16th Carpahtian Basin Conference for Enviromental Sciences Abstract Book* (pp. 113–122). Eötvös Lóránt University, Faculty of Sciences. <https://kmkt2020.elte.hu/Abstract/Online-Absztrakt-k%C3%B6tet-Online-Abstract-book.pdf>
- Fernández, D. C., Gonçalves, A. G., & Barbero, B. S. (2023). Effectiveness of interdisciplinary instruction in pre-service teacher education for sustainability: Issues from the big history and the study of climate change. *Journal of Teacher Education for Sustainability*, 25(1), 5–21. <https://doi.org/10.2478/jtes-2023-0002>
- Genc, M. & Akilli, M. (2019). The correlation between renewable energy knowledge and attitude: A structural equation model with future's educators, *Journal of Baltic Science Education*, 18(6), 866-879. <https://doi.org/10.33225/jbse/19.18.866>
- Guirao, P. E., González, I. B., & Pérez, M. V. (2022). The relationship between sustainability and food consumption in teacher training *Journal of Teacher Education for Sustainability*, 24(2), 34–47. <https://doi.org/10.2478/jtes-2022-0015>
- Guven, G., & Sulun, Y. (2017). Pre-service teachers' knowledge and awareness about renewable energy. *Renewable and Sustainable Energy Reviews*, 80, 663–668. <https://doi.org/10.1016/j.rser.2017.05.286>
- Güneş, T., Alat, K., & Gözümlü, A. İ. C. (2013). Fen öğretmeni adaylarına yönelik yenilenebilir enerji kaynakları tutum ölçeği: geçerlilik ve güvenilirlik çalışması [Renewable energy resources attitude scale for prospective science teachers: Validity and reliability study]. *Journal of Educational Sciences Research*, 3(2), 269–289. <http://dx.doi.org/10.12973/jesr.2013.3214a>
- Hofman-Bergholm, M. (2018). Changes in thoughts and actions as requirements for a sustainable future: A review of recent research on the Finnish educational system

- and sustainable development. *Journal of Teacher Education for Sustainability*, 20(2), 19–30. <https://doi.org/10.2478/jtes-2018-0012>
- Hovardas, T., & Korfiatis, K. J. (2006). Word associations as a tool for assessing conceptual change in science education. *Journal of Learning and Instruction*, 16(5), 416–432. <http://dx.doi.org/10.1016/j.learninstruc.2006.09.003>
- Jonāne, L., & Salītis, A. (2009). Non-formal energy education in the context of sustainability: Perspective of Latvian educators. *Journal of Teacher Education for Sustainability*, 11(1), 65–74. <https://doi.org/10.2478/v10099-009-0033-2>
- Kostova, Z., & Radoynovska, B. (2008). Word association test for studying conceptual structures of teachers and students. *Bulgarian Journal of Science and Education Policy*, 2(2), 209–231. <http://bjsep.org/getfile.php?id=20>
- Kónya, Gy. (2018). Környezeti attitűdöt befolyásoló hatástényezők [Influence factors of environmental attitude]. *Képzés és gyakorlat*, 16(2), 115–125. http://real.mtak.hu/90208/1/08-Konya_Gyorgy-tanulmany-2018-02.pdf
- Kovács, L. (2009). Irányított kapcsolatok a mentális lexikonban [Directed relationships in the mental lexicon]. *Modern Nyelvoktatás*, 15(1–2), 29–40. https://epa.oszk.hu/03100/03139/00009/pdf/EPA03139_modern_nyelvoktatas_2009_1-2_029-040.pdf
- Liarakou, G., Gavrilakis, C., & Flouri, E. (2009). Secondary school teachers' knowledge and attitudes towards renewable energy sources. *Journal of Science Education and Technology*, 18(2), 120–129. <https://doi.org/10.1007/s10956-008-9137-z>
- Martins, A., Madaleno, M., & Ferreira Dias, M. (2021). Women vs men: Who performs better on energy literacy? *International Journal of Sustainable Energy Planning and Management*, 32, 37–46. <https://doi.org/10.5278/ijsep.m.6516>
- Morgil, I., Secken, N., Yucel, A. S., Ozyalcin Oskay, O., Yavuz, S., & Ural, E. (2006). Developing a renewable energy awareness scale for preservice chemistry teachers. *Turkish Online Journal of Distance Education*, 7(1), 63–74. https://www.researchgate.net/publication/26415983_Developing_A_Renewable_Energy_Awareness_Scale_For_Pre-service_Chemistry_Teachers
- Olsson, D., Gericke, N., & Boeve-de Pauw, J. (2022). The effectiveness of education for sustainable development revisited - a longitudinal study on secondary students' action competence for sustainability. *Environmental Education Research*, 28(3), 405–429. <https://doi.org/10.1080/13504622.2022.2033170>
- Pegalajar-Palomino, M. C., Burgos-García, A., & Martínez-Valdivia, E. (2021). What does education for sustainable development offer in initial teacher training? A systematic review. *Journal of Teacher Education for Sustainability*, 23(1), 99–114. <https://doi.org/10.2478/jtes-2021-0008>
- Sahakian, M., & Seyfang, G. (2018). A sustainable consumption teaching review: From building competencies to transformative learning. *Journal of Cleaner Production*, 198, 231–241. <https://doi.org/10.1016/j.jclepro.2018.06.238>
- Salite, I., Fjodorova, I., & Ivanova, O. (2021). Does the JTES help us create deeper personal meanings for sustainable education? *Journal of Teacher Education for Sustainability*, 22(2), 1–6. <https://doi.org/10.2478/jtes-2020-0012>
- Saraç, E., & Bedir, H. (2014). Sınıf öğretmenlerinin yenilenebilir enerji kaynakları ile ilgili algıları üzerine nitel bir çalışma. [Primary school teachers related to perceptions of renewable energy sources on the qualitative research]. *Kara Harp Okulu Bilim Dergisi*, 24 (1), 19–45. <https://dergipark.org.tr/tr/pub/khobilim/issue/34212/378195>

- Stylos, G. Gavrilakis, C., Goulgouti, A., & Kotsis, K. T. (2023). Investigating energy literacy of pre-service primary school teachers in Greece. *Interdisciplinary Journal of Environmental and Science Education*, 19(4), e2318. <https://doi.org/10.29333/ijese/13725>
- Szalóczy, Zs. (2023). *Energia válság és megújuló energiák [Energy crisis and renewable energy]*. <https://www.linkedin.com/pulse/energia-v%C3%A1ls%C3%A1g-%C3%A9s-meg%C3%BAjul%C3%B3-energi%C3%A1k-zsolt-szal%C3%B3czy>
- Tayci, F., & Uysal, F. (2012). A study for determining the elementary school students' environmental knowledge and environmental attitude level. *Procedia – Social and Behavioral Sciences* 46, 5718–5722. <https://doi.org/10.1016/j.sbspro.2012.06.504>
- United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development*. Paris: United Nations. https://www.unfpa.org/sites/default/files/resource-pdf/Resolution_A_RES_70_1_EN.pdf
- Veisson, M., & Kabaday, A. (2018). Exploring the preschool teachers views on professionalism, quality of education and sustainability: International study in Estonia and Turkey. *Journal of Teacher Education for Sustainability*, 20(2), 5–18. <https://doi.org/10.2478/jtes-2018-0011>
- Zyadin, A., Puhakka, A., Ahponen, P., Cronberg, T., & Pelkonen, P. (2012). School students' knowledge, perceptions, and attitudes toward renewable energy in Jordan. *Renewable Energy*, 45, 78–85. <https://doi.org/10.1016/j.renene.2012.02.002>
- Zyadin, A., Puhakka, A., Ahponen, P., & Pelkonen, P. (2014). Secondary school teachers' knowledge, perceptions, and attitudes toward renewable energy in Jordan. *Renewable Energy*, 62, 341–348. <https://doi.org/10.1016/j.renene.2013.07.033>

Correspondence concerning this paper should be addressed to Dr. Ibolya Markóczi-Revák. University of Debrecen, Debrecen, Hungary. Email: revaknemi@gmail.com