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Greek preservice primary teachers' perceptions of and attitudes toward bioenergy

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ABSTRACT
Long-term energy supply constitutes a pressing global issue. As a renewable energy resource, bioenergy can play a significant role in energy sustainability. The present study aimed to investigate the attitudes and perceptions of bioenergy amongst 412 Greek preservice primary teachers utilising a specific tool, the IBPAMS. Results confirmed the factorial validity and reliability of the Greek version of the IBPAMS. It also demonstrated that the energy and bioenergy-related knowledge of preservice teachers is moderate and poor respectively, while critical perceptions are held over the sustainability of forest-based bioenergy production. Overall preservice teacher attitudes toward bioenergy are positive. Statistical analyses showed that gender influenced the responses of the motivational and critical aspects of the IBPAMS-GR. The paper's findings have important implications for teacher preparation programs.

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Introduction

The use of fossil fuels for energy production is the main contributor to greenhouse gas emissions (Arabatzis, 2013; Halder, 2016). Renewable energy sources can contribute to emission reductions leading to climate change mitigation, rural economic development and an energy security increase (Bahrami & Mohammadi, 2021; Eymur, 2017; Halder, 2014a; Han & Martin, 2018; Mahat at al., 2018; Rather et al., 2022; Welfle, 2021; Qu et al. 2010). Bioenergy is one such renewable energy source which is widely used in the world today and represents about 10% of global annual energy consumption (Halder, 2012; Halder et al., 2014). Bioenergy originates from biomass sources which include wood and wood residues, short rotation forestry, energy crops, agricultural residues, and organic waste from industry, farms and households (Özbaş, 2016; Toklu, 2017).

Bioenergy can offer considerable opportunities for social, environmental and economic benefits, if properly utilised (Halder, 2016; Rather et al., 2022) while negative consequences of bioenergy use (water scarcity, greenhouse gases emissions, deforestation, food insecurity) can be overcome via the expansion of modern bioenergy technologies (Halder, 2012; Qu et al., 2012).

According to Halder (2015, p. 59) "the transition from a society that is heavily dependent on fossil fuels to a society embracing renewable energy technologies is a great challenge." Young people including school students as future decision makers, and current energy consumers, are key players in the creation of a sustainable planet (Van Dael, 2017; Halder, 2014a; Qu et al., 2011). Therefore, the role

of education is very important given that young people's values, perceptions, attitudes, knowledge, capabilities and energy awareness are developed during the formative school years thus encouraging the endorsement of sustainable practices into their everyday lives (Alemayehu et al., 2014; Alghamdi & El-Hassas, 2019; Demirci Saygı & Şahin, 2023; Funa et al., 2022; Halder, 2014b; Han & Martin, 2018; Liarakou et al., 2009; Mahat et al., 2020; Mitra et al., 2015; Özalemdar, 2021; Tsoumanis et al., 2023; Qu et al., 2011; Van Dael, 2017; Zografakis et al., 2008). Consequently, the role of teachers is crucial as Zyadin et al. (2014, p.342) suggest: "Teachers are the principal component at the heart of education and the pedagogical process, and are thus the keystone of knowledge dissemination and enhancing societal acceptance of newly developed technologies." Similarly, Halder et al., (2016, p. 79) emphasise that teachers' "perceptions and attitudes concerning bioenergy technologies could have an impact on the students' psychological dimensions related to bioenergy." It turns out that understanding the perceptions and attitudes of learners and teachers towards bioenergy and its use is significant. Studies have shown that teachers tend to present several difficulties in their understanding of the bioenergy field (Halder, 2015). For instance, Halder (2015) found that the majority of a sample of 28 Indian science teachers were unaware that the use of bioenergy could release CO2 into the atmosphere and several ignored the use of bioenergy-based liquid fuels in motor vehicles. In Ethiopia, Alemayehu et al. (2014) revealed that science teachers had poor knowledge (awareness), attitudes and perceptions of bio-energy resources. Science teachers from Finland and India demonstrated positive perceptions of bioenergy, even though they expressed doubts over the effect of bioenergy production on biological resources (Halder, 2016). Additionally, in Jordan, secondary school teachers indicated that producing biofuels (e.g., bioethanol) from agricultural crops may cause a food crisis and that the energy produced from forest biomass incineration isn't environmentally friendly (Zyadin et al., 2014). In another study, Chinese university students' attitudes were positive towards bioenergy, but slightly less positive towards forest bioenergy (Qu et al., 2011). In Greece, a study conducted amongst students enrolled in a Technological Educational Institute found that most were in favour of renewable energy systems e.g., bioenergy (Charisiou & Goula, 2014). Similarly, Zabaniotou et al. (2019) showed that Engineering and IT undergraduate students had positive perceptions of bioenergy implementation. Thisstudent sample also believed that bioenergy would not necessarily present health or environmental risks if systems and plants were planned sustainably. Savvanidou et al. (2010) interviewed 571 respondents picked from busy spots in three Greek cities and indicated that there was a significant lack of information about biofuels, low concern over dependency on fossil fuels, and a poor awareness of other renewable energy resources aside from bioenergy. Respondents generally held the belief that the use of bioenergy is a solution that can mitigate climate change.

Students in secondary education hold similar beliefs. In this regard, Özbaş (2016) found that they tend to be interested in learning about and using bioenergy, and support the argument that bioenergy could prevent the world from global warming while realising that energy production from forests is unsustainable. In two cross-national studies, school students from Finland and India believed that bioenergy could contribute to climate change mitigation and fossil fuel reduction. In another study, learners from Finland, Taiwan, Turkey and Slovakia indicated poor levels of bioenergy knowledge and negative perceptions of forest-based bioenergy production but had positive attitudes toward bioenergy (Halder et al., 2012; Halder, 2016). Halder et al. (2010) found that a small percentage had a high level of knowledge about bioenergy. In Greece, results from studies at secondary level demonstrated positive attitudes towards using bioenergy and a strong will to be environmentally informed (Kapassa et al., 2013).

Apart from education, other factors such as gender, secondary school specialisation and past academic performance, locality and family socioeconomic status affect students' achievement in science (Acar, 2019; de Clercq et al., 2013; Fasasi, 2017; Halder et al., 2010; Martin et al., 2016; OECD, 2016; Authors, 2021). For instance, the PISA survey shows that boys tend to perform better than girls (OECD, 2016). However, in Greece, according to the results of both the PISA 2006 and 2015, girls seem to outperform boys in sciences (Giannikopoulos et al., 2010; Sofianopoulou et al., 2017). At the university level, the results of a study conducted among first-year students from six different faculties

indicated that men performed better than women in a theoretical assessment and that the mother's educational level affected overall student achievement (Authors, 2021). Furthermore, students from rural schools had acquired better knowledge of bioenergy than those from urban schools (Halder et al., 2010).

In this context and considering the importance of the education sector in fostering environmental awareness amongst the world's future citizens, the present study aimed to investigate the perceptions and attitudes of Greek preservice primary teachers toward bioenergy. Please use Palatino Linotype as the font type, 10 points as the font size; single line spacing, zero spacing before and after paragraphs; justify the text, and do not use indentations throughout the article.

The Present Study

The main purpose of this study is to investigate Greek preservice primary teachers' perceptions and attitudes toward bioenergy. The International Bioenergy Perceptions and Attitudes Measurement Scale (IBPAMS) developed by Halder et al. (2012) was translated into Greek. The study's objective was four-fold:

(1) To test the validity and reliability of the Greek version of the IBPAMS.

(2) To investigate preservice teachers' perceptions of and attitudes towards bioenergy.

(3) To investigate differences in attitudes and perceptions according to gender, locality, parents' educational level and high school specialisation.

Methods

Data Collection

A convenience sample of 412 undergraduates (67 male, 345 female) in their second and third years of study, and enrolled in the Department of Primary Education at the University of Ioannina was used. The students anonymously completed the questionnaires at the beginning of the academic year. The research assistants followed a scripted, standard protocol for introducing the study, obtaining participants' informed consent and explaining associated assurances, giving instructions on completing the instrument and monitoring students as they completed the questionnaires.

Instrument

The instrument used for this study was a modified version of the International Bioenergy Perceptions and Attitudes Measurement Scale, IBPAMS (Halder et al., 2012). It consists of 18 items across a 5-point Likert-type scale ranging from strongly disagree (=1) to strongly agree (=5). In the present modified version, one more question was added (Item 7) to investigate the sustainability of bioenergy production from forests in Greece.

Two single questions by DeWaters & Powers (2011) answered on a 5-point Likert scale ranging from 1 to 5 were also included to evaluate:

a) Self-assessed energy knowledge (How much do you feel you know about energy? 5= a lot – expert, 4=Quite a bit – informed 3= "medium" amount –somewhat informed 2= Not much – novice, 1=Nothing – not in the running).

b) Self-assessed bioenergy knowledge (How much do you feel you know about bioenergy? 5= a lot – expert, 4=Quite a bit – informed 3= "medium" amount –somewhat informed 2= Not much – novice, 1=Nothing – not in the running).

The questionnaire also included demographic variables (gender, parents' educational level [from 1 (primary school) to 4 (post graduate degree)], high school course specialisation and locality.

Item 3 "Increasing bioenergy production leading to a decrease in food production is considered a negative impact of bioenergy" was reverse scored. Among the items on the questionnaire, eleven items corresponded to students' perceptions of bioenergy and seven items related to their attitudes toward bioenergy (Table 1).A convenience sample of 412 undergraduates (67 male, 345 female) in their second and third years of study, and enrolled in the Department of Primary Education at the University of Ioannina was used. The students anonymously completed the questionnaires at the beginning of the academic year. The research assistants followed a scripted, standard protocol for introducing the study, obtaining participants' informed consent and explaining associated assurances, giving instructions on completing the instrument and monitoring students as they completed the questionnaires.

Adaptation Process

The questionnaire was translated into Greek following the International Test Commission (ITC) guidelines for test adaptation (Hambleton, 2001) and suggestions from Beaton et al. (2000). Items of the original version were translated into Greek by two bilingual speakers and then another two bilingual speakers back-translated the scale to English. Minor translation discrepancies were found, and minor vocabulary changes were made. Also, a panel of researchers/experts familiar with the literature and research area examined each item of the scale to establish face validity as well as confirm the content and cultural appropriateness of the questionnaire. Minor wording changes to some items followed.

Pilot Study

The translated questionnaire was pilot tested on a small sample of undergraduates (N=20) who examined it for appropriateness with regards to the questions, clarity of meaning, language consistency and wording. The results did not indicate problems in clarity of meaning, language consistency and wording.

Results

Reliability Analysis

The overall reliability of the 18 items on the questionnaire was α=0.74 which showed a satisfactory level of internal consistency (α=0.74).

Table 1

Overall Survey Results

	Perceptions	Attitudes	Motivation	Practical	Critical
N			412		
Mean ± SD (%)	42.59±7.09	59.34±9.73	59.96±10.47	57.94±9,90	32.65±11.70
Average mean response ± SD [b]	2.13±0.35	2.97±0.49	2.99±0.52	2.89±0.49	1.63±0.58
Reliability [c]	0.58	0.83	0.83	0.68	0.68

Reliability Analysis

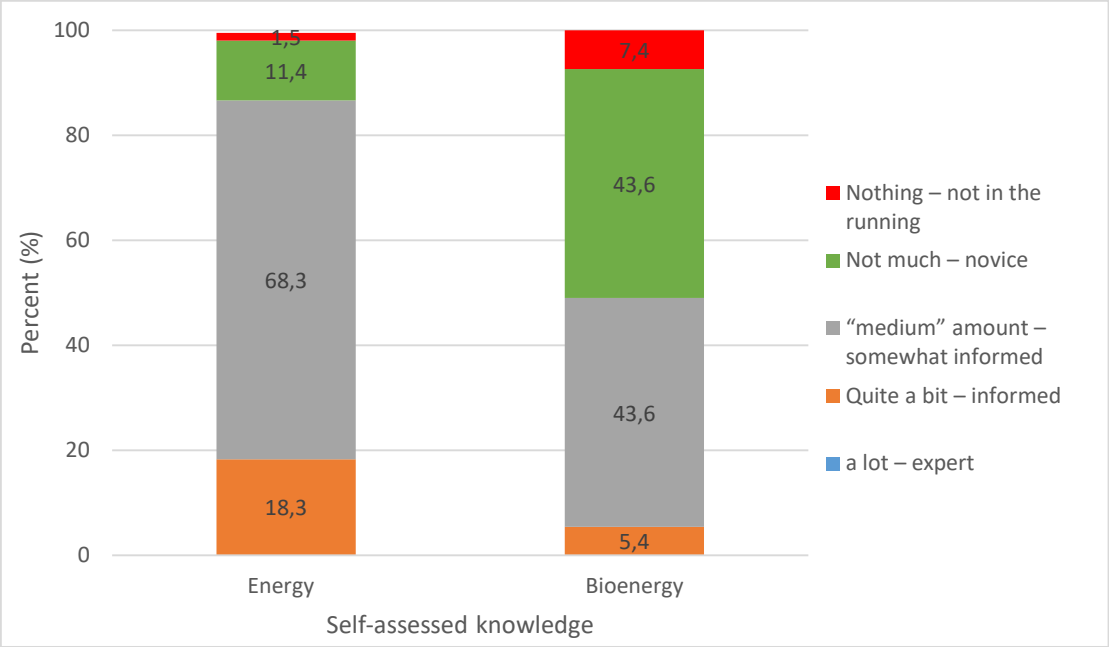
The overall reliability of the 18 items on the questionnaire was α=0.74 which showed a satisfactory level of internal consistency (α=0.74).

Self-assessed Knowledge about Energy, Bioenergy

Two questions are self-descriptions that measure energy and bioenergy knowledge. Responses showed that levels of energy and bioenergy knowledge were moderate (Figure 1).

Figure 1

Student Responses to Self-Assessed Energy and Bioenergy Knowledge



Most students (68.3%) self-categorised as moderately informed about energy. However the rate is much lower for bioenergy knowledge (43.6%). In addition, the percentage of students who declared themselves as novices (43.6%) in bioenergy is higher than the percentage of students who are deemed energy literate (11.4%). Less than one fifth of the students indicated that they have been informed about energy and even fewer about bioenergy.

Students' Perceptions of Bioenergy

Eleven items (1–11) measured students' perceptions of bioenergy; and seven items (12–18) measured their attitudes toward bioenergy (Table 2).

Among the items measuring perceptions, more than half of students (55.9%) stated that the use of bioenergy can mitigate global warming problems (Item 1) and even more students (65.3%) supported the notion that bioenergy can replace the use of fossil fuels in the future (Item 2). Item 3 explored students' perceptions of the bioenergy and food production relationship. Half the students (53%) rejected the proposition that increasing bioenergy production could decrease food production (Item 3). For the three items above, the number of undecided students was relatively high, ranging from 28.7% to 37.6%.

The next six items explored students' perceptions of bioenergy production from forest biomass. 42.6% of students indicated that wood is a major future source of bioenergy (Item 4). Those undecided and those who rejected this statement made up the remaining percentage. 54.5% of students rejected the proposition that the production of energy from wood is environmentally friendly and 47.5% dismissed the justification of cutting trees for energy production (Items 5 & 6 respectively). At the same time, most students remained undecided over the sustainability of bioenergy production from forests (Items 7 & 8) in Greece (54.5%) and globally (47.5%).

However, 75.2% of students supported tree plantations for bioenergy production (Item 9).

Finally, more than half the students (55%) demonstrated unawareness of bioenergy production or use in society (Item 10) yet the majority (88.1%) recognised the need for politicians to support the research and development of bioenergy at a societal level (Item 11).

Students' Attitudes toward Bioenergy

Students' attitudes toward bioenergy were much more positive than their perceptions of bioenergy suggested (Table 2). The proposition to use bioenergy at home in the future (Item 18: 78.7%) or to drive a car that runs on biofuel (Item 12: 65.3%) indicated their willingness to adopt bioenergy in their everyday lives. Similarly, students held a positive view toward discussing bioenergy in the school context (e.g., teachers, classmates), or at home (Items 15, 16, 17) and in learning more about bioenergy either by visiting a bioenergy plant (Item 13) or researching the topic on their own (item 14). Their responses ranged from 74.8% to 89.1%.

Table 2

Students' Responses to the International Bioenergy Perceptions and Attitudes Measurement Scale (IBPAMS)

Items	Acceptance (%)	DKn (%)	Rejection (%)
Perceptions			
1. Increased use of bioenergy can mitigate global warming problems (*M*= 2.56, S.D.= 0.739, S.E.=0.052)	55.90	37.60	6.40
2. Bioenergy can replace the use of fossil fuels in the future (*M* =2.70, S.D.= 0.735, S.E.=0.052)	65.30	28.70	5.90
3. Increasing bioenergy production will decrease food production (*M* =1.51, S.D.=0.735, S.E.= 0.052,)	9.40	37.60	53.00
4. Wood energy will be a major source of bioenergy in the future (*M* =2.11, S.D.= 0.976, S.E.=0.069)	42.60	27.70	29.70
5. Production of energy from wood is environmentally friendly (*M* =1.53, S.D.= 0.978, S.E.=0.069)	19.30	26.20	54.50
6. Cutting trees for energy production is justified (M=1.02, S.D.=0.84, S.E.=0.059)	7.40	13.90	78.70
7. Production of bioenergy from forests is sustainable in Greece (*M* =1.71, S.D.= 0.772, S.E.=0.054)	11.40	54.50	34.20
8. Production of bioenergy from forests is globally sustainable (*M* =1.79, S.D.= 0.850, S.E.=0.060)	19.80	47.50	32.70
9. Tree plantations should be established for bioenergy production (*M* =2.87, S.D.= 0.856, S.E.=0.060)	75.20	15.80	8.90
10.There is growing awareness of bioenergy in society (*M*= 1.54, S.D.= 0.853, S.E.=0.060)	16.30	28.70	55.00

11. Politicians should support the research and development of bioenergy in the society (*M*= 3.11, S.D.=0.597, S.E.= 0.042)	88.10	11.40	0.50
Attitudes			
12. I would like to drive a car in the future that runs on biofuel (*M* =2.77, S.D.= 0.773, S.E.=0.054)	65.30	30.70	4.00
13. I would like to visit a bioenergy plant in my region (*M* =3.09, S.D.= 0.723, S.E.=0.051)	85.10	12.90	2.00
14. I would like to study more about bioenergy in the future (*M* =3.09, S.D.= 0.674, S.E.=0.047)	85.60	12.40	2.00
15. I would like to discuss bioenergy with my teachers (*M* =3.13, S.D.= 0.596, S.E.=0.042)	89.10	10.40	0.50
16. I would like to discuss bioenergy with my parents (*M* =2.85, S.D.= 0.685, S.E.=0.048)	76.20	20.30	3.50
17. I would like to discuss bioenergy with my classmates (*M*= 2.82, S.D.= 0.711, S.E.=0.050)	74.80	22.30	3.00
18. I would like to use bioenergy at home in the future (*M* =3.01, S.D.= 0.665, S.E.=0.047)	78.70	21.30	0

Dimensions of Students' Perceptions and Attitudes toward Bioenergy

To determine the number of factors five criteria were used. These followed Benishek and Lopez (2001) as well as the suggestions of Pett et al. (2003) which have been reported in many studies (Kamtsios & Karagianopoulou, 2013; Raob et al., 2012; Williams et al., 2010):

- factor structure coefficients of 0.30 or greater were considered to be significant and used to interpret the factors (Stevens, 1992)
- examination of the scree plot
- factors with eigenvalues greater than 1.0
- correlation with other resulting factors
- the conceptual meaningfulness of factors.

Furthermore, the Kaiser-Meyer-Oklin Test (K.M.O) for sampling adequacy (accepted level >.50, Kaiser, 1970) and Bartlett's test of sphericity (Bartlett, 1950) were calculated to verify the appropriateness of both EFAs.

A principle-axis factor analysis was conducted to determine the factor structure of the 18 item IBPAMS with varimax rotation. The analysis produced four factors. Four items (1,3,9,10) had loadings of less than 0.5. A new factor analysis was conducted with the remaining 14 items producing 3 factors. The K.M.O. was .793 and the Bartlett's test of sphericity was statistically significant (774.264, p<.000), supporting the factorability of the correlation matrices. All items exceeded .5 on their factor, and these three factors accounted for 53.528% of the total variance.

Factor structure coefficients and factor labels are presented in Table 3. The exploratory Factor Analysis revealed three key dimensions of students' perceptions and attitudes toward bioenergy (Halder et al., 2012). A dimension named "Motivation" represented students' positive attitudes toward learning about bioenergy through different possible means. The items clustering on the same dimension named "Practical" represented the practical ways of using bioenergy in everyday life, the suggestion that politicians should support the development of bioenergy and the perception of replacing fossil fuels with biofuels in the future. The "Critical" dimension consisted of items that highlighted doubts raised over existing methods of producing bioenergy from forests which were considered by many as unsustainable, unjustified, or being environmentally unfriendly (Table 4).

Table 3

Exploratory Factor Analysis of the IBPAMS Items

Rotated Component Matrix[a]			
	1	2	3
Motivation			
16. I would like to discuss bioenergy with my parents	.816		
17. I would like to discuss bioenergy with my classmates	.796		
14. I would like to learn more about bioenergy in the future	.754		
15. I would like to discuss bioenergy with my teachers	.730		
13. I would like to visit a bioenergy plant in my region	.638		
Practical			
18. I would like to use bioenergy at home in the future		.740	
2. Bioenergy can replace the use of fossil fuels in the future		.648	
12. I would like to drive a car in the future that runs on biofuel		.642	
11. Politicians should support the research and development of bioenergy in society		.624	
Critical			
5. Production of energy from wood is environmentally friendly			.693
8. Production of bioenergy from forests is globally sustainable			.672
6. Cutting trees for energy production is justified			.669
7. Production of bioenergy from forests is sustainable in Greece			.653
4. Wood energy will be a major source of bioenergy in the future			.600

Table 4

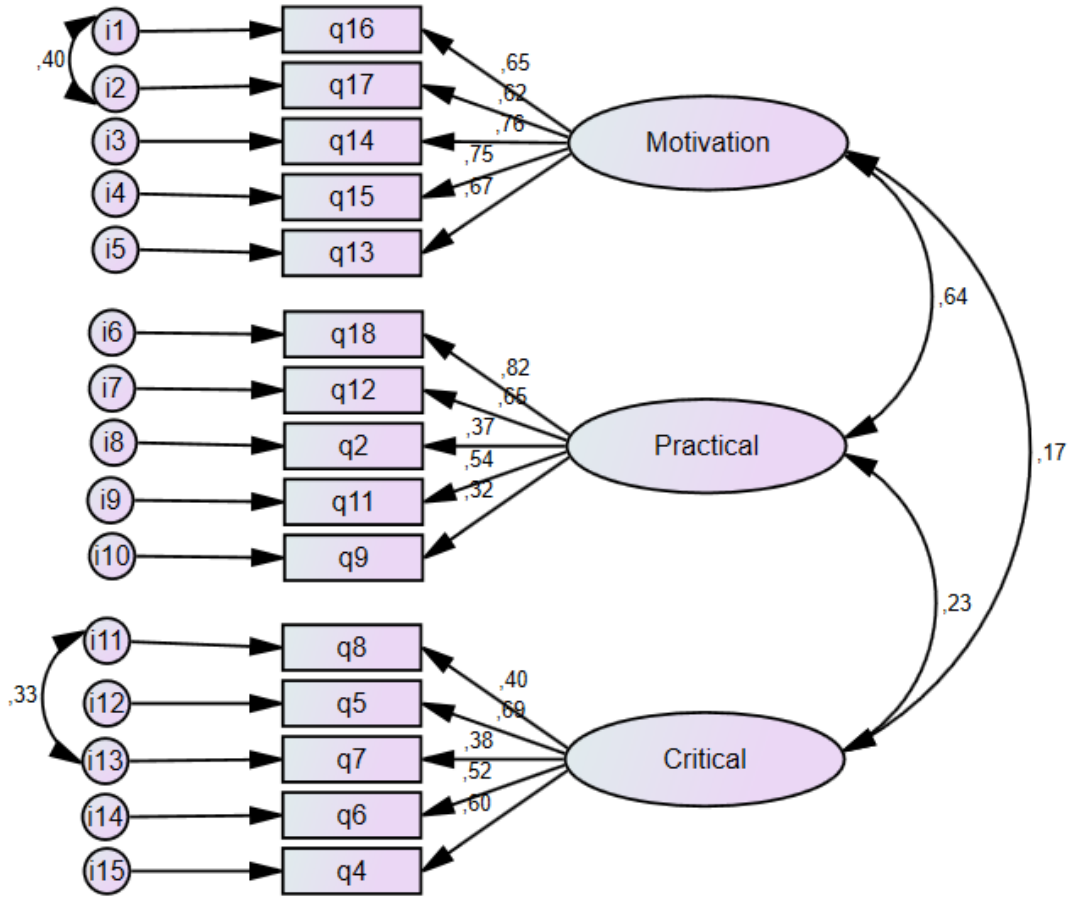
Number of Items, A-Cronbach and % of Total Variance of the IBPAMS

Factors	N (Items)	Factors Cronbach's Alpha	Percentage of variance interpreted by each factor (%)
Motivation	5	0.83	28.212
Practical	4	0.68	15.344
Critical	5	0.68	9.971

The Confirmatory Factor Analysis (CFA) AMOS tested the fit of the proposed structure of the questionnaire. As part of the CFA, factor loadings were assessed for each item. The model-fit measures were used to assess the model's overall goodness of fit (CMIN/df, CFI, TLI, SRMR, and RMSEA) and all values fell into acceptance levels (Haviz et al., 2020; Hernández Fernández & Camargo, 2022; Hu & Bentler, 1999; Mahat et al., 2018; Ullman, 2001; Stylos et al.,, 2022; Stylos et al., 2023). The factor model (motivation, Practical, Critical) yielded a satisfactory fit for the data: CMIN/df= 0.214, CFI= 0.975, TLI=0.969, SRMR=0.05, and RMSEA=0.033.

Figure 2

Confirmatory Factor Analysis on IBPAMS



Differences in Dimensions of Students' Perceptions and Attitudes According to Gender, Parents' Educational Level and High School Course Specialization

The data deviated significantly from a normal distribution and non-parametric tests were accordingly conducted (Field, 2013). Statistically significant differences were observed between men and women on two dimensions. Specifically, women, compared to men, seemed to show more positive attitudes toward learning about bioenergy (motivation) and tended to be more critical of producing bioenergy from forests (Tables 5-8).

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Table 5

Differences in Dimensions of Students' Perceptions and Attitudes according to Gender

Mann Whitney U Test				
	Gender		Mann Whitney U	p
	Male	Female		
Motivation	83.03	104.98	2129.000	.047
Practical	92.03	103.28	2417.000	.311
Critical	79.94	105.56	2030,000	.022

Table 6

Differences in Dimensions of Students' Perceptions and Attitudes according to High School Course specialization

Mann Whitney U Test				
	High School Course specialization		Mann Whitney U	p
	Social sciences/humanities	Positive/ Technological		
Motivation	93.32	99.82	2437.000	.521
Practical	92.71	102.60	2342.500	.330
Critical	97.00	83.16	2232.500	.177

Table 7

Differences in Dimensions of Students' Perceptions and Attitudes according to the Father's Educational Level

Kruskal-Wallis Test						
	Father's Educational level					
	Primary & Secondary Education	Post-secondary/ Tertiary Education	Postgraduate studies	x^2	df	p
Motivation	102.77	96.04	120.67	2.032	2	.362
Practical	101.92	94.57	137.75	5.768	2	.056
Critical	100.15	105.34	92.63	.650	2	.722

Table 8

Differences in Dimensions of Students' Perceptions and Attitudes according to the Mother's Educational Level

Kruskal-Wallis Test						
	Mother's Educational level					
	Primary & Secondary Education	Post-secondary/ Tertiary Education	Postgraduate studies	x^2	df	p
Motivation	100.54	104.20	86.81	.740	2	.691
Practical	97.61	107.73	90.88	1,749	2	.417
Critical	104.62	94.03	135.69	4,464	2	.107

Discussion and Conclusions

The main goal of the study was to investigate preservice primary teachers' perceptions and attitudes toward bioenergy. For this purpose, a specific tool (the IBPAMS) was adapted. The factorial validity and reliability of the Greek version of the IBPAMS (IBPAMS-GR) is in line with the study of Halder et al. (2012).Greek preservice primary teachers showed moderate and poor levels of energy and bioenergy knowledge respectively. In comparison to other renewable resources, it seems that the concept of bioenergy is relatively unknown to students. While these results are in line with previous studies (DeWaters & Powers, 2011; Halder et al., 2010; Halder et al., 2012), they however contradict the findings of the study by Delshadet al. (2010) who found that university students were well aware of the notion of bioenergy and exhibited positive perceptions of second-generation biofuels only.Preservice teachers held critical perceptions regarding the sustainability of forest-based bioenergy production. Half the students questioned demonstrated that the use of bioenergy can contribute to global warming mitigation and the replacement of fossil fuels without causing food crises, a finding that equally corresponds to that of Halder et al. (2014c) and Özbaş (2016). However, the same proportion of students were undecided over the sustainability of bioenergy production from forests (Halder et al., 2010; Halder et al., 2012; Halder, 2014a; Özbaş, 2016). About half the sample rejected the view that forest-based bioenergy production is environmentally friendly or that there is a growing awareness about bioenergy in society and more so could not justify forestry bioenergy as a good practice. However, most students are in favour of tree plantations for bioenergy production and political support in the development of bioenergy.Students' attitudes were generally more positive than their perceptions of bioenergy suggested. More than three quarters of students held positive views toward learning about bioenergy in formal (school) or informal (home) settings and using bioenergy at home or driving a car on fuel derived from bioenergy. These results are consistent with previous studies conducted with teachers (Halder, 2016; Halder et al., 2016), secondary students (Halder et al., 2012;2013; Özbaş, 2016) and university students (Kapassa et al., 2013; Zabaniotou et al., 2019) but contrary to the finding of the study by Alemayehu et al. (2015).Similar to Halder et al. (2012), the principal component analysis showed three aspects of preservice teachers' attitudes and perceptions of bioenergy: motivation, practical and critical as described above. The scores revealed that the motivation-driven and practical aspects were satisfactory and the critical aspect was low. Analyses on statistical differences indicated that gender was the only variable that affects the aspects. Specifically, women were more motivated and critical than men. Studies have provided consistent results that women are more environmentally directed than men (Zelezny et al., 2000, Tranter, 2011). The low level of critical perceptions may be due to the lack of awareness or limited knowledge of bioenergy issues, concerns over air quality or reduction of forest lands, and conflicting views expressed by experts and non-experts alike.

Implications – Limitations

The use of bioenergy alone cannot solve all environmental problems. However, it can contribute and play a key role in this direction. Negative attitudes and perceptions of bioenergy do not promote its acceptance. Schools and universities are encouraged to create awareness and improve knowledge about bioenergy. To achieve an energy literate society significantly depends on teachers, who are the most important element in implementing educational reform. Teacher preparation programmes should focus on their students' training in renewable energy, energy technologies, and sustainable energy use. Teachers equipped with knowledge and skills can actively participate in their students' energy literacy skills formation.

Although the study's findings cannot be generalised, they provide information about bioenergy-related attitudes and perceptions among a sizeable sample of preservice teachers. Proposals for future research include selecting a larger sample of preservice and in-service teachers. Finally, future researchers should focus on improving students' awareness and knowledge of bioenergy,

which will improve their perceptions of bioenergy. Therefore, we suggest that research could be directed towards developing curricula that include topics like modern renewable energy technologies and their impacts on sustainability.

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