European Journal of Education and Pedagogy
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The Science and Technology Courses that Choose the Preservice Teachers during their Studies in Greece

Konstantinos T. Kotsis, Nikoleta Siarka, and Georgios Stylos

ABSTRACT

Education has as its fundamental goal the cultivation, socialization, and smooth integration of individuals into the needs of modern society. The goals of education include the understanding of the content of the Physical Sciences (P.E.) course, which is analyzed at all educational levels, as well as the necessity of the modern teacher to know Physical Sciences. The present work has as its object of study the investigation of the preference of the elective courses of Physical Sciences, Technology, Environment, and Mathematics. 140 students of the Undergraduate Study Program of the Department of Primary Education of the University of Ioannina (DPE) participated in the research carried out. The questionnaire, completed by the students, consists of 33 multiple-choice, closed, and open-type questions. A descriptive analysis of the responses for each question and the correlation of student preference with Gender and High School Orientation Group was performed. According to the results, it seems that students generally choose more Physical Sciences and Environment courses than Technology and Mathematics. Regarding the comparison between Gender, for all four years of study, females seem to prefer these electives more than males. Regarding the Orientation Group, the students coming from the Humanities Studies show, with a small difference, a greater preference than those from the Sciences Studies and Economics and Computer Studies. Of particular interest are the results regarding how courses are selected and, in general, with the existing curriculum related to Gender.

Keywords: Preservice Teachers, Physical Sciences, Primary Education, Technology.

Published Online: May 22, 2023

ISSN: 2736-4534

DOI :10.24018/ejedu.2023.4.3.666

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I. Introduction

Education has as its fundamental goal the cultivation, socialization, and smooth integration of individuals into the needs of modern society. As it is understood, understanding the content of the Physical Sciences course is also included in the goals of education. The specific course is analyzed at all educational levels, demonstrating its effect on the preference for compulsory and elective courses offered by the Department of Primary Education of the University of Ioannina (DPE).

The course of Physical Sciences plays an important role in the education of students, which is why there has been a steady increase in teaching hours in the Greek school curriculum in recent decades (Kokkotas, 1989).

In Primary Education, the teaching of sciences must mainly serve the goal of systematic observation, the student's awareness of the evolution of phenomena (observational dimension) ("Physics" 6th Grade Research and Discover Teacher's Book, 2011). According to the Analytical Curriculum (Government Gazette 304B/13-3-2003), the course "Environmental Studies" is taught in grades 1, 2, 3, and 4, in which references are made to phenomena related to the Physical Sciences (energy, bodies) and in 5th and 6th, the course "Physics," in which a more detailed approach and deepening of physical phenomena is made. The Sciences course should not be based only on the theoretical background but should also have a practical dimension. Teaching Sciences in Primary Schools (Government Gazette 304B/13-3-2003) should have a clear laboratory orientation. According to the latest Ministerial Decision 160407/D1/2021 – Official Gazette 5928/B/16-12-2021 (applied on a pilot basis), the education of sciences in recent years has been oriented towards the implementation of interdisciplinary STEM (Science, Technology, Engineering, Mathematics) approaches. The activities carried out in the context of teaching should strengthen the development of students' ability to create, the use of new technologies as learning and thinking tools, the development of problem-solving techniques, and the cultivation of methodological skills. Thus, with the use of IT (Information and Communication Technology) (modeling, simulation, visualization programs, videos, etc.), it becomes possible to study and analyze phenomena that would be difficult to carry out either due to time or due to the inability to record observations or equipment available in the school unit.

Concerning Secondary Education, teaching should, in principle, aim at the qualitative approach to the interpretation of phenomena (interpretive dimension) with a gradual introduction to quantitative relationships and formalism) ("Naturally" 6th Grade Research and Discover Teacher's Book, 2011). It is a separate academic subject consisting of purely physical concepts without the involvement of other disciplines, e.g., Chemistry). According to the Analytical Curriculum (Government Gazette 304B/13-3-2003), it is taught in all classes of Secondary Education and is expanded and enriched depending on the level. As in the Primary and the Secondary, the same methodological framework is followed, which includes the trigger of interest, formulation of hypotheses, experimentation, formulation of the theory, and continuous control.

Furthermore, the teaching is not only focused on the macrocosm but also on the microcosm. In this context, the importance of performing experiments during the educational process is emphasized (Government Gazette 5518/B/29-11-2021). Of course, due to the lack of logistical infrastructure and the inherent impossibility of performing some experiments, using the ideas and connections schematically referred to as PHYSICS (Physics, Technology, Engineering Sciences, Mathematics, Language) is used foreseen (implemented on a pilot basis). It is, in other words, a variation of STEM which integrates technology into the specific educational context of the investigation. Its activities concern the utilization of sensors – haptics, visualizations, simulations, conceptual mapping, video analysis software, etc.

As far as Higher Education is concerned, teaching must be consolidated with the completion of quantitative treatment and mathematical formalism (formalistic dimension) ("Naturally" 6th Primary Research and Discover Teacher's Book, 2011). Natural Sciences are taught in many schools, each approaching it in a different context. In particular, the Sciences course is compulsory at the Department of Primary Education of the University of Ioannina. However, it is also offered in elective courses, several of them of a laboratory nature. They focus mainly on applications in everyday life and on experiments to formulate concepts in the physical world, with no emphasis on solving them with mathematical operations. Finally, students become familiar with learning theories but also with alternative teaching methods, mainly with the use of ICT, as it leads to the improvement of the educational project (Baer, 1998 & Government Gazette 5381/B/19-11-2021) and seems to work, reinforcing both teaching and learning (Kisla *et al.*, 2009; Bikos, 2012; Nagler & Ebner, 2009).

The training of teachers in Greece first started in 1834. According to Antoniou (2002), the subjects taught to the students were at the beginning, mainly theoretical, while in 1840, the Physics course was added. The first University Departments of Primary Education were established in 1982 by Law 1268/82, including the department at the University of Ioannina, which began operating in 1984. For their admission, there are written exams and no exams in the Academic School itself as was done in the Pedagogical Academies. According to the New System of 2016, students can come from all three Orientation Groups (Humanities Studies, Sciences Studies, Economics, and Computer Studies), choosing the appropriate scientific field of specialization (E.O.E., 2016).

In the modern era, the demands of the educational process are constantly increasing. Therefore, the teacher is called upon to respond effectively to them. The teacher should have the Pedagogical Knowledge of the Physical Sciences. Content, i.e., not only the knowledge he possesses but also skills he acquires through his experience in the classroom, which will help him "communicate" this knowledge to the students of (Baxter & Lederman, 1999. Gess – Newsome, 1999, Gess – Newsome, 2015). He must be well qualified (Athanasopoulou, 2019), to recognize the particularities of the school context in which he operates and to be able to answer the students' questions. Furthermore, it must discover new sources of learning, stimuli, supervisory and didactic means to stimulate students' interest and offer learning with an exploratory-experiential nature, leading to the discovery of knowledge (Dimitriou, 1993). Finally, his role is guiding and advisory (Mpikos, 2012), and it is considered important to be informed about developments and to be constantly educated to be able to apply the appropriate learning processes, with the contribution of T.P.E., offering the maximum learning benefits (Kekkeris, 2010).

II. Research

This research investigates the preference criteria for the elective courses in Sciences and Technology by the Department of Primary Education students at the University of Ioannina.

The number of participants amounted to 140 students from the Department of Primary Education of the University of Ioannina who were studying in their 4th year or older. Of the 140 students, 10 participated (7 Female and 3 Male) in the pilot study and 130 in the main study. During the pilot research, the participant's responses and interest in the questions, the time required to complete the questionnaire, and any deficiencies and errors in its content and difficulties related to understanding the questions were checked. The time taken to complete the questionnaire was approximately 20 to 25 minutes. The sample was taken by the random sampling method. Of these, a percentage equal to 79.3% were Female, while regarding the Orientation Group they had chosen in High School, the majority came from Humanities, with a percentage equal to 77.1%.

The questionnaire that the participants of this work were asked to fill in consists of four sections. In particular, the first section includes general questions regarding the demographic characteristics of each participant, such as gender, year of study, the number of courses "used" from previous years, the orientation group they had chosen in high school, and whether they have previous teaching experience. The second section includes questions about compulsory courses and elective courses, the usefulness of the content of the specific elective courses for their career as future teachers (five-point Likert scale), and the reason for choosing them. In addition, the third section concerns how to choose the courses offered each year, according to the Study Guide. Finally, the fourth section consists of questions on a five-point Likert scale and closed and open-type questions aimed at the general evaluation of the Study Program.

All statistical analyzes were performed with the IBM SPSS Statistics 26.0 statistical package. The descriptive analysis of the questions revealed the overall preference of the participants. Specific statistical indicators (frequency, cumulative frequency, percentages, etc.) were calculated, and the appropriate diagrams and tables were created to display the variables visually. Furthermore, a correlation between distinct variables was carried out (criterion x2) to check whether there was a statistically significant relationship between the selected variables from the correlation tables and the Chi-Square test of independence. Finally, a statistical significance test of the difference between means was performed to test the difference of preference (score) and responses compared to the demographic characteristics of the participants.

III. Results

140 students of the Department of Primary Education of Ioannina participated in the research, of which 79.3% (N=111) were Female and 20.7% (N=29) were Male, coming from the three Studies Groups of High School: Humanities, 77.1% (N=108), Sciences Studies, 17.9% (N=25), and Economics and Computer Studies, 5% (N=7).

Regarding the four-year elective courses, the courses most preferred by students were "Physics in everyday life" and "Environmental Education and Sustainability", with percentages of 84.3% and 87.1%, respectively. On the contrary, the courses with the least preference were "Digital Literacy (Spring Semester)" and "Utilization of ICT in Educational Research," with percentages below 5%.

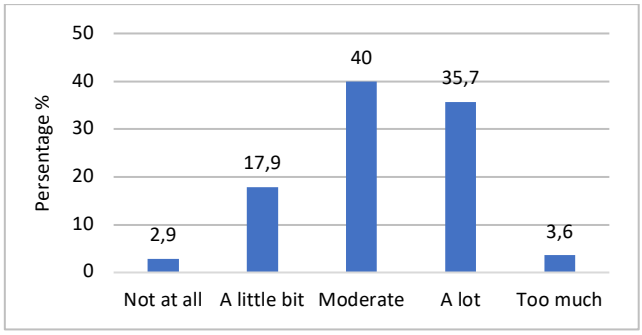

Fig. 1. The response of the Preservice Teachers to the equation "How close to the needs of a future teacher is your Curriculum in terms of compulsory subjects".

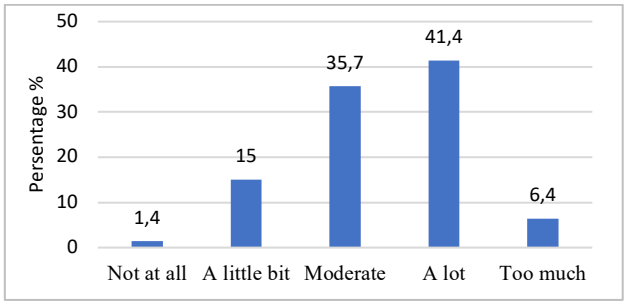

Fig. 2. The response of the Preservice Teachers to the equation "How close to the needs of a future teacher is your Curriculum in terms of electives courses".

The usefulness of the Compulsory Courses and the Elective Courses of the Study Program regarding the needs of a future teacher, as stated by the students themselves, are presented in Fig. 1 and 2.

The percentages of preference of the elective courses of Sciences, Technology, Environment, and Mathematics of the PPS of DPE are presented in Table I for all four years of study. It is observed that a large number of students do not choose elective courses in Technology. The percentages are divided for the elective courses of Mathematics and Environmental Education. Finally, there are optional courses for sciences, which show high percentages of preference.

TABLE I: The Selection Rates of the Sciences and Technology Elective Courses of the Primary Education Department

Year of Studies	Course	Do you choose it? Yes (%)	No (%)
1	Introduction to ICT in Education I	44,3	55,7
1	Digital Literacy I	5,7	94,3
1	Introduction to ICT in Education II	38,6	61,4
1	Digital Literacy II	5,0	95,0
2	Teaching and Digital Technology	11,4	88,6
2	Physics in everyday life	84,3	15,7
2	Environmental Education and Sustainability	87,1	12,9
2	Didactics of Informatics	13,6	86,4
2	Computational Mathematics – Practical Exercise	16,4	83,6
3	Experiential Teaching Techniques: Applications in Environmental and Geographical Education I	30,0	70,0
3	Experimental teaching of Science concepts	44,3	55,7
3	Experiential Teaching Techniques: Applications in Environmental and Geographical Education II	6,4	93,6
3	Atmospheric and Space Science Topics in Education	8,6	91,4
3	Educational Programming Environments	10	90
3	Laboratory Approach to Physics Concepts	30,7	69,3
4	Mathematics Teaching Issues in Primary School	50,0	50,0
4	Mathematics and Arithmetic	21,4	78,6
4	Utilization of ICT in Educational Research	0	100
4	Research Approaches to STEM Education	2,1	97,9

Table II shows the Preservice Teachers' responses, according to their opinions, on how useful each elective course is from the students who chose it.

The criteria by which students choose elective courses for all years of study are presented in Table III.

Based on the correlations made for the electives of Sciences and Technology offered in the 1st academic year (Introduction to ICT in Education I & II, Digital Literacy I & II) chosen by a greater percentage of males. Also, the students mainly come from the Group of High School of Economics and Computer Studies.

For the elective courses of the 2nd year (Teaching and Digital Technology, Physics in everyday life, Environmental Education and Sustainability, Didactics of Information Technology, Computational Mathematics-Practical Exercise), it was observed that they are chosen by both sexes, regardless of Orientation Group, who had to follow in high school. The two sexes choose these courses for similar reasons.

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TABLE II: THE STATEMENTS OF THE STUDENTS ON HOW USEFUL THEY ARE, THE ELECTIVE COURSES IN SCIENCES AND TECHNOLOGY

Course	Useful				
	Not at all	A little	Quite	A lot	Too much
Introduction to ICT in Education I	0,7	2,9	5,0	18,6	17,1
Digital Literacy I	0,7	0,7	2,9	0,7	0,7
Introduction to ICT in Education II	0,7	0,0	4,3	15,7	17,9
Digital Literacy II	1,4	0,7	2,1	0,0	0,7
Teaching and Digital Technology	0,7	0,0	1,4	7,1	2,1
Physics in everyday life	0,7	1,4	8,6	38,6	35
Environmental Education and Sustainability	1,4	2,9	20,7	32,9	29,3
Didactics of Informatics	0,7	2,9	1,4	5,7	2,9
Computational Mathematics – Practical Exercise	0,0	0,7	5	5,7	5
Experiential Teaching Techniques: Applications in Environmental and Geographical Education I	0,7	0,0	7,1	16,4	5,7
Experimental teaching of Natural Science concepts	0,0	0,7	2,9	11,4	29,3
Experiential Teaching Techniques: Applications in Environmental and Geographical Education II	0,0	0,0	2,1	2,9	1,4
Atmospheric and Space Science Topics in Education	0,0	0,7	1,4	3,6	2,9
Educational Programming Environments	0,0	0,7	2,1	6,4	0,7
Laboratory Approach to Physics Concepts	0,7	0,0	0,0	9,3	20,7
Mathematics Teaching Issues in Primary School	0,0	1,4	5,7	27,1	15,7
Mathematics and Arithmetic	0,7	0,7	5,7	7,9	6,4
Utilization of ICT in Educational Research	-	-	-	-	-
Research Approaches to STEM Education	0,0	0,0	0,0	0,7	1,4

TABLE III: SELECTION CRITERIA OF ELECTIVE COURSES

Year of Studies Criterion	1	2	3	4
Completion of required units to obtain a degree	14,3	30,7	20,0	23,6
Completing knowledge	1,4	3,6	3,6	5,0
Acquisition of new knowledge in new subject areas	-	15	7,1	4,3
Deepening due to personal interest	5,7	9,3	13,6	9,3
All the above	20,7	39,3	26,4	27,9
Other	0,7	1,4	0	0,7
I didn't choose them	49,3	0,7	29,3	29,3

Finally, for the elective courses of the 3rd year (Experiential Teaching Techniques: Applications in Environmental and Geographical Education I & II, Experimental Teaching of Physical Students Concepts, Atmospheric and Space Science Topics in Education, Educational Programming Environments, Laboratory Approach to Physics Concepts) and 4th year (Topics Teaching Mathematics in the Primary School, Mathematics and Numeracy, Research Approaches to STEM Education), was observed to be chosen by both sexes, regardless of the Orientation Group they had followed in High School. Males choose specific electives to complete the required credits for a degree, unlike females, whose choice is driven by a mix of elements (deepening, new knowledge, etc.).

Females usually choose the courses according to the subject they are dealing with and mainly the ones that interest them with a rate of over 95%.

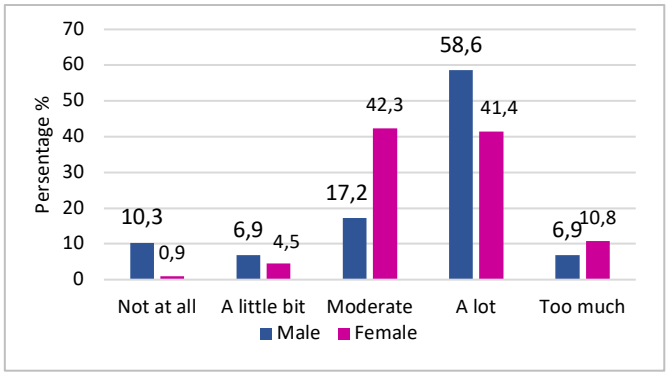

Fig. 3. The response of the Preservice Teachers to the equation "How satisfied are you with the knowledge offered by the elective courses".

The answers to the students' questions about how satisfied they are with the knowledge they received from the optional and compulsory courses of the PPS are presented in Fig. 3 and Fig. 4.

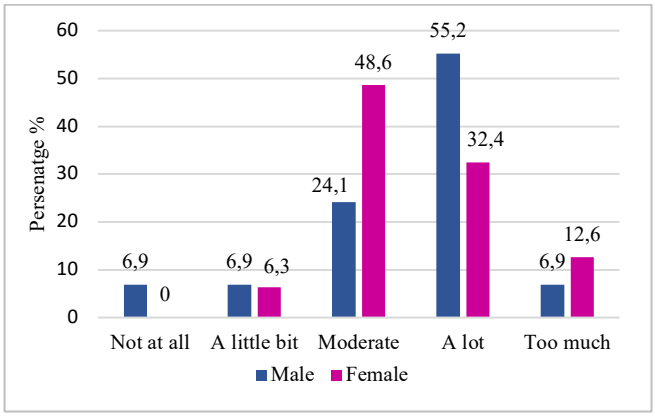

Fig. 4. The response of the Preservice Teachers to the equation "How satisfied are you with the knowledge offered by the compulsory courses?"

The general average preference for Science, Environment, Mathematics, and Technology elective courses is M=85.98. In particular, males have M=80.93 (SD=7.54), and females have M=87.30 (SD=6.625). It is observed that females prefer these electives more than males.

Because the variables do not follow a normal distribution, statistical significance testing was performed with the non-parametric Mann-Whitney U test. It was observed that there is a statistically significant difference U=858.000, z=-3.868, p=.000. That is, it appears that Gender has a statistically significant effect on Elective Course Preference, so Course Choice and Gender are dependent variables. Tables 4 and 5 show the statistical analysis to compare the results of elective course preference with respect to gender.

TABLE IV: MANN-WHITNEY TEST FOR GENDER

	Gender	N	Mean Rank	Sum of Ranks
Score	Male	29	44,59	1293,00
	Female	111	77,27	8577,00
	Total	140	-	-

TABLE V: MANN-WHITNEY TEST STATISTICS FOR GENDER

	Score
Mann-Whitney U	858,000
Wilcoxon W	1293,000
Z	-3,868
Asymp. Sig. (2-tailed)	0,000

The students who in High School followed the Humanities Orientation Group have M= 87.30 (SD= 7.05), the Sciences Orientation Group M= 81.74 (SD= 6.15), and the Economical and Computer Studies Orientation Group have M= 80.74 (SD= 7,009). It was observed that those coming from the Humanities have a higher average preference for the specific elective courses.

Because the variables did not follow a normal distribution, statistical significance was tested with the non-parametric Kruskal-Wallis test. It was observed that there is a statistically significant difference H= 16.676, p=.000. It seems, that is, that the Orientation Group has a statistically significant effect on the Selection in elective courses.

TABLE VI: KRUSKAL-WALLIS TEST FOR THE ORIENTATION GROUP

	What orientation group did you choose in high school?	N	Mean Rank
Score	Humanities Studies	108	78,10
	Sciences Studies	25	45,84
	Economical and Computer Studies	7	41,36
	Total	140	-

TABLE VII: TEST STATISTICS FOR THE ORIENTATION GROUP STUDIES IN HIGH SCHOOL

	Score
Kruskal-Wallis H	16,676
df	2
Asymp. Sig.	0,000

a. Kruskal Wallis Test.
b. Grouping Variable: Orientation Group Studies.

Tables VI and VII show the statistical analysis to compare the results of elective course preference with respect to the orientation group.

IV. CONCLUSIONS

In this paper, an attempt was made to determine the preferred elective courses of Sciences and Technology by the Department of Primary Education students at the University of Ioannina. The differences between the participating male and female students in terms of the preference of the elective courses of the specific department were identified and highlighted, regarding the demographic factors and specifically the Gender and the Orientation Group.

In particular, concerning the elective courses of Sciences and Technology during the first academic year, it was found that male students chose them in the majority. The students mainly come from the Economics and IT Studies Orientation Group. Certainly, both males and females found their content relatively useful. It should be noted that the Male chose the specific courses to complete the required units for obtaining a degree, in contrast to the Female, whose choice results from a jumble of elements (deepening, new knowledge, etc.).

Regarding the second year, it was observed that the choice of courses does not depend on Gender and Orientation Group. In other words, they are preferred by both males and females who mainly come from Sciences Studies, Economics, and ICT Studies and find their content very useful. Also, both sexes choose the particular courses for similar reasons.

Regarding the third and fourth years, most subjects seem to be equally preferred by both sexes, coming from all three Orientation Groups. Their content is generally considered very useful. The preference for specific courses depends on gender in terms of the selection, as males choose them to complete the required credits for obtaining a degree, in contrast to females, whose choice results from a jumble of elements (in-depth, new knowledge, etc.).

They consider the content of the compulsory courses average, while the elective courses are very useful for their career as future teachers. It was observed that females usually choose the courses according to the subject they are dealing with, mainly those that interest them. Also, males seem to be more satisfied with the knowledge they received from the compulsory and elective courses offered by the Study Program, in contrast to females, who, although not particularly satisfied, consider them more important than males for their future path as teachers.

Overall, across all four academic years, it was observed that the preference for elective courses in Sciences and Technology depended on both Gender and the Orientation Group they had chosen in High School, as females coming from Humanities chose them more. It should be noted that courses related to Sciences, Environment, and Mathematics are chosen more by students than courses related to Technology.

Finally, the students noted that in their school's Curriculum, they would like their internship to be longer and extend over all four years, aiming better to prepare them for their future courses in education. They suggested introducing new courses, changing theoretical courses to more practical ones with a didactic nature, and deepening specific subjects by creating more workshops for experiential learning.

CONFLICT OF INTEREST

The authors declare that they do not have any conflict of interest.

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2. Gavrilas, L., & Kotsis, K. T. (2023). Assessing elementary understanding of electromagnetic radiation and its implementation in wireless technologies among pre-service teachers. *International Journal of Professional Development, Learners, and Learning*, 5(2), ep2309. https://doi.org/10.30935/ijpdll/13191.
3. Vavoulioti, A. R., Stylos, G., & Kotsis, K. T. (2023). Acceptance of nuclear energy by pre-service teachers in Greece. *Aquademia*, 7(1), ep23004. https://doi.org/10.30935/aquademia/13205.

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