

Experimental Teaching of Biology: A Professional Challenge. How Prepared Are the Teachers of High Schools of Heraklion, Greece?

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Abstract: In this research the education and training that had been received or wished to be acquired by the Science teachers in the experimental teaching of Biology in high schools, was investigated. It focused on the laboratory practice, didactic methods that can be used in more effective experimental teaching of Biology, pedagogic methods that can be implemented in laboratory team teaching, official and legal issues related to laboratory work and the organization of the seminars, which constituted the dependent variables of a quantitative analysis. A questionnaire consisting of closed type questions was answered by Science teachers of many specialties, who served in Secondary Education at Heraklion Crete prefecture. The asked teachers had not received adequate education in carrying out laboratory exercises of Biology neither during their university studies nor in in-service training. Most of them had taught the course theoretically but a few had carried out laboratory exercises of Biology. The need of training on issues of didactic practices and evaluation was firstly classified, with a significant percentage of methods that can be applied to provoke students' curiosity in scientific issues related to daily life and recognize the value of the Life Sciences by team collaboration and respect of others.

Key words: Teachers training, experimental teaching of biology, laboratory practice.

1. Introduction

The adult education and training, particularly in issues of experimental learning and teaching, as laboratorial exercises of Natural Sciences are, is a field of considerable amount of knowledge and experience that has accumulated during last years. The training in laboratorial issues concerns all the Science teachers, not only biologists, because experimental teaching is part of their daily scientific and professional object in the high schools (Gymnasiums and Lyceums). The Greek Science teachers may teach different and various cognitive objects, and many of them are not with their own specialty, as a consequence of the different year composition of

specialties and demands of each high school. So, they need support in teaching of the new disciplines, many times in their professional life. In each high school, a teacher is in charge of the laboratorial teaching of Physics, Chemistry and Biology, supporting the rest Science teachers, for 3 h per week.

According to relative documents of the Hellenic Ministry of Education and Religion [1], concerning Secondary Education, the Laboratorial Centers of Natural Sciences (EKFE), the Regional Educational Training Centers (PEK) and the School Advisors are responsible for undertaking the organization of seminars on teaching Sciences. Generally in Greece and in Europe, the activities of continuing training, in which participates henceforth important percentage of adult population, are extended and upgraded permanently. In the training courses of C Community

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Frame of Support, it is forecasted to train 8000 teachers [2]. The conditions under which the adults are educated require different confrontation and scientific investigation is more difficult than those for the individuals of smaller ages. Until now, the local Training Centre (PEK of Heraklion) has organized seminars for permanent and newly appointed teachers, in a variety of disciplines of Sciences, without previous investigation on their training needs. In Greece, there is no central planning, coordinating agency, not even a general legal framework defining the relevant organizations, agencies, persons and standards for ongoing training [2].

The reform of the Secondary Education during the last years focuses on the teaching of Natural Sciences in high schools and promotes a more participatory and experiential teaching methodology. The new curriculums aim to help the students acquire the scientific literacy by the application of the scientific method in the cognitive objects of Natural Sciences [3]. The materialization of laboratorial exercises of Physics, Chemistry and Biology in the high schools, in a collaborative way, consists of the most comprehensive form of teaching, demanding appropriate infrastructure and expertise [4]. These are not available in all the Greek Gymnasiums, even by the school year 2004-2005 the laboratorial exercises in the courses of Natural Sciences were embodied in the high school curriculum and then they are required to be taught obligatorily. The Lyceums are better equipped but the examining logic that dominates in the Lyceums, because of the National Examinations, pushes the teachers to reject experiential methods of teaching, something that is contrary to the nature of the Natural Sciences, which are eminently experimental and not descriptive sciences and should be taught as a way of thinking and an attitude of mind [5]. The Inquiry Based Science Education has dominated as a result of the progress made in teaching of Natural Sciences [6]. Playing back of the historical sequence of the experimental steps can help in

building scientific concepts [7]. If trainees listen passively to the lectures at seminars, they do not develop their competence in action, especially for teaching science as inquiry, in contrast to the traditional teaching science as information [6].

The research goal was the investigation of the education and training that Science teachers of Heraklion prefecture have received in the experimental teaching of Biology, also, their aspects about the training needs in materializing laboratorial exercises of Biology in high schools. The research aimed to recognize and clarify the Science teachers' needs in those didactic and pedagogic methods in laboratory lessons, implementing the new Natural Sciences curriculum, which can develop the students' skills, sharpening observation and critical thinking, evaluation and respect to persons, materials and protocols. The research also focused on practical issues concerning the experimental teaching of Biology, such as official, legal, laboratory organizing, keeping rules of safety and hygiene and enabled teachers to reveal their preferences on the organizational process of future training.

The results could help the trainers in integrating and exploiting theory with good practices in more effective planning and building of training programs, according to the needs of Science teachers and the capacities of the training organizations. The people in charge of educating and training teachers and the educational policy makers needed to build up more creative planning and take correct decisions.

This research has become timely because of the restructuring taking place in Greek high schools, and especially in Science teaching, which found Science teachers unprepared, in need to apply the new curriculum with didactic, not familiar methods.

2. Materials and Methods

The Strategic Methodology that was followed, in order to approach the inquiring objects, was the Quantitative Method [8, 9]. The inquiring process of

field research was carried out in 2005 in Heraklion Crete prefecture, Greece.

2.1 The Sample and the Tools of Data Collection

The research sample consisted of 32 permanent Science teachers, in a total of 110, of Secondary Education. As the sample is convenient and opportunistic, the results of this research referred only to the teachers of the Heraklion prefecture, without general applicability. Twelve of them had attended the long seminar on “Computers in the Didactic Methodology of Natural Sciences”, after being selected by lottery among applicants twice. The rest were acquaintances and friends of the researcher. Asked teachers were of all specialties, like Biologists, Physicists, Chemists, Geologists, Naturalists, Agronomists, in an analogy according to their frequency in the schools. In each school, the majority of the Science teachers is Physicists, fewer are Chemists and Biologists, scarce are Naturalists and Geologists.

Tools of data collection, which confirmed the opinions that are formulated in the present work, constituted the questionnaires with closed type questions and the literature overview [8, 9]. The questions took shape in consideration of the opinions that had been expressed in past conferences and discussions by the Science teachers, what the researcher had participated. The questionnaires were surnamed and delivered by hand in March 2005, to the Science teachers who served in Heraklion prefecture, after a personal contact with the researcher.

2.2 The Variables

The independent variables were constituted by the personal information of asked teachers with regard to their studies, their current and previous work and previous experience in teaching Biology and carrying out laboratory exercises of Biology. They were represented with the group A of partitionist and intervallic questions. More specifically, they were

asked personal elements (the sex, the age), studies (basic studies, other degree, postgraduate title of studies, foreign language certification, use of PCs, when they had graduated from University), current work (employment type: permanent, alternate, hourly waged, the type of school they worked: Gymnasium or Lyceum, the courses of Biology that they taught in 2005), work during the previous years (years of unemployment before becoming permanent in public schools, the type of employment, the Biology courses that they had taught), school laboratory experience: number of materialized exercises of Biology, Chemistry and Physics per year in Gymnasium or Lyceum, type of experiments: of demonstration or guided.

The dependent variables were represented by the group B of Likert scaled questions [8]. The most of dependent variables constituted questions of the training needs that the sample teachers had in teaching Biological issues and laboratory practice. They were grouped and coded in the following theme fields: laboratory practice (dangers of experiments, ways to prevent and avoid them, first aids, the arrangement of laboratory vital space, the auxiliary work in laboratories, the critical functional size of school teams), didactic methods and pedagogy used in the experimental teaching of biology (more specifically ways that can be used in cultivating critical thinking of students, documenting their opinion, provoking curiosity on scientific issues of daily life that are related to the Biological issues and improving the teaching skills to record observations, to well organize the measurements, to draw the conclusions and evaluate methods, materials, protocols and themselves). The same group included questions on pedagogic methods that can be implemented in laboratory team teaching of Biology with regard to students' developing respect to others, to disciplining in instructions and guidelines, acquiring responsibility, self-confidence, healthy habits, recognizing the contribution of Natural Sciences in the quality of life.

A portion of questions referred to official and legal issues related to laboratory work (laboratory book keeping, materials, devices and experimental protocols, laboratory support, the legal cover of teachers in case of an accident, the cooperation with the head laboratory teacher). Teachers were also asked to express their opinions on the organization of the seminars: flexible timetables, the ways of selecting trainers and trainees, the venues, the advisable period and duration, the ways of teaching and learning in more effective training.

Biology is a cognitive object taught in B and C classes of Lyceums and Gymnasiums. Students of C class of Lyceum are examined in biology after their own choice, nationwide, to access academic faculties; the rest take in-school exams. Because of the very demanding exams, the instructional demands of Biology in C class of Lyceum are multiple and high. Additionally, in the issues of the curriculum, findings of the Biological research of the last 20 years are included, which were not included in the academic curriculum of the periods of the asked teachers' studies.

As the data was mainly quantitatively obtained from the questionnaires, they were grouped, categorized and analyzed in a comprehensive data treatment. In the statistical analysis, the specialized software Microsoft Excel and the Statistical Package for Social Science SPSS 6 were used. Simple percentage, intermediate indicator and the non-parametric factor of cross-correlation Spearman (r) were the major statistical tools employed in the data analysis. Searched patterns and tendencies between

categories of data, such as similarities and differences, conceptual relationships and links, also relationships between the variables and the categories, such as relationships of coherence, peer exclusion, causality and reciprocity were analyzed [10]. Then, the results were discussed in combination with the inquiring planning, the methodological frame, the theoretical questioning and the literature of the overview findings.

3. Results and Analysis

3.1 The Identity of the Research Sample

The research sample consisted of 32 permanent teachers, of ages older than 40 years, of different Natural Sciences specialties who served in Gymnasiums (51.9%) and Lyceums (40.7%) or even in both of them (7.4%) simultaneously at Heraklion secondary education region, with many years of previous experience. The majority was men (74%), 40.7% have up to 10 years of previous experience, 37.0% have 11-20 years and the rest 22.3% have more than 21 years of previous experience in the schools of secondary education. Table 1 shows the percentage of the teachers of the research sample on specialties, academic and post-graduate studies and teaching training. Most of them were Physicists (55.6%), the rest were Biologists (11.1%), Chemists (18.5%), Geologists (7.4%), Naturalists and Agronomists in equal percentage 3.7%. They had postgraduate titles of study M.Sc.D./M.Ed. (14.8%) and Ph.D. (7.4%), the 40.7% had a First Certificate in English and 74.1% were quite able to handle a Personal Computer. For

Table 1 Percentage of science teachers on specialties, academic, post-graduate studies and teaching training.

The identity of the sample regarding specialties, studies and training					
	Specialties	%		Studies & Training	%
Academic studies	Biologists	11.1	Post-graduate studies and training	M.Sc.D.	14.8
	Geologists	7.4		Ph.D.	7.4
	Agronomists	3.7		English Language (Level B)	40.7
	Physicists	55.6		Use of Computers	74.1
	Naturalists	3.7		Attended Seminars at the Regional Training Centers	63
	Chemists	18.5		Annual Training Course (SELME)	22.2

the 40.7% of the sample had passed 11-20 years since they graduated from the university faculties, for the remainder 59.3% had passed over than 21 years.

The majority of the teachers (48.2%) had been waiting for more than 10 years until they were appointed permanently in public schools, the 37% had been waiting from 11 to 16 years and only 14.8% was appointed immediately after finishing their university studies. Before appointed at the public schools, most of them offered private lessons (22.2%), 11.1% attended postgraduate Educational Programs, 25.9% had not worked as teachers and 11.1% was unemployed. The rest (29.7%) had combined the private lessons with the work in schools as associate teachers or other type of work before their appointment to public schools.

The 63.0% of asked teachers had received training in Regional Training Centers (PEK) and the 22.2% in the Yearly Training Course (SELME).

3.2 The Existing Situation

All the asked teachers had teaching experience of Biology courses in the schools of secondary education. The 51.8% teachers of the samples had taught Biology (theory only) in high schools up to 5 years and in equal percentage in the B class of Lyceum, while in the C class of Lyceum the percentage was slightly

lower (40.7%). In 2005, the 44.4% of the sample taught Biology in Gymnasium and the 25.9% in Lyceum, the rest did not teach Biology but other Science cognitive objects that year. In Fig. 1 the teaching years of Biology by the Science teachers are shown, regarding the type of high school serviced (Gymnasium or Lyceum). In percentages 18.5%, 51.9% and 37% they had not taught biology in Gymnasium, in the C and B class of Lyceum, respectively.

The materialization of laboratory exercises of biology in the high schools was very low, also does the consequent teaching experience that emanated from them. Approximately half of those asked (51.9%) had carried out laboratorial exercises of Biology in Gymnasiums, while in Lyceum, clearly less (29.6%). During the last 5 years, the 33.3% of the sample teachers had carried out up to 2 demonstration experiments of Biology per year and in 23.1% guiding students (Fig. 2). In the same period, they had carried out 3 to 5 demonstration experiments per year in percentage 14.8%, while guided 19.2%. A very small percentage of teachers (7.7%) had guided students to materialize more than 5 laboratorial exercises of Biology per year or they had materialized demonstration experiments (7.5%) within the last five-years period. The Remainder (44.4%) had not

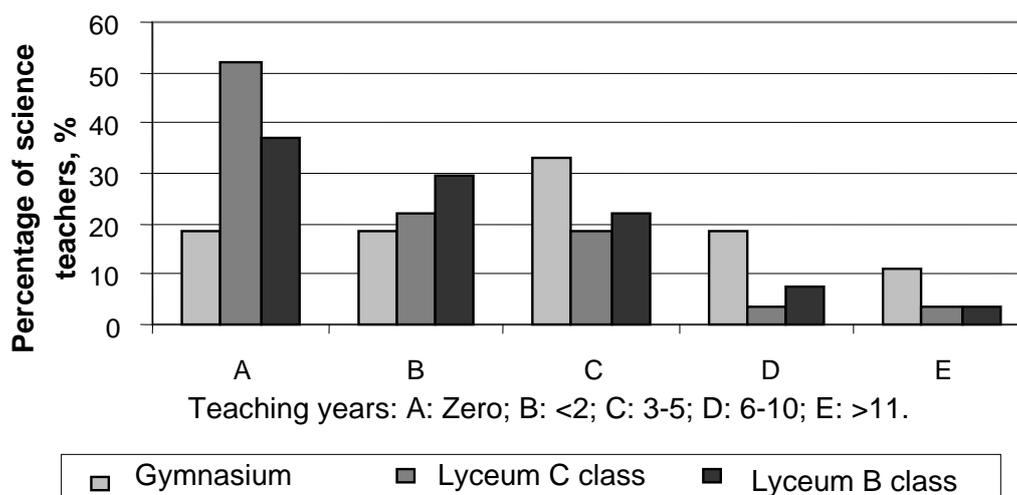


Fig. 1 Teaching experience of biology.

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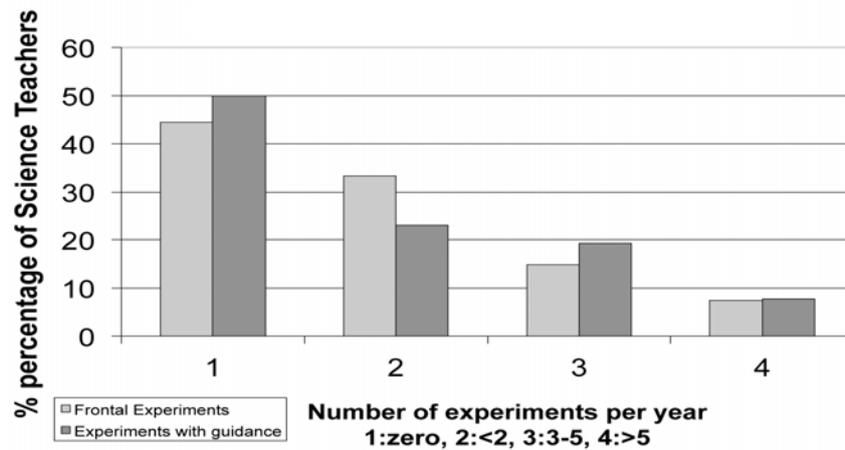


Fig. 2 Materialization of experiments of biology.

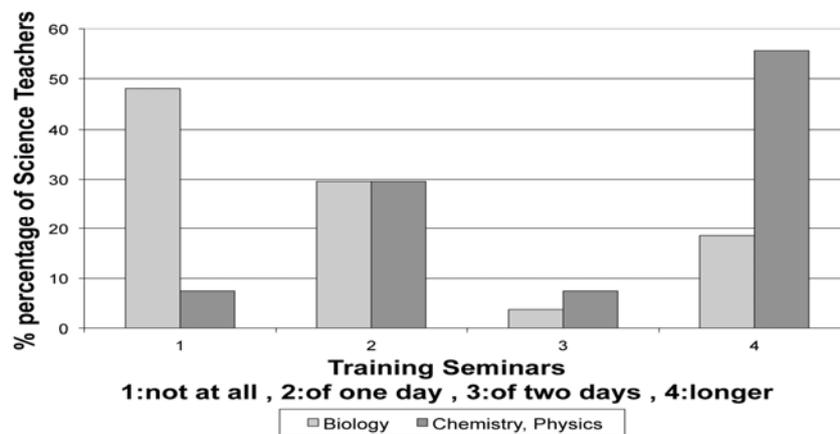


Fig. 3 Training seminars on laboratory exercises of biology, chemistry, physics.

carried out demonstration experiments in the Biology and they had not guided students in it (50%).

The instructive methods and the pedagogic practices that can be applied in the school laboratories were barely during the last 30 years, or not taught in the Academic Faculties at all, which is the period of university studies of the sample teachers who now serve in the high schools of Greece. More than half (66.7%) had not carried out laboratorial exercises of biology at their university studies or had a few (14.8%) and only the 18.5% of the sample have carried out enough.

The offered training to the Science teachers by the Educational Training Organisms, until 2005, in laboratory teaching of Biology, was generally limited and less than in Physics and Chemistry. The 40.7% had received in-service training in the theoretical

issues of biology issues and the 51.9% in Laboratorial Exercises. More specifically, in the laboratorial exercises of biology, the 29.6% had been trained with seminars of one day, of two days the 3.7% and more than three days the 18.6% (Fig. 3). The remainder (48.1%) had not received training in the experimental teaching of biology. The asked teachers had received more extensive training in experimental teaching of physics and chemistry: only the 7.4% of sample had not been trained, the 55.6% had been trained in seminars of more than three days and only the 29.6% had received training of one day or two days (7.4%). Even, the Yearly Training Courses (SELME), until 2000, offered two hours per week on biological theoretical issues, didactic and pedagogical methodology of biology, but not in experimental practice.

3.3 Training Needs in Laboratory Practice, Official, Legal and Management Issues

As resulted in training needs, the teachers feel that their needs in laboratory practice are relatively high, as presented in the Table 2. Their training needs in theory of biology that is related with the laboratory exercises are not so high such as the prevention of accidents and dangers lurk when the students are inside the laboratory materializing exercises. Less than half of them have training need in making students to work experimentally in teams.

The training needs in official, legal and management issues that are related with the Science Laboratories of high schools are presented in Table 2. Roughly half of the asked teachers declared relatively big need in all the relevant questions of this research theme field, with the higher percentage (62.5%) in their legal cover in case of accident inside the laboratory space. An appreciable percentage (25%) does not consider that they have need of training in the laboratory book keeping, in material and work protocol in the school laboratories. Most of the teachers who declared big training need in laboratory book keeping, materials and experimental protocols had the less years of service ($r = -0.524, P = 0.021$).

Also, the fewer years they had taught Biology in B class of Lyceum, the more training they wished in this training field ($r = -0.538, P = 0.017$) and also in updating laboratory equipment ($r = -0.651, P = 0.003$). This can be explained by the limited school experience that they have, in contrary with older teachers who are enhanced by the notice that the more years they had taught biology in the C class of Lyceum the less need of training they feel that they have in the above mentioned areas ($r = -0.584, P = 0.009$ and $r = -0.509, P = 0.026$).

Several declared that they have big need of training in legal cover in case of an accident inside the laboratories (Intermediate indicator value was 3, max value). This training need is reduced by the number of teaching years in Lyceums.

The more they have taught in the C class of Lyceum, the less need of training they feel that they have in the methods of prevention of accidents in laboratories ($r = -0.464, P = 0.045$) as well as in the critical functional size of school teams that they materialize laboratory exercises of Biology ($r = -0.584, P = 0.009$). Similar results were also with the years of teaching in the B class of Lyceum ($r = -0.575, P = 0.010$).

Table 2 Percentage of the teachers who declared that had training needs in laboratory practice, official, legal and management issues related to the use of the Science Laboratories.

Type of need	Median	I do not have	Small	Relatively big	Big
Training needs in laboratory practice					
Theoretical background of biological laboratory exercises	1	12.5	45.8	29.2	12.5
Laboratory dangers	2	8.3	29.2	41.7	20.8
Accident prevention	2	4.2	41.7	45.8	8.3
Laboratory space layout	1	16.7	29.2	33.3	20.8
Auxiliary work	2	12.5	25	37.5	25
Teams management	1	12.5	45.8	20.8	20.9
Training needs in official, legal, management issues					
Laboratory book keeping	1	25	29.1	41.7	4.2
Updating laboratory equipment	2	12.5	41.7	37.5	8.3
Consumables	1	8.4	33.3	33.3	25
Legal cover of accidents	3	0	12.5	25	62.5
Support from the head of laboratory	2	8.3	29.2	33.3	29.2

Scale intermediate values: 0 to 3.

3.4 Training Needs in Didactic Methods and Pedagogy

The teachers' training needs in didactic and pedagogic methods that are related to the experimental teaching of Biology are presented in the Table 3.

Teachers are interested in conquering those instructive methods that will develop curiosity on scientific subjects which are related with the everyday life of their students (66.7%). A statistically important tendency ($P = 0.019$) is presented in the teachers that expressed wish of training in those instructive methods which can be used to provoke curiosity of the students in scientific subjects that are related with their everyday life and their self-assessment. This wish possibly expressed as a need to find out methods, techniques and procedures to stop the apathy and the uninterested students who are in alarmingly high rate concerning the school teaching subjects, which becomes larger year by year. The more years of experience they had in the high schools, the most training they wished in the instructive methods that they can use in provoking curiosity in scientific subjects that are related with the everyday life ($r = 0.713$, $P = 0.009$).

The needs of training on instructive practice and evaluation with regard to the ways of exploitation of laboratorial exercises in the comprehension of the syllabus are high and slightly increased compared with the pedagogic practice. Roughly half of the teachers declared relatively big training need in methods of students' self-assessment (50.0%) and in evaluation methods, materials and experimental processes by themselves (58.3%) (Table 3).

The pedagogic needs of the asked Science teachers seem to be less than the instructive, in terms of experimental teaching of Biology. Less than 50% of the asked Science teachers declared training needs in pedagogic methods required in the materialization of laboratory exercises (Table 3). Only 1/5 of the teachers does not feel that they have particular training needs in methods that will prompt the students to healthy habits (20.8%), to respect the laboratorial space and the materials that are used (16.7%), and to discipline in the laboratory directives and guidelines (25%), given the intermediate indicator value 1 in the total of questions of unit in scale 0 to 3, which is found near the choice "small training need" of the questionnaires. Most teachers have not training need

Table 3 Percentage of teachers who declared their training needs in issues of experimental teaching of biology, concerning didactic methods and pedagogy.

Training needs in didactic methods and pedagogy of experimental teaching of biology						
	Type of need	Median	I do not have	Small	Relatively big	Big
Instructive methods	Develop critical thinking	2	8.3	33.3	45.8	12.5
	Documentation of aspects	2	4.2	41.7	45.8	8.3
	Provoke curiosity in scientific everyday issues	2	8.3	25	54.2	12.5
	Recording of observations	2	16.7	33.3	41.7	8.3
	Self assessment	2	0	37.5	50	12.5
	Evaluation of processes, materials, methods, etc	2	12.5	12.5	58.3	16.7
Pedagogic methods	Team collaboration	2	8.3	37.5	41.7	12.5
	Respect of the others	2	20.8	20.8	45.8	12.5
	Discipline to guidelines	1	25	16.7	45.8	12.5
	Healthy habits	1	20.8	33.3	37.5	8.3
	Acquisition of responsibility	1	16.7	33.3	29.2	20.8
	Recognition of the value of Life Sciences	1	16.7	45.8	20.8	16.7

Scale of intermediate indicator values 0 to 3.

in the methods that they can use to help the students to recognize the value of Life Sciences.

3.5 Opinion Expression on the Training Process

Regarding to the process of the training, the teachers' opinions were divided between their own participation or not in the planning and formation of the training timetable, in the venues and in the choice of the trainers (Fig. 4). More than half of the percentage of them (58.3%) does not want to express opinion on the training methodology and on the trainees' selection (62.5%). Several of them (70.8%) wish to express opinion about the period that the training courses will take place and about the duration of them (62.5%).

4. Discussion

In a large scaled survey of the Greek Pedagogic Institute concerning the training needs of the teachers of Primary and Secondary Education which was carried out in 2010, before the commencement of the Major Program of Training 2011-2013, the needs seem mainly located in order of hierarchy, managing

classroom problems, modern teaching approaches, exploitation of new technologies, teaching methodology and discipline in the development of creative relationships with students and parents. In the last two positions are the following topics: organization and administration of education and self-evaluation of the school unit [11]. In this survey there is an important note that also concerns this research. The concept of "need" is often confused with synonymous concepts, such as the necessity, desire and demand. The training needs can be divided into conscious, expressed or not, and latent [11]. Even much discussion can be developed and objections may arise on the meaning of the term "need", that possibly attribute the respondents, this research does not dealt with the understanding of this term.

The way of sample selection which followed makes the sample as possible random, although random samples are rare in education. The population synthesis of Science teachers was represented more or less by the sample, regarding the specialties and their frequency in schools. The 32 asked teachers consist of a statistically sufficient of 110 permanent Science

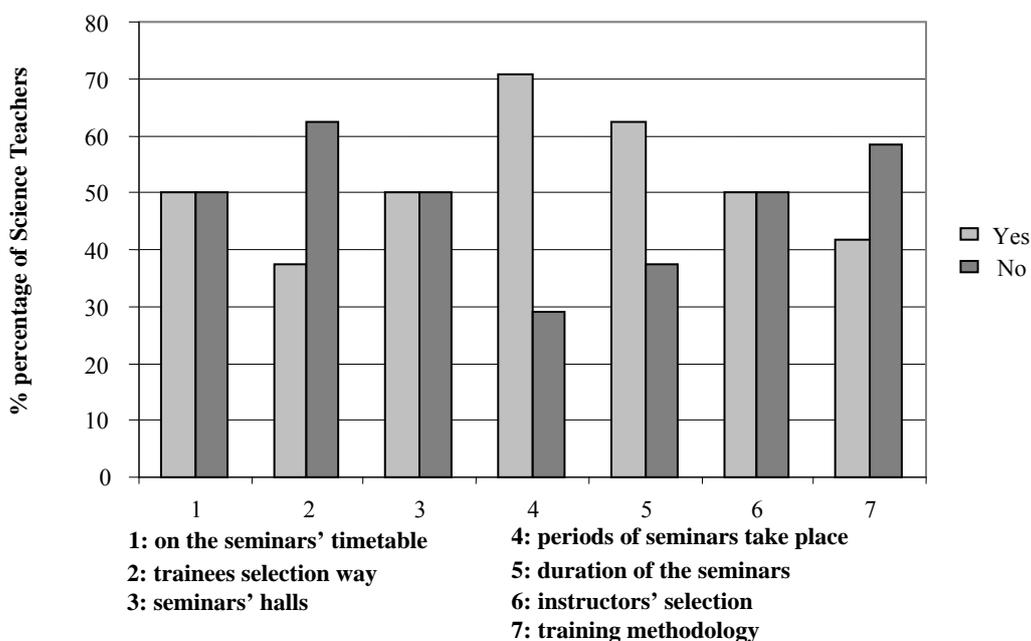


Fig. 4 Opinion expression by the science teachers on their training process.

teachers (29.1%) served in 2005, in high schools of the Heraklion prefecture, in the province and the city. The portion of them (12) which had attended the long seminar on “Computers in the Didactic Methodology of Natural Sciences” [12] had perceived their needs in more effective teaching of Natural Sciences, upgrading the traditional, by using new technologies. Most of them, in the previous years, had materialized laboratorial exercises of biology in many schools of the city or the province, consequently their opinions do not only reflect the current situation but also crystallize that of previous years. These teachers are all permanent, many of them with high qualifications and multiple experience in the teaching of Natural Sciences’ courses but not in experimental teaching of Biology.

In the closed type questions of questionnaires there was a variety of alternative answers, not to limit and direct the choices. Also, in most of them the possibility of “another” answer was given, with space for writing, where those asked could be differentiated by developing their personal opinions, a possibility which very few teachers used. It is concluded that the choices that the questionnaires offered covered all the tendencies and helped to express comfortably integral opinion on the research subjects.

By the analysis of training needs that was expressed at category, it is classified first need, with the use of intermediate indicator value, the relatively big need of training on issues of didactic practices and evaluation; the medians in all the individual answers of this unit had value 2, in scale 0 to 3. Second in line comes the need of training in official, procedural and legal subjects that are related with the teaching of laboratorial exercises of biology in the schools; medians had value 1.8 in scale 0 to 3. Mediocre needs of training had the teachers of sample in laboratory practice and in the required theoretical background of biology with median value 1.5 in the scale 0 to 3.

The high percentage of training needs in laboratory dangers and ways of avoiding them reveals that the

Science teachers can not handle well the students inside the laboratories, that is why they are afraid of accidents and they want to learn more about how to avoid them. As from the data analysis the negative relation between the years of teaching in C class of Lyceum came out, and the positive with the number of teaching years in Gymnasium with the training needs in laboratory dangers prevention and legal cover in case of accident, it is obvious that the teachers who have worked more with younger students consider them dynamic able to cause accidents in the Gymnasium laboratories. Similar analysis also showed that in Gymnasiums it is more difficult to organize and handle student teams in effective work function than in Lyceums.

The training needs in didactic, pedagogic practices and evaluation were high. Roughly half of them declared relatively big training need in methods by which they will learn the students in self-evaluation or to evaluate methods, materials and experimental processes. The evaluation, differs from the marking which teachers and students know well, consists basic element of learning, demands more exigent competences that should allocates a teacher and needs to be cultivated consciously [13]. The use of the laboratories in the Constructivist approach of teaching and learning emerged as a solution and answer to the question on the implementation, evaluation and revision of the previous curriculum of Natural Sciences [14]. A number of 3-5 laboratorial exercises of Biology are suggested by the Greek Pedagogic Institute to be materialized per year in high schools [15]. In a survey of the Centre for Educational Research to identify the training needs of newly appointed Science teachers in secondary education, the results showed that training needs vary not only according to the specialty, but even according to the university graduation as mentioned in Ref. [11]. Also it was found that the introductory training for all disciplines of education should focus on learning theories and issues of teaching and assessment of the

student, connecting theory and practice.

The very low percentage of training need in theoretical issues related with the laboratory exercises of Biology reveals the teachers self-confidence regarding their scientific knowledge. Their needs are mainly concentrated in the field of experimental application of Science. As most teachers have relatively small training need in the methods that they can use to help the students to recognize the value of Life Sciences, they feel able and sufficient to persuade their students about the significance of the Natural Sciences in the life. Maybe this comes from their high level of education that they have received and from the long teaching experience that they have. In a research of Papanau, carried out in 1999 with questionnaires in a sample of 328 teachers of secondary education, a high proportion of the sample considered significant training in psychology (especially women) and on teaching methodology, as mentioned in Ref. [11]. The fact that most of the teachers, except biologists, had not received any education in biology when graduated, nor initial training when appointed by the public schools, in combination with the frequent changes in the school books and curriculum during the last years, makes the teaching work difficult and prevents the culture and further development of initiative practices in the school laboratories. Although Science teachers have materialized a great number of laboratorial exercises in their university studies of their specialties, they do not feel comfortable and familiar with the experimental teaching of biology, since biology is a Natural Science. This tendency seems unexpected if combined with the relatively small training needs in the theoretical issues of biology that they declared. This is probably due to the fact that the experimental teaching of biology, in the rapidly changing educational world, in the framework of the new curriculums, has multiple didactic and pedagogic demands, more intensive and specialized to which they can not respond because of their inadequate

preparation for practicing the profession. They need support for the transition of the scientist of one specialty to the teacher of all the Natural Sciences.

The relatively high percentage (62.5%) of the training needs in supporting by the head teacher of laboratory shows that the duties of the teacher in charge are not very well clarified, since this position was established one year before the research. In the future, the official duties of the laboratory head teacher, among the colleagues, must be described more clearly. Of course, by the years, the operational requirements will specify and concrete this cooperation.

About half of the asked teachers wish to express opinion on the process of their training. The adults have different reserve of experiences, social roles, other orientation opposite in the learning, and finally, they have bigger possibility of choices and initiatives in regard to whether and how they will participate in the training process [16]. Adult educated are persons in development. They are not passive individuals; they actively participate in dynamic activities [13]. This is in effect for all participating in all the types of education of adults.

In research interviews in a sample of newly appointed secondary teachers who attended the introductory training program in the prefecture Aitolokarnania in 2006-2007, it showed that teachers were annoyed because they were not asked about their educational needs and the particular characteristics were not taken into account. A previous study in the same prefecture in the year 2004-2005 in 67 teachers of high school, also showed that the investigation of needs is necessary, when designing training programs [11].

As a results from the answers analysis, only a small number of Science teachers and for a few instructive hours during the last five-year period, materialized Biological demonstration experiments and still more seldom by guiding students. So, students do not practice in laboratory work by applying experimental

protocols, individually or in teams. By the document of the Greek Ministry, the laboratorial exercises in the courses of biology, physics and chemistry became obligatory and incorporated henceforth in the curriculum of Science courses, since 2004, so the Science teachers acquired one more motive to seek training in the experimental teaching of biology [1]. In a survey of the Centre for Educational Research to identify the training needs of newly appointed Science teachers in Secondary Education, the results showed that training needs vary not only according to the specialty, but even according to the University graduation, as mentioned in Ref. [11]. It was also found that the introductory training for all disciplines of education should focus on learning theories and issues of teaching and assessment of the student, connecting theory and practice.

As also resulted from the answers analysis, the biology was not in the training priorities of the Regional Training Centre of Heraklion (PEK) during the last years. PEKs were founded in 1999 and since function as institutions for concretization of training programs but, over the years, the offered programs were limited only in the Initial Training. Exception is the training programs in using and teaching of Computer [11]. PEK do not allocate mechanisms of investigation and recording of teachers' training needs. They do not have mechanisms of decision-making which allow the essential discussion of criteria, objectives and priorities in each PEK separately. Thus, the PEK, using their traditional ways of training, do not cover absolutely the training needs of teachers [17]. Need to extend the related field of analysis to distinguish the sections, the continuities, discontinuities, regressions and contradictions constituting the Greek educational policy of the teachers' professional development [18]. In any case, most of the asked teachers (68%) wish to receive training in the laboratorial exercises of Biology. Otherwise, teachers are those persons who are in need of lifelong learning, so they have to

develop variety of skills, due to different speeds and rapidly changing demands of students, Natural Sciences, Technology and Pedagogy. The training can be seen as an object of educational change as well as a driver importing educational changes [19].

The European Union provides financing for projects which develop and upgrade the employment of the citizens and focus on suitable faculties, so that they will be able to improve their self-appreciation and adaptability in the job market. The multifaceted dimensions of Education of Adults were determined in the European Council of Prime Ministers in Lisbon, in March 2000 [20]. In the relative Memorandum of European Committee, the methods of teaching and learning are clarified: "the profession of teachers will suffer radical changes in the next decades. The teachers and educators will become drivers, advisers and mediators. Their very important role is to help and strengthen teaching, which as far as possible they are by themselves the persons in charge for their education". The experimental teaching of biology and generally of Natural Sciences, in the framework of the Greek educational reconstruction and structuring of the new curriculums, has multiple didactic and pedagogic demands, more intensive and specialized over the current years [3]. New technologies can upgrade the school courses attracting the students' interest, increasing their participation in the laboratory exercises and experiential learning [4]. Every school reform is undoubtedly connected with teacher education and goes side by side with changes in contents and methods of teacher training [21].

5. Conclusions

The Greek Science teachers of the Secondary Education express need for fuller education and appropriate training in more effective teaching of Sciences. Their demands crystallized in a synthesis of the scientific knowledge of all the cognitive objects of Natural Sciences with skills and competences of

teaching them on both an experimental and a theoretic level. Since there is a questioning round the exploitation of laboratories and their teachers in charge, that leads to hesitancy and inaction in schools, and on the other hand there is a great interest in incorporating innovative practices in the school teaching process, it is henceforth required, of a further investigation of the needs in materializing laboratory exercises of biology, in combination with physics and chemistry. By the long time school experience, the teachers have faced intensively the apathy, disinterest and depreciation of the school scientific knowledge which was expressed as a significant percentage of training need in methods that they can apply in managing and confronting it, to provoke students' curiosity in scientific issues related with everyday life and recognize the value of the Life Sciences by team collaboration and respect of the other.

In this direction it would contribute to this research, even it is of limited range, with the combination of results of other reported studies from elsewhere in Greece, mainly the survey of the Greek Pedagogic Institute, under other prismatic view and analysis. The fact that most of the teachers, except biologists, had not received any education in biology when graduated, nor initial training when appointed by the public schools, in combination with the frequent changes in the school books and curriculum during the last years, makes the teaching work more demanding and the teachers' request of training satisfiable immediately. The academic programs of studies and the training courses needed to be reformed to the direction of the most completed preparation of new teachers in the Experimental teaching of Life Sciences and to give emphasis in the laboratory practice as integral part of the didactic and pedagogic school procedure. The success of the training programs, which will be developed in the future, lies on the precise determination of the training needs of the trainees and in the type of training that they wish to receive, not only in Biology but, generally in Natural Sciences.

What the researcher expects is the Science teachers' need to be heard, the institutions in charge of training to give the proper priority in the future, on the training issues which will correspond to the current requirements of the Science school teaching. Our societies, in the dawn of the third millennium, are in need to pass the Science knowledge from the past to the future; the teachers' debt to this, they are the bridges connecting the past with the future generations, as the writer Nikos Kazantzakis said. And after doing this, they ought to cut these bridges down and let the young people to walk ahead.

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