Abstract—In this paper, we present the modeling, design, and a segment of the implementation of an Open Personalized Learning Environment (OPLE) for the Electrical Engineering course that is taught at Vocational Schools. We describe in detail how the chapters of the course are used in the online environment. As methodological principles of this construction we emphasize on the students' learning behavior, and on the individualized promotion of knowledge, considering the simplicity and the dynamics of the open personalized environment.

Index Terms—Electrical Engineers, Internet, Technical Education.

I. INTRODUCTION

In the last few years, the Open Personalized Learning Environments (OPLE) have grown exponentially and they are globally at the center of the educational and research interest [9]. Education visionaries, educational reformers, online environmental designers, and internet researchers throughout the meta-web 2.0 era have documented the potential of online educational environments and are trying to improve them [20]. The goals of these improvements address the student’s attendance and their learning progress (Learning Analytics) as well as exploitation of the results related to the expansion of the teaching progress (Teaching Analytics). However, creating an effective open online learning environment remains an important and complex issue, as the simplification of the procedures for the user, increases the complexity of the required programming for such an environment [18].

In this paper, we present the modeling, the design, and a segment of the implementation of an OPLE for the course of Electrical Engineering in Vocational Education and Training (VET). In our design, greater emphasis is paid on the support and on the educational opportunities that the environment provides for students. The environment that we propose provides equal educational possibilities and opportunities for students and is addressed to everyone regardless of whether it is used individually or in a class mode.

The simpler the user participation procedures, the more difficult the programming components are [2]. Furthermore, a serious issue for the design and efficiency of an OPLE is the availability of the required resources and of the appropriate digital infrastructure. This issue is exacerbated in Greece, since the Greek national educational system, operating according to joint Presidential Decrees, imposes throughout the Greek territory the use of the Pan-Hellenic School Network [1] as a digital infrastructure, which has several limitations regarding the available resources and the possible applications that can be run on it.

This necessity for equal educational possibilities was sought after, explored, and reinforced for another reason: our own experience in what we encountered during the COVID-19 pandemic period. Abruptly, the interest in OPLE peaked among many practicing educators, coordinators, and theorists as the e-learning systems reached and far surpassed their functional limits during this pandemic [7]. Thus, Online Learning Environments were a necessity during the COVID-19 pandemic. Especially for VET, the impact of the crisis created by COVID-19 has not gone away as dealing with it requires specific Education Policies by the European Union [16]. Even today (summer 2020), educators and international organizations [5], [22] are looking for strategies and plans so that the pedagogical system remains as intact and resilient as possible.

In our version of the OPLE we take into account the simplicity and the dynamics of the open personalized environment. As a result, we record the possibilities and the necessity for the expansion of the OPLE to improve education. In addition, the new, advanced online forms of teaching and learning that we propose are approached not as something helpful for education, but as a dynamic coexistence with all the other existing traditional forms of teaching. From the pedagogical science’s point of view, the presented in this paperwork improves the educational process by using a combination of supervisory tools specifically designed for VET [12], and enriched by modern communication technologies [13] with the ultimate goal of authentic teaching and deep learning [19].

The paper is organized as follows. In Section 2, we present a short introduction to the Vocational Schools’ reform in the recent years and as an extension of this, a coarse presentation of the educational structures of the technical schools. Then, we present a critical object of learning, Electrical Engineering, for the evolution of the "Electrical Systems and Networks Technician» specialty, explaining why we chose this specific learning object for processing and how we integrate it into Education Technologies (construction environment – web address for the Pan-Hellenic School Network, individual accounts for students, targeted online referrals materials). In Section 3 we focus on the design methodology and the modeling of the innovative teaching practices based on the Unified Modeling Language (UML).
diagrams. In Section 4, we present in detail a part of the environment. In Section 5, we provide conclusions, the evaluation of the system and its added value.

II. THE ELECTRICAL ENGINEERING COURSE FOR THE SPECIALTY OF "ELECTRICAL SYSTEMS AND NETWORKS TECHNICIAN"

A. Context Definition

The teaching methodologies that are applied in VET require specialized approaches as the nature of teaching itself shapes the knowledge standards for the students and for the graduates [14]. It should be noted that the VET graduates along with their graduation gain a specialized degree in their field. Moreover, it has been observed that a large percentage of them seek to join the production workforce as specialized personnel. During the period 2015-2019, a highly targeted effort was made in Greece to support VET. The aim of this effort was the effective institutional, educational, and pedagogical reforms in various fields [11].

Due to the connection between the teaching methods and the standards met in the production line, the VET students have rather high ambitions for their professional rehabilitation and self-confidence and the need for individual improvement and development of their abilities and skills from the very first years of their studies. [17]. These learning orientations act as a catalyst in the involvement of students in their studies. Thus, the teaching methodologies applied in VET should connect formal with non-formal learning [8] and work towards the students’ successful professional development.

B. Detailed Description of the Proposed Syllabus

Electrical Engineering is the most essential course in the Electrical Science track of VET. The Electrical Engineer, in order to obtain his degree, must have a background of the theoretical knowledge capable of solving theoretical and practical problems as well as the ability to manage the problems that arise in this field. According to the curriculum, the course of Electrical Engineering is mixed. Its content includes both theory and laboratory exercises. The object of the Electrical Engineering course is the study and the analysis of direct and alternating currents in order to calculate the electrical quantities of a circuit, such as the Electric Voltage, the Potential Difference between two points of a circuit, the Intensity of the Electric Current, and the Current circuit.

The course of Electrical Engineering starts in the second grade in the Department of "Electrical Engineering, Electronics and Automation" and continues in the third High School grade, in the Specialty of “Electrical Systems and Networks Technician” where it is also a Nationwide Examined course for students who choose to continue to higher education. In addition, students come into contact and understand important structural tools of the Specialty, the laws of alternating current and the effect of these laws on integrated industrial and laboratory facilities. This guided research along with the support of internet resources combined also with the basic learning material, are the innovative elements within the paper, as they create special pedagogical methodologies for VET, since this proposal can be generalized in other sections and/or other subjects. The educational method we follow is a mixture of traditional education, enriched with the possibilities offered by the internet. The elements of the course are divided into four levels and are related to the chapters:

- Level 1: Ohm’s Law calculation, Electric Current, Electric Potential Difference (voltage), Electrical Resistance, Electric Circuit.
- Level 2: Kirchhoff's Current Law, Kirchhoff's Voltage Law, Resistance Connection.
- Level 3: Electric Power, Electrical Energy, Device Efficiency.
- Level 4: Electric Field, Electric Field Intensity, Alternating Voltage, Capacitor / Coil in Alternating Current.

To organize the sub-sections, we took into account not only the completely up-to-date pedagogical learning processes [10] but also the well-known basic material [15] which correspond to the teaching instructions from the Curricula Studies and the material of the Laboratories of Vocational Schools.

For the teaching interventions in the above material to be organized and our online construct to work, an extensive use of different forms of teaching and a precise coordination of different online "tools" must be made. To achieve this goal with the best result, we must first plan the needs and organize a new combination of the available resources from the Pan-Hellenic School Network. For describing and modeling the needs we used the diagrams provided by UML as it has been developed in the recent years in modern system analysis and design applications [3]. In the diagrams we formed the specifications of the project and organized its design.

III. NEEDS PLANNING – WEBSITE MODELING AND ORGANIZATION FOR THE "ELECTRICAL ENGINEERING" COURSE

The three main characteristics that define the educational purpose of OPLE are mass, openness, and the use of e-learning methods [21]. To achieve these features, the UML diagrams are used to represent the teaching and learning processes. In this section, we emphasize on our Web Application modeling. To achieve the maximum student simplicity, we need excessive planning on modeling and organization. We chose UML as it has been effectively implemented in advanced design applications in the recent years [6].

The component diagrams of the Web Application show the components of the code and the physical structure of the construction. On the right side of the diagram of Figure 1 we see the student-user and the constructor-programmer. These are two separate entities that “use” the web application. The application in turn connects - “uses” a “database” where all the users’ data is stored, as well as an online server (“web server”) on which our application is located.
Figure 2 shows the steps that the student-user follows as he/she navigates through the web application. More specifically, as soon as the student-user logs in, a button for "continue" or "start" appears depending on the level.

The diagram in Figure 3 depicts the computer nodes of the system. More specifically, on the left-hand side of the diagram we have the database where the protocol "WebSocket" is used to communicate with the web server on which our application is loaded (artifact). Through the Hypertext Transfer Protocol (HTTP), the application reaches the computer of the student-user and becomes visible with the help of the browser and Hyper Text Markup Language (HTML). The reciprocating flow of the system is achieved by connecting the user to the web application as well as the continuous interaction with it.

The user data is stored in a Database provided by the Pan-Hellenic School Network (PSN) to teachers (Figure 4). PSN (www.sch.gr, https://www.sch.gr/english) is the national network and the monopoly internet service provider (Internet Service Provider, ISP) of the Ministry of Education and Religions. PSN provides e-learning, communication and collaboration services, e-government and user support and assistance services, with personalized access to 1,203,424 users.

The student-user can log in PSN via his personal PSN account. To use the website course, student-user needs to create an individual account. Once connected, he/she can start studying the theory, the exercises and any material posted on the website immediately. On the other hand, the teacher connects and edits the contents of the website. It should be noted that the teacher uses the tables of the database to see in real time the results from the activity of each student individually. In addition, the student-user has the ability to contact the administrator of the application or his teacher via e-mail at any time and tell them what he needs both for technical (bugs, crushes) and for evaluation issues.
Figure 5 captures the static view of our system at a moment. In the diagram of Figure 6, we have the student-user as an actor and the application as a single set of objects, as well as the database where the user data is found and stored.

In the diagram of Figure 7 we include all the actions performed by the objects and the student-user (actors) to achieve a result. The connection of the numbered lines represents the sequence of interactions of the actions.

IV. THE ORGANIZATION OF THE WEB APPLICATION

In this Section we present the web application as it works in PSN. With the website "Electrical Engineering - Vocational School" (http://kotsifakos.mysch.gr/elenap/en/#/) we target the online, active support of students in the 2nd and 3rd grade of Vocational Schools (Figure 8). The website was built using the basic tools of Internet Technologies [4]. We utilized HTML, Cascading Style Sheets (CSS), Javascript and Data Structures. HTML enabled us to edit and produce files and CSS was a key technology tool for displaying HTML document elements. JavaScript was the basic script language whose code was embedded in HTML and runs on the client side (browser). We used JavaScript to manage the elements and objects of the HTML page. The content of the website can be utilized during the school lesson.
In the submenu "Home" (Figure 9) the student-user can automatically register with his personal data. Appropriate programming has been done so that only valid user data is entered. After registration, the student-user can log in to the system (Figure 10).

Fig. 9. Register and Login Page of the Web Application

Fig. 10. Utilization of Application's Levels for the Acquisition of Knowledge

The application allows teachers to post notes for the multiple chapters of the course according to the curriculum (textbook references, announcements, suggested web addresses and other course-related information). In addition (Figure 11), the student-user can be bestowed with posted videos about the lesson as well as suggested presentations for the relevant material. This allows the teacher to support targeted internet browsing and utilize useful online resources.

Passwords are sufficient to navigate to the individual submenus. Those who participate in the modern educational process know the great benefits based on the effect of the multimedia as well as the positive effect they have on all the learning processes. The student-user can also search for new resources on the internet to enrich his studies. Finally, the student-user can utilize the provided educational websites of the application in order to help both in the understanding of the theory in the respective section of the book and in its completion with the application of the levels.

Fig. 11. Utilization of Multimedia as a Learning and Communication Tool

V. CONCLUSIONS

The learning opportunities that the internet gives us engage students in rich interactive learning experiences, transforming them from passive receivers to active participants. Digital technologies offer opportunities for open access and authentic learning. This paper dealt mainly with the improvement of the educational process and its enrichment with the use of various means offered by modern technology and more specifically the internet. The added value of the paper lies in the search for criteria that further push for the redesign of the introduction of new technologies in education as realistic proposals for the creation of a modern, student-friendly, educational model.

On the other hand, it is important for teachers to know the methods of utilizing OPLE by enriching their teaching practices and seeking improvements to their teaching. The environment we propose can work with the existing digital infrastructure as another distance learning option. The specific educational material, the introductory section of Electrical Engineering, was designed and developed during the pilot application based on case studies and best practices in the field and after its evaluation, will be redesigned following the suggestions of the students and teachers involved.

Through the environment that we propose, we highlight the concerns and the suggestions for the importance of creating educational material in authentic learning environments with a focus on OPLE within the modern school. Through the design and organization of OPLE, mixed forms (newer and
traditional) of teaching applications are utilized with the aim of updating and enriching the pedagogical methods, which ultimately contribute to the upgrading of the teaching provided in VET. OPLE is a complete cohesive intervention entity, not only for the specific teaching unit, but enriches the boundaries of today’s educational methodology. The utilization of modern tested and easy-to-use tools for each VET Specialty, as well as the utilization of other means of PSN are learning tools for students and help future actions for the expansion of new innovative services for VET.

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