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The Role of Education in Designing Bioclimatic Buildings to minimize Energy Consumption

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ABSTRACT: One of the major problems that humanity has to face today is environmental pollution due to over-consumption of conventional forms of energy, with the building sector leading, resulting in a change in the climate and the nature and threat to the lives of people, animals and plants. In the building sector, the awareness of the need to minimize energy consumption has led to an effort to improve the energy performance of buildings by applying the principles of bioclimatic architecture. The aim is to ensure thermal comfort conditions for building users, exploiting the favorable climatic conditions prevailing in each area. It seeks to exploit renewable and inexhaustible energy sources such as sun and air. The commitment to solar radiation and the protection against cold winds during the winter and the use of cool winds as well as protection from the hot sun rays during the summer. The purpose of this study is to explore ways of educating students, building professionals and building users in acquiring environmental conscience and understand the multiple benefits of bioclimatic design for the environment and the economy. Bioclimatic architecture should be a rule and not an exception.

KEYWORDS: Education in Bioclimatic Buildings, Environmental Education, Pedagogical Significance of Space, Lifelong Learning, Experiential Learning.

I.INTRODUCTION

The overconsumption of conventional energy sources, resulting in greenhouse gas emissions and adverse effects on the environment, has necessitated the implementation of measures for Sustainable Development so as to ensure the satisfaction of today's generations needs without compromising the ability of generations of the future to meet their own needs [1, 2]. Extending the above concept in the building sector led to the introduction of the concept of Sustainable Building that aims to create responsible and maintain a healthy built environment based on the principles of rational use of resources and ecology [3].

However, the introduction of the above concepts into the people's lives can be achieved through their education. According to Dewey (1897), "education is not preparation for life, it is life itself" [4, 5].

Besides, Humboldt (1769-1859) had aptly stated that school education is the one that gives people the skills and abilities needed to cope with life as members of society. School is what gives people the necessary treatment for new conditions and perceptions. In short, whatever you want to introduce to society tomorrow you must teach it at school today [6, 7].

Therefore, the goal of sustainable living and the introduction of the principles of bioclimatic architecture in people's lives could not be achieved without education, with schools playing a major role in this. Although learning is acquired both outside and through schools, schools at all levels of education, in modern societies, are the only ones that enable the education of the population in a systematic manner. Thus, attitudes, values and behaviors that can contribute to sustainable living are cultivated and introduced into people's lives [8].

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II.A BRIEF ANALYSIS OF EUROPEAN ENERGY POLICY AND GREEK REALITY IN THE ENERGY PERFORMANCE OF BUILDINGS

In Greece, the first measure taken to improve the energy performance of the Greek buildings was the regulation of the thermal insulation in 1979. It was largely based on German DIN 4108 and was considered to be a particularly effective regulation at the time [9]. Since then and for many years the Greek institutional framework on energy efficiency of buildings has remained unchanged.

However, in the last two decades, the European Energy Policy is geared towards tackling climate change, reducing CO_2 emissions, energy security, etc. In order to achieve the above objectives, it has issued directives to all Member States of the European Union.

In 2000, the European Commission adopted the Green Paper which set out the strategies that the countries of the European Union should take in order to be self-sufficient and safe, while saving energy and carbon emissions [10].

Then, in order to keep up with the European Energy Policy, Greece is making an effort, issuing in 2001 the integrated KOXEE (Regulation for Rational Use and Energy Saving), where it was the first attempt to introduce the principles of bioclimatic architecture. However, it has never been implemented.

In 2002, the European Commission, in the framework of the Green Paper, adopted Directive 2002/91/EC, according to which all Member States should, by January 2006, set the minimum energy efficiency of new and existing buildings [11], and to make it compulsory to issue an energy performance certificate, while giving general principles to apply a common calculation methodology.

This Directive was followed by Directive 2006/32/EC, according to which final energy consumption in buildings should be minimized and Energy Service Companies (ESCOs), with a major focus on reduction of energy consumption in buildings should be created [12].

However, despite the demands of Europe, Greece did not take effective measures to implement the directives, with the result that in 2007 the European Commission would bring it to the European Court where it was convicted in accordance with the European Court of Human Rights Decision C-342/07 [13].

In the context of the European Commission's pressures, the risk of fines and the urgent need to tackle climate change, Greece had to take action. Thus, with Law 3661/2008: "Measures for the reduction of the energy consumption of buildings and other provisions", it tried to incorporate the European Directive 2002/91/EC into the energy policy of the country [14]. For the implementation of this law, KENAK 2010 (Energy Performance of Buildings Regulation) was adopted, and it was in force in October 2010.

Subsequently, the European Parliament and the Council adopted Directive 2010/31/EU introducing the concept of Near Zero Energy Building [15]. All Member States had to increase the number of nZEBs. Therefore, in order to harmonize its institutional framework with this Directive, Greece has adopted Law 4122/2013. However, the definition of the zero energy consumption building and its characteristics is not specified [16]. As a result, Greece is failing to achieve the goal set by Europe that all new public buildings from 2019 and all new private buildings from 2021 should be zero-energy consumption.

Also in 2010, with the “Europe 2020” Development Program, all Member States should contribute to the following objectives: greenhouse gas emissions should be reduced by 20% compared to 1990, the energy used should come from renewable sources by 20%, and energy efficiency should be increased by 20% [17].

In addition, according to Directive 2012/27/EU, Member States are required to upgrade the energy efficiency of the existing public buildings from 1 January 2014, 3% per year [18].

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Under the threat of risk, Greece, failing to meet the targets set by Europe by 2020 in both public buildings and private buildings, has adopted Law 4342/2015 [19], as well as the new KENAK 2017 (Building Energy Efficiency Regulation).

Also, in recent years, the Greek state, with programs such as "Household Energy Efficiency" for private buildings and other programs for public buildings and businesses, offers subsidies for their energy upgrading.

From all of the above it can be concluded that the Greek legislation on energy planning has significantly delayed its harmonization with the requirements of Europe. Therefore, the Greek authorities have begun to deal with energy policy issues with a long delay, with the result that limited diffusion of bioclimatic architecture is due solely to individual initiatives [20]. However, the responsibility doesn't come from only the Greek authorities, but also from all the Greek citizens who until the last years lacked of energy consciousness.

Greece, therefore, faces insurmountable barriers to the energy upgrade of buildings. This is due to the fact that until now, the principles of bioclimatic architecture have not been applied to most of the Greek building stock. Indeed, in densely populated cities, with anarchic urban design that does not take into account the environmental factor, the application of the principles of bioclimatic architecture becomes difficult. As a result, there is an increase in CO_2 emissions in Greek cities and a strengthening of the greenhouse effect.

According to CRES, most of the existing Greek buildings, of the order of 65%, are classified in the lowest energy category E-H, 32% are classified in the G-D and only 3% in category A-B [21].

However, there are some examples of bioclimatic buildings in Greece. A typical example is Solar Village 3 (SV-3), which was built in the late 1980s in Pefki, a suburb of Athens, within the framework of a joint Greek-German research and demonstration program. There are 33 buildings and 420 apartments. Architectural design of homes follows the principles of bioclimatic design, e.g. direction and openings towards the south, good thermal insulation and especially passive solar measures. The main axis of the buildings is oriented towards the east-west axis and thus it is possible to shade between adjacent buildings. Solar Village Project buildings are very well insulated and solar panels meet their needs for electricity, space heating, cooling and domestic hot water. Studies have shown that conditions of thermal comfort prevail in buildings both in winter and in summer. Moreover, it has been shown that these buildings, due to their high thermal capacity, proper insulation and natural ventilation, did not need air conditioning systems [22].

Another example of a bioclimatic building is the solar sports center of Thessaloniki, built in 1990. With the use of passive solar systems and without the use of conventional forms of energy, heating, hot water and cooling are provided [23].

Also, many important architects and engineers, following individual initiatives, and according to the desire of the owners of the buildings, designed bioclimatic buildings. A typical example is the architect Tombazis Alexandros, with representative works of the AEGEK Group building, the S&B Industrial Minerals SA building, the sun building 4, the Monetary Museum for the Bank of Greece at Amerikis Street in Athens, the bioclimatic building of the Department of Pharmacy of the University of Patras, etc. Also, important architect in the bioclimatic design of buildings was Bougadellis Harry, with important projects such as the hospital Henry Dunant, the Panteion University, the student camp at the cape of Chania etc. Another important architect is Fyntikakis Nick, with important bioclimatic work such as the Archaeological Museum of Thessaloniki and many others [20].

A brief review of the current situation suggests that the development of bioclimatic architecture in Greece has so far been rather disappointing. It was limited only to some very interesting public pilot projects as well as private buildings following the will of their owners. The largest part of Greek buildings, however, is far from the energy efficiency standards set by the European Union.

In order to remedy this unfavorable situation, the education of the Greeks on Sustainable Development and bioclimatic architecture is necessary. School education for sustainable development has three pillars: the students, the teaching and the institutions [8].

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III.THE POSITION OF STUDENTS IN THE EDUCATIONAL PROCESS FOR THE INTEGRATION OF SUSTAINABLE STRUCTURE IN THE SOCIETY OF TODAY

Modern societies, in order to face environmental, social and economic challenges, must be composed of citizens willing to learn. The term student is not defined with the narrow boundaries of place and time but with the willingness to participate in the learning process. That is, as a learning society it is not meant the closed community of a school but the wider society. The term pupil is related to his participation in society as a member of a learning society [8].

In the process of education, the student-members of society "freedom is the first condition", as Humboldt (1769-1859) rightly argued. The role of the state in the process of learning must not be intrusive and determinant it should ensure freedom in education [7].

Every person, for example, must take care of the essential and not formal education of himself. With genuine education, the inner forces of man are formed and cultivated so the concept of a human being filled with knowledge does no longer exist [6, 7].

People do not just need education, they need paideia. These are two concepts that seem to look like, but in fact they are so different. A person with education does not mean that he has got paideia. Maronitis (2009) states that paideia is a method, whereas education is an action and that paideia must be voluntary while education must be compulsory [25]. Thus, education is meant to teach the institutions and values of obedience and discipline, as well as the production of "economically efficient" citizens, endowed with a lot of "technical knowledge" that makes them competitive in society [26]. While paideia is a potentially dynamic concept, it includes ideas and feelings as well as perceptions shaped by the experience and evaluation of each individual [27]. The world is evolving and everything that can't be adapted simply disappears, somewhat like the dinosaurs disappeared. For this reason we should talk about providing environmental paideia rather than education from the educational system of all levels of education [28]. The term environmental education also clearly embraces the integration of bioclimatic designing in the culture of pupils, tomorrow's citizens of the country.

A vibrant workshop on environmental education can also be the bioclimatic design of the school buildings, ie the places where the educational process takes place [29]. Both schools and residential buildings will contribute to the acquisition of environmental education by students, citizens and engineers, improving their performance when designing bioclimatic buildings.

Besides, the great Greek architect Tombazis A. (2009) referred to an architecture that touches the heart and not the eyes [30].

Finally, according to the principle of individuality, each person should be educated on his own initiative. According to the German thinker Selbstformung, it is the so-called self-education [7]. Self-education means the educational training of the individual who, knowing his desires and needs, begins to acquire new knowledge on his own initiative. But self-education does not mean social isolation, but ongoing contact with educational institutions, organizations, and training centers. New technologies and the use of the Internet contribute significantly to its distance learning. Thus, the process of education is not limited either spatially (school) or time (youth) but extends throughout the life of man [31].

- **The pedagogical significance of space in the procedure of acquiring environmental paideia by the students**

School and home areas play a key role in the process of developing and educating children [24, 32]. The pedagogical significance of space is great as it is the tool that appropriate manipulations can be used to achieve specific goals and lead to the acquisition of knowledge, emotional maturation and socialization of children [33, 34].

The shape, the aesthetic configuration, the size and generally the design of the buildings, "reflect" society, present the values and behaviors of the users, and they can also shape their behaviors and lead to changes with the appropriate configuration of the environment [35, 36].

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From all of the above it can be concluded that the bioclimatic configuration of school buildings and residences contributes not only to the reduction of emissions of gases dangerous to the environment but also acts as an educational tool as a "good example", shaping the behavior of the residents while familiarizing them the whole population with bioclimatic building design practices. In particular, with regard to school buildings, the bioclimatic design of new school buildings and energy upgrading of older ones will act as an environmental education for students and tomorrow's citizens shaping their energy behavior and paving the way for sustainable development and a better tomorrow.

In Greece, since 1998, the "School Buildings Organization SA" has been created, which was replaced by the company "Building Infrastructure SA". The company is responsible for building new educational infrastructures and modernizing existing ones directly in Attica and indirectly in the rest of Greece [29, 37].

- **Lifelong Learning and Self-Education in Bioclimatic architecture**

Comenius J. in his work 'Pampaedia' in 1657, had written that the world is a school for the entire human race, from birth to death, so at any age it is not too late to start learning [38].

In the past, the skills and knowledge of each individual originated primarily from initial education and training, while continuing professional development was considered optional and concerned only those who were enthusiastic and willing. Gradually, continuous professional development was recognized as a vital means of informing each person's career. In today's global knowledge-based society, continuous professional development is seen as a key component of the wider perception of lifelong learning. This learning is continuous and not simply linked to employment. It is formal and informal and contributes to the personal and professional development of the individual [39].

In today's society, the rapid scientific and economic progress as well as the technological development and the rapid production of new knowledge make it necessary to provide constant information and information in various sectors of society and of course in the field of education [40]. Specifically, this chapter refers to the continuing education and training of civil engineers and architects in bioclimatic architecture. Thus, the main objective for professional engineers of the 21st century is to continually learn and develop skills and knowledge so that they respond quickly and effectively globally to technological and organizational changes as well as changing market conditions, customer requirements, government policies and national and international regulations [39].

In formal education, the education provided by the formal education system, usually issued with a certificate or diploma [41], is included. In a rapidly changing world, the training of future engineers should endow them with skills that equip them for lifelong learning. Students should perceive learning as an end in themselves and fun. In their curricula, they should be taught problem-solving methods, developing critical thinking, metacognitive and self-directed lifelong learning skills so that throughout their careers they can adapt and learn in a dynamic world are constantly changing [42].

Non-formal education includes the training provided within the organized educational framework [41]. These are the so-called Training Programs that refer to graduate engineers with the aim of training them on new technologies, completing and renewing their knowledge on legislation, specifications and organization of bioclimatic building studies as well as their application on the construction site. Also, the basic aim of the programs is the training of engineers on issues concerning the particular constructions and materials of bioclimatic buildings, as well as their evaluation. The technical knowledge taught is usually unknown due to the fact that it is not used or applied to the current building practice, but it is necessary for the proposed interventions in the high energy consumption of existing buildings.

Informal learning includes all human learning activities during their leisure time or their professional, social and cultural activities. It includes all self-training activities. Self-study involves the study of printed material or material over the Internet or through the use of a computer or a variety of educational infrastructures, as well as all the knowledge, skills and abilities that the individual acquires through his professional experience [41].

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IV.THE TEACHING OF BIOCLIMATIC DESIGN IN THE SOCIETY OF TODAY

Architects and civil engineers, who are responsible for shaping the built environment, are also responsible for its viability through the projects they create. It is therefore important to instill the principles of sustainable development into student engineers so that they are able to create healthy environments for the future [43, 44]. The need to apply the principles of bioclimatic construction in the building design process is widely recognized by the educational community. However, the road is long, until sustainable design is firmly established in architectural learning. This is because [45]:

- Many polytechnic schools have not yet fully endorsed the issue of sustainability. Most efforts are sporadic and are treated as an extension of the regular curriculum.
- Sustainability teaching requires a different approach than traditional.

However, it is not enough just to introduce sustainable design courses at universities to train and educate those involved in building or to improve the performance of sustainable buildings. In addition to these urgent requirements, it is equally necessary to inform the public about the benefits of sustainability, by promoting, encouraging and advertising bioclimatic design, environmental education, organizing actions and demonstrations of bioclimatic buildings, organizing informative campaigns and the labeling of the risks of "conventional architecture" [53].

Teachers who teach sustainable building should realize that they are teaching values. To do this, the schools where they teach should be a place where values are on the agenda and human life is not valued according to the market economy where man is just a worker [8].

- **Experiential Learning as a proposal for the teaching of Bioclimatic Design of buildings**

"Only what you accepted with your soul,
is what you learn and incorporate into
your life and character "
John Dewey (1938) [4, 46].

Experiential learning, i.e. learning derived from direct experience, has its roots in antiquity. The Chinese philosopher Confucius (551-479 BC) had aptly mentioned [47]:

"I hear and I forget. I see and I remember. I do and I understand".

In modern times, experiential learning as a method of teaching approach has employed many scientists and educators. David C. Kolb (1984) defined experiential learning as an educational process by which knowledge is created through transformation into experience. Knowledge arises from the combination of experience and transformed experience [48, 49]. Therefore, experience and learning are two concepts interdependent and inseparable [50]. Other teachers such as Colin Beard and John P. Wilson (2002) gave the concept of bridging reality and knowledge through action. Thus, as experiential learning, the process of cognitive capture of active commitment between the individual's inner world and the external environment is defined. In other words, the foundation of experiential learning is based on the interaction between the individual and the outside environment [51].

In the building sector, the teaching of sustainable building can be accessed through the experiential learning and practical training of students in the architectural and civil engineering departments of polytechnic schools.

Experiential learning is already an important place and applies to the teaching programs of many educational institutions around the world. The combination of theoretical teaching with experiments, with spatial simulations of building works, are effective tools for preparing future engineers to meet the challenges of their profession.

The pedagogy of the architectural design must be turned out of the classrooms to deal with real problems and to seek solutions through which learning arises. In particular, outdoor work, where students can create and test their design suggestions, helps to better understand bioclimatic design. However, what is usually the case is that outdoor activities

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are limited to gathering information on the ground, then designing and evaluating are performed internally simply as office work. But the intention of universities should be the creation of real outdoor halls. The learning process is made easier by combining the study room with the cafeteria, the discussion room and the patio, the computer room and the corridor, the design studio and the external environment [52].

V.THE ROLE OF INSTITUTIONS IN THE EDUCATIONAL PROCESS FOR THE INTEGRATION OF SUSTAINABLE ARCHITECTURE IN THE SOCIETY OF TODAY

People, as members of a global society, should act on the principle of "think globally, act locally". Under this slogan, people in order to achieve sustainable development and reach "distant places" and "future times" should change mindset. However, thinking is not enough, action is also necessary. As individuals, action choices may be limited, but with the help of the institutions, thought can eventually become a reality. Institutions create channels that enable people to go beyond the boundaries of personal service and act globally [8].

At present, both at a global, European and national level, strict guidelines and institutions are paving the way for integrating the principles of bioclimatic design into new and existing buildings.

VI.CONCLUSION

Bioclimatic architecture is not just a different way of building, a new trend that revives today or a money-saving technique or a way to eliminate mankind's perceptions due to reduced ecological consciousness, nor an obligation stemming from Community directives the energy performance of buildings. The bioclimatic design of buildings is an imperative that starts from accepting the events of reckless use of energy resources, environmental destruction and degradation of the quality of life of animals and humans and continues with the realization that it is a socio-political issue rather than technical which requires primarily a change of attitude and a redefinition of the social priorities and objectives of humanity.

Therefore, today's society requires an environmental awareness of all citizens and bioclimatic architectural training of the engineers of the future. To date, ignorance of climate-based building objectives and benefits, academic inertia and rigid curricula of educational institutions, coupled with limited expertise, non-social compliance, and lack of inspired standards have led to a non- sustainable lifestyles and a questionable future for mankind.

Sustainable architecture therefore requires a restructured academic curriculum, adaptation of teaching subjects and methods to instill the sustainable spirit of future architects and civil engineers, professionals, and above all a bold revision of the social priorities of humanity.

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