

# Pythagoras Project: Development of an innovative training package on Indoor Environment Quality

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## ABSTRACT

The aim of the Pythagoras project is the development and assessment of Greek national training material in the sector of indoor environmental quality. The need for education in this specific sector is dictated by the significant indoor environment deterioration and associated health hazards, which are caused by low ventilation levels, combined with the use of many modern building materials that aggravate pollutants emissions. Early in the project, a review is undertaken of the international literature and the syllabuses of foreign research and educational institutions active in indoor environment quality issues. At the same time, the requirements of the Greek educational and broader society, related to issues of indoor pollution and health, are determined. A training methodology is consequently developed, with the objective to optimally cover all the parameters associated with the indoor environment quality, for trainees of various disciplines. The training material is produced both in printed (book) and integrated electronic (e-learning) format. Additionally, four seminars are organized covering the respective sections of the training package. The training package is being assessed both by the trainees but also by international experts in the sector of indoor environment quality.

## KEYWORDS

E-learning, Indoor Environment Quality, market for education material, training package

## PURPOSE OF THE WORK

The aim of the Pythagoras project is the development of pre-graduate and post-graduate level national training material in the sector of indoor environmental quality. The need to provide education in this specific sector stems from the reported

deterioration of the indoor environment in many Greek areas. Low ventilation levels, combined with the use of many modern building materials, lead to a significant decline in the indoor environment quality, aggravated by pollutants emissions that can harm the health of building occupants.

Previous scientific studies and experimental measurements carried out by the research team have repeatedly shown extremely high concentrations of indoor pollutants (especially VOC's and CO<sub>2</sub> – in school buildings CO<sub>2</sub> levels sometimes exceeding 1800 ppm –), thermal discomfort conditions and low levels of air change indoors. Since national use of air conditioning systems is rising exponentially, but lacking the appropriate design and control precautions, indoor climate is expected to continue deteriorating, forming a major problem for the population. Architects, designers, building owners, occupants and technicians need to be informed and become aware each of their own responsibility in designing and maintaining healthy buildings.

The scope of the Pythagoras project is to define and study all parameters that constitute the national body of knowledge on indoor environment issues, in order to develop a market driven educational material.

The project started on March 2004 and is due to be completed by the end of 2006. The project is co-funded by the Ministry of National Education and Religious Affairs, Managing Authority of the “Operational Programme for Education and Initial Vocational Training” and the European Social Fund. The research team consists of five education institutions, namely the Aristotle University of Thessaloniki, the University of Ioannina, the Technical University of Crete, the Technological Educational Institute of Crete, led and coordinated by the National Kapodistrian University of Athens.

## **METHOD OF APPROACH**

In order to develop a training material that covers all related parameters and integrating all the disciplines associated with indoor environment quality, the research team has carried out four specific tasks:

### **Task 1. A review of international literature, syllabuses and research activities.**

A review was undertaken of the international literature and the syllabuses of educational institutions as well as the research activities in indoor environment quality issues. Research has been carried out on related bibliography, education material, distance learning programmes, scientific journals and publications, international conferences, standards, guidelines and legislation on the subject. Specific attention has been paid to the education and research material available at the national level.

## **Task 2. Determination of the national need for education on indoor pollution and health.**

The Greek society's educational needs related to issues of indoor pollution and health are determined through a broader study. For this purpose, a questionnaire was developed, summarily covering all aspects of indoor environmental quality issues. The questionnaire has been distributed to a broad range of building experts (architects, scientists, building service companies etc.), building owners and users, as well as national institutions, chambers, agencies, universities, associations and offices in various areas of the country.

In the ongoing process of studying the need of the Greek society related to issues of indoor pollution and health, 61 answers have contributed to the following results:

- 98% considers indoor environment quality an important issue.
- Only 13% considers the existing education on the matter of indoor environment quality sufficient.
- 87% feels there is a need for education material on indoor environment quality.
- 25% (mostly industry) already has staff trained in indoor environment issues.
- 52% wishes to train staff in the measurement and assessment of indoor environment issues.
- 7% declares that they are aware of specific polluting activities within their buildings. This concerns mostly industrial activities.
- Emission sources mentioned included tobacco smoke, traffic exhausts and industrial emissions, the air conditioning system, office equipment, CO<sub>2</sub> from vital human functions, furniture, activities and insufficient cleanliness of spaces. Also, refurbishment of spaces, cleaning activities, oil feeding and drainage were mentioned.
- Mould and humidity sources exist in at least 21% of the buildings.
- 23% of the buildings are characterized by specific odors and annoying conditions of temperature and humidity.
- Smoking is allowed in 51% of the buildings. Only 8% of the buildings have designated smoking areas.
- According to the answers provided, only 16% of the buildings contain materials that can influence the indoor air quality. Among such materials mentioned: floor carpets, dust, paint, glues and materials related to the nature of the organization or company, perfumes and paper .
- Employee symptoms (like dyspnea, irritation of eyes and headaches) were reported only in 5% of the cases.
- 3% of the buildings are equipped with a central air quality control system. This concerns mostly the major industry sector, where exposure levels are more or less known.
- Natural ventilation is possible in 92% of the buildings, but it is considered sufficient only in 69%.
- In 44% of the buildings there is a central mechanical ventilation system available.
- 36% of the users declared to have the possibility of influencing the temperature and humidity of spaces manually. Thermal conditions are rarely controlled by a Building Management System (BMS).
- According to the answers provided, in 92% of the buildings, the HVAC system is checked and maintained regularly, usually once per year.

- 39% of the buildings has been built prior to 1980 which means that at least 39% of the buildings does not fulfill the requirements of the building regulations.

The study has shown that there is a definite and specific market need for education material and training package on related issues. It has been pointed out that the indoor environment is considered a subject of great importance, but the means and knowledge for assessment and control of its quality are scarce.

According to the answers provided, there should be no specific indoor quality related problems encountered; the main sources of indoor pollution are considered to be outdoor, while no symptoms have been reported so far by occupiers of the specific buildings. However, this could possibly be just an indication of ignorance regarding the subject, as well as of a significant deficiency in communication and reporting. In fact, since in the majority of buildings mentioned smoking is allowed and in many of them natural ventilation is not considered sufficient, it seems more realistic that the indoor air quality is not good at all.

### **Task 3. The development of a training methodology**

Consequently, a training methodology is developed, with the objective to optimally cover all the parameters associated with the indoor environment quality, for trainees of various disciplines. The training material is hierarchically structured and includes multiple outgoing links; i.e. each study unit includes a number of special links leading to further reading material. This way, a standard and fixed linear study methodology is provided by the teacher while, additionally, optional deeper levels of information are available for the student to explore the cognitive subject and fulfill his/her personal need for supportive study. The methodology can be visualized in the form of a tree trunk, which stands for the core education material, and its branches that represent the outgoing links.

### **Task 4. The training package**

The training material is about to be produced both in printed (book) and in integrated electronic (e-learning) format. The training package includes a list of questions and case studies and the electronic format in particular also provides for a forum of exchange of views and information. Additionally, four seminars are organised in four different areas of the country, covering the respective sections of the training package. The training package itself is being assessed both by the trainees but also by international experts in the sector of indoor environment quality.

## **STRUCTURE OF THE TRAINING PACKAGE**

Aiming at the development of a comprehensive indoor environmental quality training package and as a result of previous study of existing bibliography and education material, the structure of the national package has been defined as follows:

Chapter 1. The general issue of indoor environment quality

Chapter 2. Physical parameters defining the indoor environment of buildings

- Chapter 3. Deterioration of the indoor quality from nuclear compounds
- Chapter 4. Chemical pollution of indoor environment
- Chapter 5. Pollution of indoor environment by particulate matter
- Chapter 6. Biological indoor pollution
- Chapter 7. Contribution of HVAC systems to indoor environment deterioration
- Chapter 8. Solution techniques for indoor environment problems
- Chapter 9. Impact of indoor environment quality on human health
- Chapter 10. National and international regulation, standards and exposure limits related to indoor environment
- Chapter 11. Assessment methodologies of indoor environment
- Chapter 12. Exercises and case studies of indoor environment related problems

## CONCLUSIONS

The study of the indoor environment quality carried out within the framework of the Pythagoras project has shown that there is a definite and specific market need for education material on related issues. There are clear indications that the means and knowledge for assessment and control of the indoor quality are scarce and that the necessary communication and reporting skills are missing.

The development of the Indoor Environment Quality training package in the course of the Pythagoras project, has resulted in significantly broadening the scope and outreach of the research team and their associated institutions in the pre-graduate and post-graduate levels, in the sector of indoor environment quality and pollution.

Furthermore, a continuing study is proposed, carrying out measurements and scientific on site assessment for a number of representative case buildings, aiming to compare the level of their tenants' awareness with the actual operational issues.

## REFERENCES

1. Amourgis, S. *Definition of the format of text material for distance learning – Guidelines*, School of Science and Technology, Hellenic Open University, Greece.
2. Roach, M., Blackmore, P., Dempster, J. (2000). *Supporting high level learning through research – based methods and e-learning*, UK.
3. Santamouris, M., Mihalakakou, G., Patargias, P., Gaitani, N., Sfakianaki, K., Papaglastra, M., Pavlou, C., Doukas, P., Primikiri, E., Geros, V., Assimakopoulos, M.N., Mitoula, R., Zerefos, S. (2006). Using intelligent clustering techniques to classify the energy performance of school buildings. *Journal Energy and Buildings*, article in press
4. Spengler, J.D., Samet, J.M., McCarthy, J.F. (2000). *Indoor air quality handbook*, McGraw-Hill.
5. WHO Europe. *Assessment of Exposure to Indoor Air Pollutants*, WHO Regional Publications European Series, No. 78