A STRATEGIC APPROACH TO CLIMATE RESPONSIVE DESIGN USING COMPUTER BASED LEARNING

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Abstract

Existing computer software to support the teaching of environmental issues to architecture students is mainly based on energy calculation methods or packages of information split into subject areas. Neither approach seems to adequately support the early stages of the design process. The paper explores the construction of a model for a computer based learning system to teach the development of environmental strategies. Different strands of educational theory were used to develop teaching principles based around consideration of the subjective quality of knowledge influenced by ideas and theories from different sources; the importance of learning a "language" consisting of methods and theories of a subject and their application in context and the suggestion that "deep " learning requires conceptual changes. A suitable framework for the development of environmental strategies is suggested and its implementation using multi-media software as a method of integrating different types of information and learning materials is proposed. The paper concludes that the process of analysis is a key part of the system and should be made the focus of the structure and contents.

Introduction

Existing computer software to support the teaching of environmental issues to architecture students is mainly based on energy calculation methods or packages of information split into subject areas. Neither method adequately supports the early stages of the design process as students do not have the experience to use the information effectively or to understand its relevance in design situations.
The aim of the research was to devise a model for a computer based learning system for the development of strategic environmental analysis techniques which can be used in different circumstances, for instance, at different design stages and for evaluating design precedents in text books and magazines. Early strategic decisions account for a large proportion of energy use and have often been made before the involvement of an energy consultant. Yannas(1991) suggests that it is at this stage that designers require support to recognise the main environmental priorities and constraints and translate them into architectural and constructional objectives. These then provide a framework

around which other decisions fit.
Central to the problem with existing materials seems to be differences in epistemology between the design process and design related subjects such as environmental science. The development of learning materials which are more compatable with the design process seems to start by looking for a representation of knowledge on which suitable learning strategies can be developed. The subject can then be structured following this so that it can be implemented using a computer based learning system.
The paper examines a number of theoretical positions on which educational principles may be based and derives a strategy from them, then proposes a model for a computer based learning system for the development of environmental strategies based on a bio-climatic design methodology, (Olgyay, 1973).

Knowledge representation

Developments in computer based materials often concentrate on the hardware and software available rather than the educational strategy to be adopted. However, research (Knuth, Duffy, 1990) suggests that rather than being atheoretical these materials just do not acknowledge their educational and philosophical foundations.
A number of theoretical positions were examined in order to develop an educational framework on which to base the project.
The positivist or behaviourist perspective is an often unacknowledged basis for work in the development of learning materials. This suggests that there is an objective view of reality, that knowledge can be set out by experts and subjects should be learnt for their own sakes. This position seems to fit many existing forms of presentation of design related information in books and through lecture courses. Although information is theoretically available students are not always able to translate it into design solutions.
A second perspective which has been influential in primary education is Piaget's theories of cognitive constructivism (Piaget, 1970). These suggest that rather than being objective, knowledge is subjective, structured by the individual according to the way in which it has been acquired. These knowledge structures are constantly being revised in the light of new experiences. Gelernter(1988) uses these theories to explain the split in architectural education between lectures and project work putting forward the concept of "design knowledge". He suggests that if knowledge is to be applied in design it should be learnt as part of a design related process. A third theoretical standpoint, and one that seems particularly relevant to architecture is that of social constructivism, using work by Freire(1970) as an example. This suggests that education is socially constructed and must be considered from the viewpoint of a particular cultural background. Learning is a part of the interaction between the individual and that culture. If this interaction is to be meaningful, social factors such as the learners past experience and future needs must be taken into account. Dialogue and collaboration are used as tools to mediate and establish a common ground between the individual and the wider group. Theory is considered a tool which should reflect and develop practice rather than existing as an objective reality.
The fourth position to be considered is that of the work of Schön(1990) and his study of professional practice. The world of the professional can be considered as similar to a cultural group with the same tensions between the individual, the group and the cultural context. Schön suggests that the skill of the professional is knowing how to operate within this context and knowing what do in a particular situation rather than possession of a particular body of knowledge. He suggests that an important skill is that of "reflection in action" or the ability to continually question and extend the boundaries of knowledge to reflect changing circumstances. Knowledge is seen as a tool to be "used" rather than "possessed". Professionals learn as much by playing the game as by reading the research literature, and learn how to balance theories from different sources and knowledge learnt from experience.

Educational principles

A number of principles can be extracted from this study to make up an educational strategy.

1. An important principle seems to be that of "situated cognition", that theory relates to a specific context. Related to this is the principle that knowledge is actively constructed within that context and that it is analysis that translates information into knowledge. The theory and background of these analysis methods is as important as the information itself.
2. The second principle seems to be recognition of the difference in conception as a result of different experience between experts or authors of the material and students or users of it. Deep learning requires conceptual changes and an effective teaching strategy should address the users current ideas and challenge common mis- conceptions and should be able to respond to differences in users requirements and method of working. Feedback is important both extrinsic, as an external process, and intrinsic or as a part of the activities of the programme.
3. The third important principle seems to be the recognition of the "second order" nature of academic knowledge as described by Laurillard(1993) - the difference between abstractions and reality and the importance of learning the relationship between them. This mapping forms a bridge between theory and practice and these abstractions such as diagrams and graphs of environmental science and architectural descriptions of buildings using photographs, drawings and models forms a language which is shared by members of a group or profession. Manipulation and use of this language is an important part of the skill of the professional.

Computer based learning

Computer based learning systems have developed from the early programmed learning and drill and practice routines with a strong behaviourist slant to more open and flexible types of system using high quality graphics which claim to support "discovery" types of learning.
Hypermedia or multi-media systems were originally conceived as databases of information such as text, graphics, video, sound, animation. These can be arranged as cards, frames or files with links between objects. These were originally seen as associative links so that users could intuitively navigate large collections of information exploring by browsing, learning by osmosis the natural structure of knowledge they contained. Originally these systems were considered as an end in themselves and it was thought they could be expanded infinitely to become vast libraries. Later when it was realised that information was not knowledge and that learning involved a more active process than exploring they were seen as resources which could support specific activities. Multi-media purely becomes a method of integrating different types of information with the specific purpose dictating the contents and structure, for instance as a presentation or database.
It has been suggested that such collections provide an opportunity for students to carry out original research instead of repeating examples and theories from text books.- However, as Laurillard(1993) suggests, unless sufficient direction is given, access to a multi-media database seems to be no more useful than access to a library. Where direction is given and analysis methods made specific with the theory and background of these methods provided multi-media offers the possibility to provide a rich and diverse source of materials for a range of interactive media.

Environmental design strategies

Yannas(1991) suggests that environmental issues are especially difficult for architects to deal with. "Many aspects are multi-variate, space/time/use dependent and counter-intuitive. Without specialist knowledge (which takes some time to acquire and assimilate) architects have little to help them "visualise" this dynamic and may easily be led by the wrong kind of intuition".
A method of developing this ability seems to be through the learning of an analytical framework similar to that used by an energy expert. Yannas suggests that key variables affecting environmental performance are climate, site(micro-climate), building type and location. A strategy can then be developed in response to these variables using firstly, basic elements of sun, wind etc. for instance, promoting or restricting solar gain, ventilation etc. The strategy can encompass differing requirements at different times of year and conflicting responses at others. Design decisions can then be measured against this. Decisions may either reinforce or work against the strategy in which case compensating measures would have to be made and the strategy refined. A non-linear form of a system is

particularly important as it allows users to develop a feel for the interactivity of the design variables and enables certain aspects to be "fixed" and the compensating measures worked out. Yannas again suggest that this is of particular value as existing materials often focus on "idealised situations" offering no guidance on what can be done when these conditions cannot be completely met.
Watson and Labs(1983) offer a method of developing these into suitable design concepts. They have developed a range of strategic responses to different climate conditions which they relate to a catalogue of design concepts or rules arranged into groups, ranging from the macro to the micro scale. Rules are numbered and referenced to more detailed information.
An important use and development of this conceptual framework would be through the analysis of precedents using Rapoport's(1990) theory of built form as data from which lessons and principles should be derived rather than the copying of forms and details with no awareness of meaning and context.
The process of analysis and interpretation required to build up this conceptual framework has the potential to become the central purpose of a package and forms the foundation on which a deeper understanding can be developed through further experience.

Design Principles

The following section examines some suitable computer based elements which could make up a package. An appropriate model seems to use the structure of the design or research process itself with the package set out as an argument which the student can follow, construct or elaborate on. The package would focus on an investigation around a particular thesis with materials to enable the issues to be analysed. These supporting materials would reflect the holistic structure of knowledge by using different approaches and influences. Different types of computer materials could be used as appropriate to suit the different learning needs making up the package.
A multi-media presentation would provide an introduction setting out the background, context and purpose of the programme, explaining concepts and demonstrating processes. Simulations would provide experimental materials which could be tested, for example, bio-climatic charts with climate data overlaid, sun path analysis using site and precedent models testing the sun path at different latitudes and at different times of the day and year. A multi-media database would provide precedent examples of photos, plans, descriptions, 3D CAD models etc.; climate information with data, descriptions, photos etc. and site examples with CAD models, descriptions, etc. Interactive exercises would be used to develop environmental strategies and suggest suitable design concepts to support them built up from a repertoire of options. These could be used to propose suitable strategic responses for theoretical cornbinations of design variables and to analyse precedents in terms of the suitability of the design as a response to climate. An expert commentary would provide feedback and suggestions for further activities.

Conclusion

The methodology of producing computer based materials by examining the mechanics of learning and the particular nature of the subject to be taught seems to allow the possibility of developing new types of materials which can be designed to be more compatible with both the learning and the design process.
This seems to be a particular strength for the teaching of environmental issues in architecture where the representation of information in books does not always translate into design solutions and principles are often counter-intuitive. Learning in terms of strategic responses to design situations offers the possibility of building a framework on which a deeper understanding can develop.
Further work and implementation as computer based learning would be required to determine in detail how such a system would be constructed.

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