REQUIREMENTS OF AN EXPERT SYSTEM FOR DESIGN STUDIOS

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SUMMAR

The goal of this paper is to study problems of the transition from traditional architectural studio teaching to CAAD studio teaching which requires a CAAD expert system as studio tutor, and to study the behavior of the student in this new environment. The differences between the traditional and computerized Studio teaching and the experiences in this field are explained referring to the requirements for designing time in relation to the expertise of the student in the application of a CAD program. Learning styles and the process of design in computerized and non-computerized studio teaching are discussed. Design studio requirements of the students in traditional studio environment while doing design works are clarified depending on the results of an empirical study which explained the relations between the tutor and the student while they were doing studio critiques. Main complaints of the students raised in the empirical study were the lack of data in the specific design problem area, difficulties of realization of ideas and thoughts, not knowing the starting point of design, having no information about the references to be used for the specify design task, having difficulties in the application of presentation techniques. In the concluding parts of the paper are discussed the different styles of teaching and their relation to the CAAD environment, the transformation of the instructional programs for the new design environment, the future expectations from the CAAD programs, properties of the new teaching environment and the roles of the expert systems in design studio education.

INTRODUCTION

Teaching in architectural design lacks the sufficient scientific foundation, the scientific principles, and is guided by specialized empiricism, intuition and experience. The deficiency of architectural design education is the critical and comparative feedback based on generally accepted principles. There are some questions to be answered. Can a scientific theory of architectural design education be developed? There are fundamental differences among the various fields of architectural design education and there are various tutor, student and organization related variables to make any sort of common theory possible.

In the transition from traditional architectural studio teaching to CAAD studio teaching, the requirements for a CAAD expert system as studio tutor and the behavior of the student in this new environment are the subjects of this paper. The goal of this paper is to raise awareness and generate discussion about the present and projected future of the architectural design studios in the schools of architecture. For the investigation of the present situation in architectural design studios design research is the main tool to generate new theories and to identify the variables of the design studio. This paper mainly deals with the learning styles of the students and their fitting to the traditional and computerized studio teaching. The problems of design studio are described in three groups such as prescriptive, cognitive descriptive, and computational.

LEARNING STYLES

Learning styles of the students are investigated by various cognitive scientists. Different explanations demonstrate diversified aspects of designers' cognitive behavior when they make design. Differences in cognitive styles are also important in many experiments in design research that require a number of subjects to tackle a prescribed problem. The differences constitute a variable that is not being controlled. Four different categories of learning styles are distinguished by Cross and Nathenson (1981) such as:

1) Convergent and Divergent
2) Impulsive and Reflective
3) Field-independent and Field-dependent
4) Serialistic and Holistic

In "convergent" thinking an individual takes the information and converts it towards the single right answer. In contradiction to this the person who thinks "divergently" deals not with one correct answer, but a wide range of answers. The "reflective" thinking is the style attached to the persons who tend to consider the relative accuracy of the alternative answers before responding a solution to a given problem. On the contrary "impulsive" learner tends to put forth the first answer that presents itself to him/her. The other learning style is put forward by Witkin (1969) as "field-dependent" and "field-independent". He found that people differed from one another in the way they perceive the domain of the problem and themselves. Witkin uses the concept of field-dependent to characterize the person who is influenced by the domain and field-independent characterizes the person who is free from the domain. 'The last learning style is put for-ward by G.Pask and Scott as serialist and holist. "Serialist" people learn gradually step by step in logical small phases, try to make every point clear before moving on to the next point and take a straight route through teaching material with no digression or unnecessary information. "Holist" people pick up small bits of information that are not logically necessary, but which help him/her to remember certain facts . Holist people like learning thing-, in different ways .... and then learn, remember and recapitulate as a whole in terms of "high-order" relations' (Cross, Natheson, 1981).

Newland, Powell and Creed (1987) found this classification of learning styles inadequate and proposed another model mainly depending on the Kolb-Leary predicted relationships. Their classification is oriented towards the personality characteristics of designers. In this study architect designers are grouped into four categories as a consequence of discussion on learning styles and communication between the people. These categories are as follows:

1) Common Sense Learners
2) Dynamic Learners
3) Contemplative Learners
4) Zealous Learners

According to the above authors, "Common Sense" designers are abstract thinkers who have learned to exist as effective designers by combining this ability with active experimentation. These designers are self disciplined, dominant but not domineering and are good listeners. They attempt to construct a reasonable understanding of the world by seeking out underlying patterns. 'These learners are efficient planner architects who are establishment's guardians of professional standards.... "Dynamic" learners are defined as in a continual process of being shaped by their surroundings and gregarious for variety in an attempt to widen their perspectives, trying anything new as long as they are actively and personally involved' (Newland, Powell, Creed, 1987), In the same article "Contemplative" learners are defined as struggling to find the existence of a unique wholeness in life. They do this by desensitizing over plenty of data picked up from carefully studying the many facets of that whole. 'These designers are those who like to consider a montage of information; if well structured and complete, such a montage can result in attitude change and the shaping of new behavior. "Zealous" learners' reality is also a montage of information from which useful parts can be removed. However, some attributes of this observed world are perceived as totally inappropriate and the need to engage with their world to alter these faults gives rise to a realization that this can not be done independently Such groups learn through practical action and doing. Useful information which helps them to do best what they want to do is readily accepted by them' (Newland, Powell, Creed, 1987).

REQUIREMENTS OF STUDENTS IN A TRADITIONAL STUDIO

Design studio requirements of the students in traditional studio environment while doing design works are clarified depending on the results of an empirical study which explained the communication between the tutor and the student while they were working in an architectural design studio, "Architectural Design Education: Design Knowledge Communicated in Studio Critiques", by B. Uluoglu (1990). She put the different types of difficulties the students faced in the studio teaching into rank order using Kendall’s X_2 test method on 32 students. The results are as follows:

1) having no information about references such as books, brochures, journals to be used for the specific design task,
2) the difficulties of the realization of ideas and thoughts he/she has in mind,
3) the low qualities of studio conditions,
4) not knowing the starting point of design,
5) having difficulties in the application of presentation techniques,
6) the lack of data in the specific design problem area,
7) having difficulties in the visualization of the dimensions in the real world,
8) having difficulties in the visualization of the proposed end of the studio project,
9) having difficulties in the visualization and understanding of the 3-dimensional drawings of design,
10) having difficulties in the communication with the studio tutor.

In this study other aspects of studio learning are examined asking questions about what students learn at their first studio experience or the schematic expression of the students in their approach to design. In the responses of the students what they pick up during their first experience in the studio learning are ranked as follows: 50% space organization, 33.3% architectural language, 33.3% user and equipment dimensions, 30% functional relations of the spaces, 16.7% user requirements, needs and expectations, 10% the way architects work, 10% 3-dimensional thinking, 10% perception, observation of the environment, etc.

The students' expression of the design process of their own is analyzed in relation to gathering data, initiation of the design process which comprises analysis, direct entry and starting from an abstraction of design. Then this information is altered to delineate common schemas of the design process. The following categories are selected as the most commonly applied starting stages in the design process by the students.

1) gathering data:
a) making functional analysis or a single design solution, the development of the design.
b) functional analysis and relational graphs, making single design solution, the development of the design.

2) direct entry:
a) making a single design solution and reaching the end design.
b) making a single design solution, space and block organization of building.

3) an abstraction (mental) of the process: a) defining goals of design, or developing an idea or thinking of a life style, making a single design solution.

In this study the studio environment is accepted as a one-to-one interaction between the tutor and the student. This study was mainly concerned with the studio tutors' behavior and the way they teach architectural design.

THE KNOWLEDGE PRESENTATION OF STUDIO TUTORS

In B. Uluoglu's thesis (1990) architectural studio tutors are also studied in relation to their professional (as architect) and educator characteristics applying another survey and protocol analysis in the domain of studio. The universal and individual aspects of design knowledge possessed by the studio tutors are investigated, in relation to the extrinsic characteristics of design knowledge such as declarative knowledge and procedural knowledge applying extensive analysis techniques.

Declarative knowledge relates to the subject and object of design and the procedural knowledge relates to the design process and "how" design is completed by the designer. She developed a list of knowledge interpretation channels of studio tutors to students during the studio critiques at the Departments of Architectures at Istanbul Technical University, Carnegie Mellon University, Massachusetts Institute of Technology.

o. Interpreting and making critique
o. Orientation
o. Questioning
o. Exhibiting solution
o. Explanation
o. Talking about the past examples
o. Reminding something
o. Talking about the design problems
o. Talking about the design downfalls
o. Talking about the positive aspects of design
o. Making analogy
o. Displaying examples
o. Talking about the scenario of the design
o. Talking about the conflicts in design

These knowledge interpretation channels can be either declarative or procedural.

THEORETICAL BASIS OF CAD EDUCATION

The CAD laboratory was established in I.T.U. Faculty of Architecture in 1987 with the donation of IBM International for the purpose of combination of research and education. The theoretical model of this laboratory is published in an article by Bayazit (1987). Since then the applications in the laboratory have been based on the principles established in that paper. 'This model has three exhibited (education, research and evaluation) and one hidden (practice) components. The first and the second (education and research) will be developed interactively. There are various internal and external characteristics of the components in such a model of design education and design research. External characteristics relate to social technology, organization, resource allocation, roles, funds, experts etc. Internal characteristics relate to the mental, cognitive development of learners, i.e. psychology of learner, tutor, researcher, experts, etc' (Bayazit, 1987). In the same paper learning system in the CAD laboratory is explained as 'A learner and the process of learning are basic elements of learning system to meet the goal, for which we generally design some packages and deliver knowledge neglecting the requirements of the learner .... In our ease, the instructor provides a kind of guide to assist the learners in their approach to design. This guide should be called "language of design" or, as by some cyberneticians, "metaphors" ' (Bayazit, 1987). In the same text is explained that the interaction between the learner and instructor is provided by analogy and metaphor through conversations of any kind. Therefore metaphors, tools, devices and languages in various forms are powerful agents in activating the learning system.

In the same article by Bayazit (1987) the objective of the CAD laboratory is explained as: 'The major objective of the CAD curriculum is to enhance learners' ability in making a transition from visual perceptual to representational thinking. The CAD curriculum should include both perceptual and content oriented materials as well as representational and process-oriented materials. .... Form, color, texture, proportion, pattern rhythm, order are main concepts to be learned, and students should be able to transfer, code and analyze comparative differences and dichotomies in form and other perceptual elements. Expression and representation of them in a visual language are the main issues, to be improved in the learners and represented on the computer screen' (Bayazit, 1987). CAD studies help students in the development of their personalities. They learn how to investigate by themselves. Instead of abstract studio applications students work with the design languages of the CAD programs and meet the real world conditions in front of the computer screen.

REQUIREMENTS OF STUDENTS IN A CAAD STUDIO

We have been teaching the CAAD studio students together with the traditional studio students, because of the insufficient number of equipment to meet the needs of the whole studio group. Students who select the CAAD studio try to make at least one of their studio projects using a CAD program like AutoCAD. These students are patient learners of the CAD program and apply that to their designs.

Students have different approaches to CAAD design: 1) The first group learns CAAD skillfully while doing subordinate drawings such as facades of the existing buildings or site plans, etc., and continues sketching their designs on the computer. 2) The other group of students uses computer only for the drawing purposes. After carrying out their design phases with pen and pencil and completing all the necessary decisions, they begin drawing on the computer, equivalent to drawing with a pen on a sheet of paper.

One of the difficulties of these students in a CAAD studio generates from the inadequate knowledge of how to do design efficiently as well as inadequate knowledge of how to use efficiently a CAAD software simultaneously. CAAD softwares are not mature enough to meet the requirements of the students who are at the beginning can be considered as layman of the profession, even those of an architect. It is not easy for an unskilled person to manipulate fuzzy knowledge in front of a computer program. Computers can not help at present to design thinking. They can only be used to generate patterns, prepare symbols, even symbol libraries, and can call existing designs whenever necessary. There are quite a lot of restrictions in the use of CAAD softwares not only for the students but also for the professional designers.

Most popular softwares like AutoCAD are originally designed to meet the requirements of mechanical engineers who do not need normative, positive and craft like knowledge. Mechanical engineers require concrete knowledge. Normative knowledge relates to prevailing norms, aesthetics, values. Positive knowledge relates to the understanding of the human beings, users of the buildings and environment. Concrete knowledge relates to the basic sciences in engineering and architecture and comprises algorithms. Procedural knowledge is different in architecture and mechanical engineering. Therefore the procedural knowledge requirements of architect designers are not well covered in most of the CAD softwares yet. There are quite advanced programs which have some skills but they are too expensive to use in studio teaching.

DIFFERENCES BETWEEN THE TRADITIONAL AND COMPUTERIZED STUDIO TEACHING

The differences between the traditional and computerized studio teaching generate not only from the equipment used during the design but also from the territory of designing environment. The traditional studio environment is composed of students, tutor, design discourse, the studio itself. The computerized studio environment is composed of similar ingredients plus machines and softwares. Students require extra learning attempt and performance to achieve a solution graphically. These operations require extra time and effort. Their achievement in learning depends on their learning styles. Convergent, serialist and field-dependent students can adapt themselves to the CAAD studio more easily than the others. On the other hand their personality in terms of Newland, Powell and Creed approach, can be well suited to dynamic, contemplative and zealous learning styles. A student with a contemplative and zealous learning style easily assembles montage of elements to construct a whole design.

Holist, divergent, field-independent, reflective and impulsive students prefer to work without computer at the beginning and sometimes all through the studio works. This is easily understandable from their point of view. This is also true for common sense learners who are more abstract thinkers.

EXPECTATIONS FROM A CAAD EXPERT SYSTEM PROGRAM IN A STUDIO ENVIRONMENT

In the light of the studies on the traditional studio teaching and the requirements of CAAD studio learning we can determine the requirements of a CAAD expert system. The following list is prepared as the general knowledge requirements of architects.

o. better information
o. better access to user population
o. asking right questions
o. better understanding of the built environment
o. better understanding of the nature of people
o. better understanding of the nature of design process of designers
o. better understanding of the interactions of the above three (environment, user, designer)
o. better understanding of the nature of design praxis
o. better understanding of the modes of operating the process and of the different modes of professional-client relations

We need to be guided by tangible observations of designers to develop a better understanding of their knowledge rather than abstract speculations. The difficulty of an expert CAAD program is to turn this knowledge into a way of structure of the environmental knowledge, knowledge of users, knowledge of procedure, in other words the science of praxis.

If we accept an expert CAD program as a studio tutor we can make a list of the required responses from a tutor in front of the student when making critique.

o. Guiding to the direction of the project
o. Asking questions
o. Exhibiting solution(s)
o. Making explanation(s) to the project and exhibiting solution(s)
o. Showing past example(s)
o. Reminding necessary information
o. Showing the problems of design
o. Showing the downfalls of design
o. Making analogies
o. Displaying examples

Most of the complications in the studio environment can be removed utilizing a CAD expert system having some of these qualities. A general instructional system can be constructed to meet the basic conceptual requirements of different design problems. This system can have several subsystems and modules for the starters. Procedural requirements of the analysis stage which is explicitly written and told may be easily put into the expert system. For the purpose of giving information related to special design problems some instructional modules can be prepared to help students to find out where to start to a design problem. Declarative knowledges related to human behavior, environmental qualities, legal documents, etc. may be located in the libraries of this system. Procedural knowledge may be simulated with lists of questions, flow diagrams, check lists, etc. in a module of this system. Starting from the general system small different instructional expert systems can be developed to help the students with their library of symbols, well known buildings as well as problem pattern examples, thesaurus like shape libraries, etc.

CONCLUSIONS

In the concluding parts of the paper are discussed the different styles of teaching and their relation to the CAAD studio environment. The conversion of the instructional programs for the present design environment is explained and then the future expectations from the CAAD programs are proposed for the teaching environment. The roles of the expert systems in design studio instructions are discussed. Expert system for CAAD studio is a new concept which requires extensive design research and programming study. Expert systems may be of some help to some of the students at the beginning of their design studios in giving design information. A CAAD expert system for design studios can not replace the human experts, but may be of some help to them when educating the students if it is used appropriately.

We believe there are countless number of investigations to be completed and innumerable number of discussions to be made in the domain of CAAD studio teaching. For further developments guidance from theory to practical Systems is necessary. We consider this will improve the interactions between the theory and practice, theory and education.

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