DO DIFFERENT CAAD EDUCATION METHODS REALLY PRODUCE DIFFERENT RESULTS?

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Abstract. We compare four teaching experiences aiming to demonstrate that different CAAD education methods may produce different results: an undergrad software-oriented course, an undergrad project-based course, a post grad course with a hybrid teaching approach and a project-based CAAD post grad diploma program.

1. Introduction: the problem and hypothesis

Many have argued that new technologies imply in new ways of working (Simonson et al, 2000; Kalisperis, 1996). It involves a controversial issue between method and media. A new technology means new resources but not necessarily a new way of working. The availability of a new technology does not mean that it has been used in its full capacity. An analogy was told about a war between Anglo-Saxons and Franks, in which the first had the technology of the stirrup but did not understand fully its potential. Then appeared a Frank warrior that understood the capabilities of the stirrup lead its country to win the war. He perceived that the stirrup permitted the rider to keep his seat and to deliver a blow with a lance combining his weight and speed of his horse (Finn, 1964, in Simonson at al, 2000). A more recent analogy is the way a car was used when it was first invented. It was named as horseless carriage and could run at 20 km per hour. When the car was invented it looked like a carriage. It was only when its own potentials were understood that it started being designed with new features and used in different ways from the carriage.

In architecture these analogies apply to the computer-aided design process, particularly to its teaching approach and methods. Many architects still use computers in the design process as they used earlier technologies.

Most of architects use computers to represent what they have already decided rather than to conceive their own design ideas. Although this may not happen everywhere, it is yet the case in many architectural offices.

The following practices exemplify this trend: firstly, the emphasis is still on increasing productivity, particularly in drafting, rather than on producing better designs. This is due to the fact that computers allow the reuse of previous solutions, through copying and pasting and increases enormously the speed of drafting and printing. For this reason many believe that the objective of the use of computers is just greater productivity. Secondly, computers offer major advantages over traditional tools, such as 3D modelling, abstract and realistic rendering, natural and artificial lighting calculations, virtual environments, etc. However, those resources are mostly used only for presentation rather than design decision making. Thirdly, many architects still design by documenting the final product rather than by modelling objects and exploring different alternatives.

Why so many architects yet use computers mimicking earlier technologies? We believe that one of the major reasons for that resides on the learning method by which most architects were introduced to computer technology. A recent survey (Caixeta, 2007) shows that most architects are taught computers through the production of several independent orthographic representations, such as floor plans, sections and facades. The computer's potential to represent the artefacts in a fully integrated 3D object-oriented environment is rarely taught. That survey also shows that most architects learn to use computers by representing existing buildings. The results are courses predominantly command-based or software-oriented rather than application-oriented. The possibility of integrating computers into the decision making process characteristic of designing new buildings is also not taught. Most architects are taught with the basic presupposition that the computer's constraints are the same of the earlier technologies. Not surprising, the same survey shows that most architects tend to continue using computers in the same way they were first taught.

Therefore, we believe that the solution is of educational nature and has to be based fundamentally on three points: firstly, teaching must start from 3D instead of 2D. We must take advantage of the computer's capability of representing objects in integrated environments from which all drafting information can be later extract.

Secondly, teaching must be based on architectural issues rather than software commands or structure. The major issue should be the teaching focusing on the process of architectural designing allowing testing of different solutions, visualization and integration among its various parts, feedback and changes as much as necessary.

A Project-based Learning - PBL is a teaching method (Bridges, 1991, 2006; Boud, and Feletti, 1997, Maitland, 1997) that can be used in CAAD education allowing students into a new understanding of the potential of computing in the design process. One of the basic assumptions of PBL is that students learn better when teaching takes place in true-to-life activities. There is no separation between learning the concepts and only after that applying the acquired knowledge. In a PBL CAAD environment students are necessarily pushed beyond merely using the computers to represent what has already been decided into exploring the new possibilities that computers offer in the design decision making process. In this type of learning environment students are also encouraged to find new solutions rather than simply to describe or reproduce previous ones.

Thirdly, teaching must take place by using innovation-based computer systems rather than automation-oriented ones. Several CAAD programs today emphasize the reuse of previous solutions in the form of pre-defined components in order to increase productivity. For instance, the user is required to choose at the beginning of the design process what type of wall will be used in the project including the specification of construction materials and their properties. If this is mandatory in particular system then it becomes inflexible not allowing the designer to use abstractions at the beginning of the design process neither to develop new components. An innovation-based computer system may include pre-defined components, but it must be flexible enough to allow for abstractions particularly at earlier design stages and also allow the development of new solutions anytime in the process.

In the following sections we compare four teaching experiences verifying the students' predominant understanding and practice computer-aided design at the end of each of them. For this purpose we used the following blocks of questions:

Block I:

1. Was there an indication that the students understood the computer as only a replacement of traditional design tools?
2. Was there an indication that the students sometimes understood the computer as a tool offering new possibilities?
3. Was there an indication that the students predominantly understood the computer as a tool offering new possibilities?

Block II:

4. Did the students only design or draw by documenting in 2D?
5. Did the students design or draw by documenting in 2D but also by modelling artefacts?

6. Did the students predominantly design or draw by modelling artefacts in 3D?

Block III:
7. Did the students explore design alternatives?
8. Did the students mostly tend to stick to the first solution?
9. Did the students explore several different design alternatives in design process?

Block IV:
10. Were computers used just for representing what had been already decided?
11. Were computers sometimes used in decision making process of design?
12. Were computers mostly used in the decision making process of design?

2. A Software-based Undergrad Course:

"Computer Graphics", CG, is a mandatory course in our undergraduate program. This course is delivered in the first year of the undergraduate program and it is fairly traditional, with emphases on 2D drafting and on representing existing buildings. Students are taught to work with 2D environments and to represent documents rather than artefacts.

We analyzed its results in terms of the twelve questions stated in the previous section. We assessed the results in terms of how much the students used the computers in the design process rather than to represent the final product. The results are very predictable as seen in the section 6 (A comparative study).

3. A Project-based Undergrad Course:

"Computer-Aided Architectural Design", CAAD, is an elective course taught to the fourth year students of our undergraduate program. It is worth of note that "Computer Graphics", CG, is a pre-requisite for CAAD therefore with implications in the learning process. This course is design-oriented, but it deals with students that learned, in CG course to use computers mimicking the previous technologies. Although the teaching method used in CAAD is very different from the course previously mentioned, the students practice is greatly influenced by the way they

initially learned how to use computers in CG. The results are not so good as the next two courses whose students did not learn computers as in CG that emphases on 2D drafting and on representing existing buildings. We analyzed this course results with the same criteria used for the previous one above. Please refer to section 6 (A comparative study).

4. A Post Grad Course with a hybrid teaching approach:

"Theory and Practice of Design Computing", TPDC, is a course of our master's program. The audience of this course is composed mostly of professionals in the range of 25 to 40 years old including some few mature architects. This course started with traditional lectures to deliver the contents of introduction to computing and computer graphics, and progressed towards a design based approach of teaching in which students were lead to find and test solutions for their projects. We analyzed its results with the same criteria used in the ones above. Please refer to section 6 (A comparative study).

5. A Project-based Computer-aided Architectural Design Post Grad Diploma Course:

Computer-aided Architectural Design Post Grad Diploma, CAAD PG Dp, is a program in our school that lasts 18 months. A design based approach is adopted since the conception until the communication to the construction site. Its audience is fairly similar to the master's course TPDC. The detailed presentation of this Program has been subject of some of our previous publications (Silva, 2001; Silva & Lima, 2003, 2006). The results show several advantages in the design process of these students. They fully understood and took advantage of the computer to explore ideas throughout the design process since the conception. They explored different design alternatives. They designed by modelling objects of the real world rather than simply representing documents. Please refer to section 6 (A comparative study).

6. A comparative study:

The Table 1 next page shows the results of the comparative study using the blocks of questions described earlier in this paper:

TABLE 1. Comparison among different learning CAAD experiences.

Course	CG	CAAD	TPDC	CAAD PG Dp
Block I				
1. Was there an indication that the students understood the computer as only a replacement of traditional design tools?	Yes	No	No	No
2. Was there an indication that the students sometimes understood the computer as a tool offering new possibilities?	No	Yes	No	No
3. Was there an indication that the students predominantly understood the computer as a tool offering new possibilities?	No	No	Yes	Yes
Block II				
4. Did the students only design or draw by documenting in 2D?	Yes	No	No	No
5. Did the students design or draw by documenting in 2D but also by modelling artefacts?	No	Yes	Yes	No
6. Did the students predominantly design or draw by modelling artefacts in 3D?	No	No	No	Yes
Block III				
7. Did the students explore design alternatives?	No	Yes	Yes	Yes
8. Did the students mostly tend to stick to the first solution?	n/a	Yes	Yes	No
9. Did the students explore several different design alternatives in design process?	n/a	No	No	Yes
Block IV				
10. Were computers used just for representing what had been already decided?	Yes	No	No	No
11. Were computers sometimes used in decision making process of design?	No	Yes	Yes	No
12. Were computers mostly used in the decision making process of design?	No	No	No	Yes

The questions above were thought, as much as possible, to constraint the universe of possible answers into a yes or a no. Blocks I, II and IV contain questions that are all mutually excluding. In Block III only questions 8 and 9 are mutually excluding.

Each of these blocks contains questions that also aim to verify how closely the following objectives were achieved: 1. to teach the students to perceive the computer as a tool providing new possibilities for designing; 2. to have the students designing from modeling artifacts; 3. to have the

students exploring several different alternatives in the design process; 4. to have the students using computers in the design decision making process. For instance, an answer yes to the third question of each block would indicate that our objective was achieved; an answer yes to the second question of each block would indicate that our objective was partially achieved; an answer yes to the first question of each block would indicate that our objective was not achieved.

Although we delivered the teaching in all four courses described earlier, we had a variable degree of freedom in defining the recruitment criteria, the contents and the methods in each one of those experiences. In the course CG we had to work under great constraints for we did not have the power to define neither the recruitment criteria nor the contents. We had a very limited power to define even the methods. In the course CAAD we also did not have the power to define the recruitment criteria, because the students enrolled in it had to take CG as mandatory course. However we did have the opportunity to define contents and methods of CAAD. In the course TPDC we could partially define the recruitment criteria and fully define its contents and methods. In the CAAD Post-Grad Diploma we had the freedom to fully define all these variables: contents, method and recruitment criteria. This variety of constraints resulted in different teaching experiences and provided an opportunity for the comparison at hand.

The results achieved in CG were, as predicted, very disappointing with none of the objectives achieved. The results of CAAD were better with all the 4 objectives partially achieved. The results of TPDC were even better with one objective fully achieved (1. to have the students to see the computer as a tool providing new possibilities for designing) and the three others partially achieved. The results of the CAAD Post-Grad Diploma were very promising with the all the 4 objectives fully achieved.

Figures 1 and 2 illustrate the use of computers for decision making. Figure 1 shows a radiosity based rendering of an auditorium. Having realized the inadequacy of the initial lighting design the student proceeded to modify it until achieve a better result such as in Figure 2.

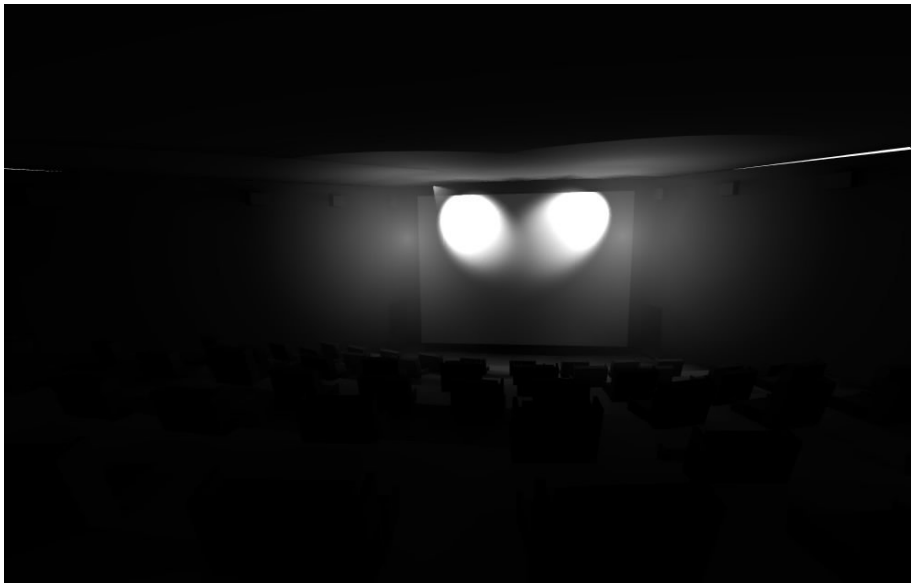

Figure 1. First radiosity study.

Figure 2. Second radiosity study.

These figures above are examples of using computers for decision making in the design process in the CAAD Post-Grad Diploma. They show the importance of testing different alternatives to improve solution instead of

sticking to the first one as it happens when computer is used mimicking traditional technology. Figure 3 bellow is an example, in that same PG Diploma of exploring different design alternatives rather than sticking to the first one.

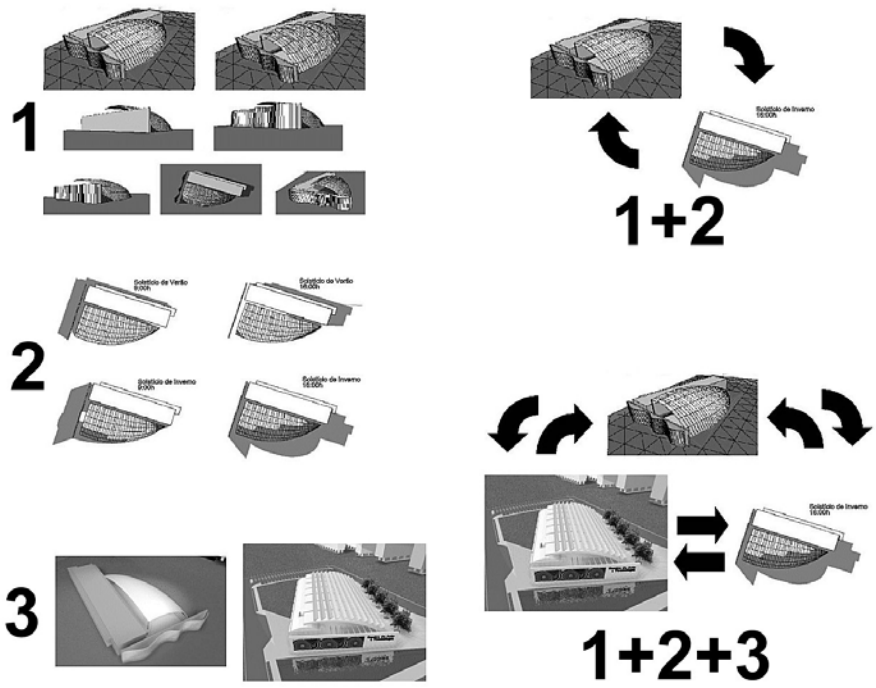

Figure 3. Example: exploring different design alternatives.

7. Conclusions:

It was our primary concern in this paper to compare the results of different teaching methods that encourage exploring different alternatives in the conceptual design phase of design with those that use computers for 2D drafting or representing existing buildings. We believe we have demonstrated that the learning approach set up at the CAAD Post Grad Program produced promising results in terms of encouraging professionals to effectively use computers in architectural design in new ways rather than mimicking earlier technologies. Students have demonstrated in CAAD Post Grad Program the capability of using computers to represent artefacts rather than documents, to explore design alternatives and to incorporate new possibilities in the design thinking process which are not available in

previous technologies (such as time, motion and immersion). The comparative results (Table 1) show that only the students of this post grad course fully understood how to use the computer to benefit the design process.

References

BOUD, D. and FELETTI, G., 1997. *The Challenge of Problem-Based Learning*, Kogan Page Ltd, London, UK.

BRIDGES, A., 1991. *DAC or Design and Computers, in CAAD Futures 1991*, Digital Proceedings, Zurich, Switzerland, pp. 65-76.

BRIDGES, A., 2006. *A Critical Review of Problem Based Learning in Architectural Education, in Communicating Space(s), in the 24th eCAADe*, Conference Proceedings, Volos, Greece, pp. 182-189.

CAIXETA, L., 2007. *O computador como ferramenta de auxilio ao processo projetual da arquitetura: o processo de aprendizagem e o atual uso das ferramentas digitais pelos arquitetos*, unpublished master dissertation, University of Brasília, Brazil.

FINN, J., 1964. *The Franks had the right idea*. NEA Journal, 53(4), 24-27.

KALISPERIS, L. N., 1996. *CAD in Education: Penn State University, in ACADIA Quarterly*, volume 15, number 3 (summer): pp. 22-25.

MAITLAND, B., 1997. *Problem-based Learning for Architecture and Construction Management, in* Boud, D. and Feletti, G. (eds.) *The Challenge of Problem-Based Learning*, Kogan Page Ltd, London, UK.

SILVA, N. F., 2001. *The Structure of a CAAD Curriculum and the Nature of Design Process: An Experience Handling Contradictions. In:* PENTTILÄ, H. (editor) *Architectural Information Management, 19th Conference on Education in Computer-Aided Architectural Design in Europe, eCAADe 2001*. Helsinki, Finland, p. 352-357.

SILVA, N. F., LIMA, E. M., 2003. *Assessing The Effectiveness of CAAD Education: A value added approach. In:* Dokonal, W. (editor) *Digital Design, XXI eCAADe Conference*, Graz, Austria, Graz University of Technology, v. 1. p. 509-512.

SILVA, N. F., LIMA, E. M., 2006. *Computer-aided Building Design Education: Simulating the Design Process in a Project-Based Learning Curriculum. In: International Conference on Engineering Education, Instructional Technology, Assessment, and E-learning*, University of Bridgeport, Springer New York.

SIMONSON, M., SMALDINO, S., ALBRIGHT, M. and ZVACEK, S., 2000. *Teaching and Learning at a Distance – Foundations of Distance Education*, Prentice Hall, Columbus, Ohio, 8-9.