Abstract. A study based on a post-occupancy-evaluation (POE), conducted in housing developments in the region of Campinas, Brazil, evaluated quality of life and sustainability indicators. These indicators were then related to site planning design guideline for low-income public housing projects that considered recommendations for integrated community and security, street and path system and parking, public and private open space and landscaping. Since this work is part of a broader study, which aims to develop evaluation tools, the proposed design guidelines were used by students in a graduate class, in order to verify its effectiveness. Bloom’s Taxonomy was used to determine educational goals for design thinking in this class. First design thinking was instigated based on students’ prior knowledge of life quality and sustainability indicators for housing design. Comprehension of proposed design guidelines was stimulated by the
reading and discussion of related literature, paraphrasing or extension of proposed design guidelines and respective illustration with reference images. An existing low-income housing development, with award winning design, was selected and an evaluation of its conformance to proposed design guidelines was conducted comparing site or design images to reference images. This evaluation subsidized a design exercise for the selected housing development. The class was offered as a partially distance course with an agenda including: tutorials, theoretical classes, seminars and conceptual discussions. A new Brazilian open source e-learning environment was experimented and critiqued. Beyond traditional CAAD tools others such as wiki, blog, polls, chat, conferencing, web authoring and visit broadcasting supported collaborative learning and design. Results indicate the viability of design teaching in distance education courses for competent designers; however the experience shows the need for innovation in synchronous communication and visualization tools specific for architectural design users. Students evaluation of selected housing development and final projects indicate that the proposed guidelines for low-income public housing projects successfully supports the decision making process in order to incorporate quality of life and sustainability indicators in design. The experience presents a model of design education which incorporates technology integrated to human and environmental dimensions.

1. Introduction

Kalay (2006) intelligently points out that architectural design and the construction of buildings are collaborative efforts, involving many individuals and requiring different skills; therefore, a highly complex and challenging task. Participants work together to achieve common goals of the joint project, however conflicts in the decision making process usually occur. Therefore, computational methods for collaboration primarily focus on assisting the communicative aspects of collaboration. The most important impacts of a network-based collaborative approach on architectural design will be its transformation from a hierarchical linear process into a distributed, interleaved process.

Bento et al. (2004, p. 8) presents effort to create Project-based learning communities in order to prepare users to best take advantage of network-based collaboration. Challenging short problems are created in order to motivate intense interaction of a remotely distributed team. Extension of the project over a period of time builds trust and working relationship among team members who have never met face-to-face. Participants experience collaborative learning from interaction with different expertise and cultural back-grounds and therefore approach problem differently. Also, in order to support long-term, large-scale learning communities the ArchNet system –
2. Site Planning Design Guidelines

The design guidelines applied in the exercise developed in our learning action resulted from previous research project undertaken to evaluate typical low-income housing projects in the State of Sao Paulo, Brazil, with a view to improve future designs (Kowaltowski et al., 2006). The principal aim of this study was the development of a design evaluation method. This method should enable designers to foresee and initiate discussions on the quality of housing designs. Quality in housing design is seen as having two fronts: the physical-environmental impact of large construction projects and the quality of life such housing developments can provide their users. The hypothesis that underlined this previous research project was that, already at the site planning stage, a large number of environmental factors are defined which may interfere in the quality of the future users’ life and have positive or negative sustainability impacts. The principal aim of that study was to create a systematic means of evaluating housing projects. Therefore, design guidelines were developed considering topics as: spacial, morphological, contextual, visual, perceptual, social and functional qualities. These guidelines were grouped in recommendations for integrated community and security, site-planning, street and path systems and parking, public and
private open spaces and landscaping. Table 1 summarizes developed design guideline presenting at least one recommendation for each topic.

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INTEGRATED COMMUNITY AND SECURITY
- Consider people’s feelings of insecurity, providing for territorial markings through adequately designed fencing and access control through gates.

SITE-PLANNING
- Ensure distances between buildings to ensure natural ventilation and privacy of individual residential units.

STREET AND PATH SYSTEMS AND PARKING
- Place parking lot in proximity to dwelling units to allow for casual surveillance. The provision for a parking spot (as a desired item) should be made for every residential unit.

PUBLIC AND PRIVATE OPEN SPACES
- Discourage incorporation of open areas into indoor space through design or location. Screen balconies for privacy and define boundaries, but avoid solid walls that prevent small children from looking out and are safety risks design models.

LANDSCAPING
- Use hardy, native plant species easy to maintain. Chose adequate vegetation for shade and avoid root damage to constructions through sufficient planting area reservation.

3. Collaborative Design Class

According to Dillenbourg (1999, p. 4-5) collaborative learning includes collaborative activity within an educational context, from studying course material to sharing course assignments. Collaborative learning is expected to occur as a side-effect of problem solving, measured by the elicitation of new knowledge or by the improvement of problem solving performance. Collaborative learning includes individual and collective cognitive mechanisms. Individual activities such as reading, building, predicting, will trigger learning mechanisms such as induction, deduction, compilation. Interaction among subjects generates explanation, disagreement, mutual regulation; which will trigger extra cognitive mechanisms (knowledge elicitation, internalization, reduced cognitive load). Finally, collaborative learning takes the form of instructions to subjects, a physical setting and other institutional constraints.
Therefore, students were instructed to work in teams to develop tasks related to conceptual discussions and design exercise. Teams varied depending on tasks. The physical settings were characterized by the digital resources of the electronic learning environment TIDIA-Ae installed at http://ulisses.nied.unicamp.br/:8180/portal. The institutional constraints were represented by the class agenda. The learning action was offered as the class denominated IC075 of the Graduate Program in Civil Engineering of FEC/UNICAMP in 2008. Hence, students were graduated architects or engineers, considered competent designers. The class was offered in an 8 week period comprising 6 hours/week. Only the first and last week of classes were offered presently.

As presented previously the design exercise proposed was to evaluate and propose interventions on an existing low income housing considering design guidelines for life quality and sustainability. A strategy based on Blooms Taxonomy for knowledge building from simple to more complex objectives guided the class syllabus relating theory to practice. The first objective was to create the ability to list parameters of life quality and sustainability for low income housing. The following objective was to make students capable of describing theses parameter associated to site planning. One step further would be to create the ability to develop studies and simulations in order to characterize and identify such parameter. Next the ability to classify and compare parameter was desirable. The final objective was to develop the ability to formulate solutions for the problem identified following the previous stages.

3.1. STUDIED SITE

The housing development Jardim São Francisco was selected as the study site. It was conceived by the architect Demetre Anastassakis and staff. The Project won the architectural contest realized in 1989-1990 for the site. The original project included a total area of 34,000m2 in the city of São Paulo, designated for 600 residences, which varied in area from 31 to 54 m2.

For its conception the technical staff wanted to value elements built by the population like villas, corners and squares, breaking from traditional forms. Therefore, the adopted party was of grouped houses, sharing division walls in order to reduce costs. The houses were arranged in a manner that villas sharing internal squares were formed as show in Figure 1. The houses were design as modules allowing expansions according to families need and resources, without aesthetics loss. The project included areas for leisure as gardens, free markets and recreation parks.

However, the housing development was not built according to original project. After 15 years of its construction various modifications in its space structure have been implemented by dwellers and its evolution did not occurred as planned (Figure 2).
3.2. COURSE DYNAMICS

A class dynamic was developed based on Bloom Taxonomy for learning objectives: familiarization, memorization, comprehension, application, analysis & evaluation and creation (Wheeler, 2005). Illustrations were created to better explain theses learning objects in class (Figure 3).

During familiarization stage of the class students got to know each other, were presented to class syllabus, participated in a brainstorm session on the subject of life quality and sustainability, and were presented to the electronic learning environment TIDIA-Ae (Figure 4A). The whole group received the same reading assignment, the fundamental article of the class (Kowaltowski et al., 2006).
In the stage of memorization (Figure 4B) students should extend or reorganize the design guidelines proposed by Kowaltowski et al. (2006). Therefore, expanded reading was proposed by each student selecting an extra article to read, over a pre-defined bibliography list, producing a critical review. These reviews were posted in Blogs and freely commented by the group. Finally, students were grouped per design guideline topics (Table 1) and based on broader readings and related discussion, collaboratively extended or reorganized design guidelines for life quality and sustainability in WIKIs.

In order to exercise comprehension students were asked to represent design guidelines recommendations in terms of images per topics as in Table 1. These images could be taken from reference projects, sketches, photographs, 3D models; whatever best represented the concept in question (Figure 4C). In order to narrow image universe and to correct mistaken choices, the whole group was asked to vote on the best three representations for each topic. Images were posted in the environment using the IMAGE GALLERY tool. Voting of best choices was executed using the POLL tool. This stage casted reference images to represent design guideline recommendations.

In order to apply knowledge developed on design guidelines for life quality and sustainability in low income housing students were asked to observe the studied site - Jardim São Francisco - and search in the project or actual site for images that demonstrated attendance or not to the studied design guidelines (Figure 4D). This task resulted in the analysis of the studied site and was remotely presented by each group as web seminars. The web-authoring tool CPqD WEBCASTING was used to develop and broadcast students’ seminars.

In sequence a second POLL was developed in order to value studied site attendance to design guidelines based on the developed analysis. A scale value where 5 represented excellent conformances to design guidelines ranging to 1 representing terrible conformance was used. This method indicated that the studied site had poor performance site planning, street and path systems and parking and landscaping; and regular performance in integrated community and security and public and private open spaces aspects (Figure 4D).

Finally students were asked to formulate solutions for the studied site considering the encountered problems. In order to better subsidize this task a remote visit to the neighborhood was realized and broadcasted to students. Collected data was posted in the TIDIA-Ae repository and also made available in a blog outside of the system (http://jsfrancisco.blogspot.com). Students were then reorganized in groups ensuring that in each new group all topics studied would be represented by a member of previous group arrangement. The final assignment would be to go back in time and simulate the participation in the original project staff and propose project
modification having had the opportunity to see the future through the viewpoint of the performed analysis.

Figure 4. Stages of the class corresponding to learning objects.
3.3. RESOURCES

The objective of this graduate class was not only to verify the effectiveness of research Project design guidelines but also to thoroughly use and test all potential of the electronic learning environment TIDIA-Ae. Therefore, most of the available resources were applied and this section will present their use.

Theory on design process, life quality, and sustainability was presented by professor throughout the class by means of web seminars using the CPqD WEBCASTING tool (Figure 5). The seminars were elaborated by professors using preferred presentation tool, then each slide was transformed to JPG image format, uploaded to the environment and synchronized with the professor’s image and speech. Each seminar lasted from 30 to 45 minutes. Students could watch seminar at any time from anywhere once it was posted. However, each seminar could be watched at a specified date and time with the presence of the professor in the chat of the tool. Student seminars were also developed and offered in the same manner.

In order to better subsidize student final project a remote visit to the studied site – Jardim São Francisco - was realized and broadcasted to students. Two locations – classroom and studied site – were connected using the video call tool SKYPE. Images of the neighborhood were then transmitted during a walk excursion using a video camera, notebook, and 3G Internet mobile modem (Figure 6). A bilateral communication occurred
during walk transmission enabling student active participation in the process. This activity was realized after site analysis was performed and while problem solutions were being formulated. Therefore, it allowed impression confirmation and resolutions of doubts of the site and its surroundings.

Tutorials explaining how to use environment resources, specific Computer Aided Architectural Design (CAAD) tools or how to develop assignments were also available. These tutorials presented step-by-step explanations (Figure 7).

Every web seminar presenting theory was followed by synchronous discussion with the entire group of students and specific specialist on the subject. These discussions were text based and occurred in the CHAT tool of the TIDIA-Ae system. Chat sessions were saved allowing further consultation.
Online meetings between students and professor also occurred using video call tools as SKYPE or conferencing tools as AGORA (Figure 8). These meetings usually discussed assignments, general agenda or system doubts. The AGORA tool was of great interest for it allowed sketch discussion with whiteboard and desktop broadcasting. However, the tool is still under development and was very unstable.

Two tools were used for asynchronous communication: MESSAGE (email) and DISCUSSION (forum) of the TIDIA-Ae system. Email tool outside the system was also used. MESSAGE and emailing was used for individual communication. DISCUSSION was used mainly to obtain free impression of participants over specific subjects. However, DISCUSSION was also used for students to declare selection of reading assignments.

The class syllabus and corresponding agenda was posted in the SCHEDULE tool. Reminders and last minute communications were available in the NOTICE tool. Assignments were presented and detailed in the ASSIGNMENT tool. These three tools together had the function to guide distributed participants throughout the class period and weekly activities.

The BLOG tool of the TIDIA-Ae system was used socially for participant presentations and also for collaborative learning in a reading and discussion assignment (Figure 9). However, this tool is still very inefficient and restricted comparing to similar ones available over the web. This is a real draw back of the system, for it can support multiple situations for collaborative learning by flexible, multiple data format and free sharing among students.

Theory, student work and design evaluations presented in slide format were posted in the PRESENTATION tool. In the case of the web seminar the slides used were also available through this tool, allowing different views of the same material.
Surveying participant opinion occurred in multiple situations during the class and the system resource used for this was the POLL. This tool was used: to select reference images, to value project/site performance and to obtain student opinion on system tools and assignments. This tool was especially important for decision support in the method proposed for design evaluation.

There was an effort to present information on multiple formats. Therefore, besides web seminar, slide presentations, text readings and animated tutorials, specific material were also available in video format. The POTCAST toll was used (Figure 10). Examples of available videos were: general introduction of the class syllabus, studied site model animations and presentation comparing Jardim São Francisco project and actual site.

The use of images was a strong point in the analytical design performance evaluation method proposed. Therefore, the system toll IMAGE GALLERY was of most importance (Figure 11). The tool allowed image sharing, visualization and argumentation.

The task of collaborative text editing was developed using the system tool WIKI. Participants could asynchronously edit together a text and the
history of edition was maintained allowing edit reversion. The group used collaborative editing to revise design guidelines. This resource was also used to register collaborative design process used by each group, when members were asked to describe in the WIKI design process used in final project development.

4. Collected Data and Analysis

For the evaluation of this teaching, learning and design experience, student data were analyzed and will here be presented and discussed. These data were collected by polls, discussions, collaborative editing, and were presented in seminars and presentations.

4.1. STUDENT OPINION

Student opinion over system resources used and assignments were obtained by opinion survey. The acceptance of assignments was in general from good to excellent (Figure 12). The final project stands out with the best evaluation by students, yet it was the most difficult task. It could be the result of the strategy adopted in the class syllabus to build knowledge from simple to more complex learning objectives. Therefore, students were prepared and motivated for the most difficult and important assignment.

Figure 11. Screen of the IMAGE GALLERY presenting list of galleries available with miniature visualization (left) and full visualization (right).
4.2. FINAL PROJECT DESIGN PROCESS

After five weeks of intense collaborative learning and experimenting with the studied site students had three weeks to develop the final assignment. The exercise was to go back in time and simulate a participation in the original project staff and propose design modification having had the opportunity to see the future through the viewpoint of the performed analysis. Digital building plans and models were available in the system repository.

We would like to know how remote resources used for interaction during collaborative learning activities would be applied in the design process for the development of the final project. We had experienced survey resources supporting collective decision-making. We would like to know if this process would be applied in student collaborative design process.

Collected data on resources used to support collaborative design indicates Google Text and Spreadsheets and SKYPE as the ICT tools mostly used (Figure 13A). Survey also shows that students developed the final project mostly with remote collaboration, however, present interaction was still present (Figure 13B).
Groups registered design process developing WIKIs over the subject. From the three groups one declares to have developed the final assignment totally by remote collaboration. In the design process of this group it was observed the most effective used of available digital media (plans and models). The group also repeated in their design process the model used in the class, that is, to develop alternatives and decide over them using polls and discussions. The other two groups used a mix of remote and present collaboration relying on present meetings for decision-making. In these groups it was noticed an emphasis in use of traditional paper design methods, this could be related to the short period to develop the assignment.

In discussion over tools to support remote collaborative design students repeatedly reported need for remote discussions/editing over drawings, but why not also over models? This experience fell short in this aspect. Next we present students opinions or suggestions on this matter: “...a place where all could draw and all could visualize changes simultaneously.”; “Despite using SKYPE with efficiency, it was necessary to discuss and intervene on drawing in the presence form.”; “... in order to remotely collaborate in design, I felt the need to sketch ideas, there could be a toll for this purpose, where all could draw in scale, with measures, in an integrated manner with all group members.”

4.3. FORMULATED SOLUTION

As previously presented students were asked in the final assignment to go back in time and simulate a participation in the original design staff and propose modification having had the opportunity to see the future through
the viewpoint of life quality and sustainability. Performed analysis indicated that the studied site had poor performance in site-planning, street and path systems and parking and landscaping; and regular performance in integrated community and security and public and private open spaces aspects.

Of the three groups only one developed this activity as proposed, the other two chose to consider the built environment and proposed intervention to the actual site. Coincidently, the group that accepted the original exercise conditions succeeded in developing the assignment totally remotely. It could be reasoned that once choosing to propose interventions for the built environment resulted in a more complex and realistic design exercise. Therefore participants encountered more difficult conditions to work in. Also, the material available was not consistent for the task.

Despite different interpretations of the instructions, solution proposed were complementary and considered issues for life quality and sustainability as suggested by Kowaltowski et al. (2006). Aspects related to public and community spaces; parking and landscaping were valued as much in the proposal over the project as in the proposals for the built environment of Jardim São Francisco. However, only the group that worked in the condition of project stage simulation formulated solutions for street and path systems. Another consequence of different exercise interpretation was that the two groups that formulated solutions for the built environment missed the opportunity to analyze causes of disagreement of the original project in comparison of how the built environment evolved.

5. Final Considerations

Results indicate the viability to promote collaborative learning with the support of the electronic learning opensource system TIDIA-Ae in distance education courses for competent designers. Beyond traditional CAAD tools others ICT tools such as wiki, blog, polls, chat, conferencing, web authoring and visit broadcasting supported collaborative learning and design thinking. However this opensource system falls short in the support of collaborative design. The opensource system used does not meet requirements suggested by Rossignac (1998), which points out that computer mediated tools for the collaborative design and exploitation of 3D datasets requires advances on: improved instant access to remote models; new generation of user-interfaces that enable easy navigation and effective use in design, marketing, education, or entertainment of animated 3D worlds; interference tracking and inspection in interactive 3D viewing and design environments; and natural communication modalities including video, voice and gesture annotations. A system as developed by Ashdown and Robinson (2005) that presents users with a desk-sized projected display with bimanual input that allows documents and images to be arranged and modified by multiple
remote collaborators would likely respond to needs on synchronous design tools suggested by students. The authors argue that large visual task spaces maximize the shared context between collaborators being more important for design tasks than conventional videoconference. Multiplayer online games have become a phenomenon of growing social, cultural, and economic importance and represent persistent online 3D environments supporting information and collaborative real-time exchange (Ducheneaut et al., 2007). However, these 3D collaborative environments mostly promote interaction in chat modes and cooperative object manipulation is still limited (Pinho et al., 2008).

Students evaluation of selected housing development and final projects indicate that the proposed guidelines for low-income public housing projects successfully supports the decision making process in order to incorporate quality of life and sustainability indicators in design. The experience presents a model of design education, which incorporates technology integrated to human and environmental dimensions in a rich interactive, reflective and participative manner. It was also noted strengthened design behaviour and methodology.

References


Kowaltowski, et al., 2006. Quality of life and sustainability issues. Habitat International, 30(4), 1100-1114


