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Architecture Project: City Plan, Home and Users – Children as Architects

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Abstract

The general objective of the present study was to analyze how elementary school students developed environmental competence during an architectural project. The computer-supported collaborative learning environment was used to support the participants' collaborative design activities. The main research question: What kind of design learning processes and environmental competence will emerge during the project? Sixth graders (n=29) designed 7 apartment buildings of several types, for a building site planned by the City of Helsinki. The project lasted one half year and integrated with many school subjects. The participants' quantitative contributions to the database were analyzed, and further, the qualitative content analysis was conducted on the students' notes. For the deeper analysis, we selected notes that were related to 1) analysis of the neighborhood, 2) constructing design context, and 3) reflection on the project –notes, which we took to represent participants' "learning outcome". The results revealed that, according to the evidence we obtained, students gained in several aspects of awareness and environmental competence related to architectural concepts and principles.

Keywords: Learning by collaborative designing; knowledge building; technology-enhanced learning; environmental competence

1. Introduction

The innovation society creates novel challenges for education; it requires competencies that develop through participation in the practices of working with knowledge and solving authentic problems (Bereiter, 2002). For that reason, young students need both the experiences and the tools to participate actively in the innovation society. In the present day, students are expected to engage in creating, sharing,

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and designing complex cultural artifacts by capitalizing on versatile collaborative technologies. Design learning provides a powerful means to these objectives, by challenging students to find answers to complex and difficult design problems and by promoting their capacity to act as change agents (Carroll et al., 2010). Students' experiences of collaborative designing in educational settings appear to promote the practices of collective elaboration of design ideas (Drain, 2011; Murphy and Hennessy, 2001) as well as the implementation of these ideas in the actual design of artifacts.

Initiatives to involve children in assessing and planning their local environments are very common in studies of environmental psychology (Chawla & Heft, 2002, for an overview see Francis & Lorenzo, 2002). Students might interview residents and conduct walking tours in order to determine the most important design issues related to the local environment, which they wish to address (Chawla & Heft, 2002; Horelli & Kaaja, 2002). In this way children learn to know the natural and built environment around them as well as the people who are using it. These studies (Horelli & Kaaja, 2002; Francis & Lorenzo, 2002) shed light on processes of participation that may foster children's awareness and environmental competence in exploring, evaluating and improving their local settings. The awareness of residential environments refers to the people's experiences of the places and buildings they encounter in their daily life whereas environmental competence refers to learning about and acting in the environment.

Environmental competence is broadly defined as a capacity to deal with one's surroundings in effective manner in one's practical and cognitive activities (Pedersen, 1999). In general, the development of environmental competence is informal ongoing process during the whole life span, but it can be facilitated and supported during a person's formal education (Pedersen, 1999). Environmental competence has been said to consist of three main aspects; 1) personal awareness and attitudes, 2) environmental knowledge and 3) practical environmental skills (Pedersen, 1999). Personal awareness and attitudes embrace interest and knowledge about one's environment and ability perceive the environment accurately. The environmental knowledge involves knowledge and facts about surroundings whereas the practical environmental skills engage environmental exploration, personalizing the environment and developing useful cognitive maps (Pedersen, 1999). Environmental competence is learned within an environmental context that involves active participation and commitment. There are quite convincing arguments that participation on the environmental or architectural projects prepares children for active citizenship, teaches useful design skills, and increases environmental awareness and competence (Chawla & Heft, 2002; Horelli & Kaaja, 2002). However, very little research in Design and Technology education has been done to assess how the children's environmental awareness and competence increase during these kinds of projects.

The aim of the present article is to introduce the longitudinal school project called "Architecture Project: City Plan, Home and Users -- Children as Architects" that engaged students in collaborative inquiry and designing. During the architecture project, the elementary students designed apartment buildings with the help of a professional designer. The aim of the project was to develop elementary students' environmental competence about architectural design principles as well as to learn architectural concepts, such as city plan, building volume, building site. Further, the project aimed to develop students' understanding of various design constraints related to building requirements, utilities of the space and users' needs etc. The Architecture project was based on the following ideas: 1) intensive collaboration between the teacher, the designer, and researchers, 2) integration of many school subjects, such as history, mathematics, mother tongue, biology, geography, visual arts, and design & technology education, and 3) fusion of conceptually-driven (minds on) inquiry with a materially embodied one (hands on), for solving a real-world architectural problem. During the whole project, a technology enhanced learning environment, Knowledge Forum, was used. The ideas behind the Architecture Project rest upon the Learning by Collaborative Designing –model (LCD model, Seitamaa-Hakkarainen et al., 2010), which is a pedagogical model that assists teachers and students who are engaging in design activities. The following specific research questions were addressed:

- How does the Architecture Project actualize in the technology-enhanced learning environment?
- What kind of design learning processes will emerge during the project?
- What kind of environmental competence do students develop?

In the following section, we will first introduce the pedagogical ideas behind of the project. Then, we describe the empirical study and discuss the results in light of recent research in Design and Technology Education.

1.1. From knowledge building to collaborative designing

In order to provide the students the opportunity to deliberately engage with knowledge objectives of learning, Bereiter and Scardamalia (2003) have pursued ground-breaking research on technologies and pedagogies of collaborative knowledge building. In knowledge-building, the learning is treated as analogous to innovative processes of inquiry, where new conceptual artifacts --such as ideas, questions or plans—are communally created and participants' initial knowledge is either substantially enriched or significantly transformed (Bereiter, 2002). Further, Bereiter and Scardamalia (2003) emphasized the importance of design mode in student learning. In design mode, students are concerned with the usefulness, adequacy, improvability, and developmental potential of ideas. A central aspect of knowledge building, in the present project, is to engage elementary school students in creative working with knowledge aimed at collectively improving design ideas generated.

While knowledge building nicely highlights conceptual aspects of inquiry, it gives too little focus on the role of tools, instruments, prototypes and other physically embodied aspects of inquiry. In the present article, designing is seen as an integral part of inquiry oriented knowledge building that is strongly materially embodied. The designing cannot be reduced to mere play with ideas (conceptual artifacts); in order to understand and improve the ideas in question, these have to be given material form by means of practical exploration, visualizing and model making. Accordingly, we say that in order to engage in productive working with knowledge, students have to be both “minds on” (working with ideas) and “hands on” (implementing ideas by creating materially embodied artifacts). Design activities develop the ability to enhance and transform ideas through visualization, which involves testing the practicality of multiple solutions through sketches and prototypes (Welch et al., 2000; Hope, 2005). Through designing, students learn to view the same information from many viewpoints and to represent various solutions and alternative forms of presentation. This process entails evaluation of the solutions as well as reflection on the design process itself.

Learning by Collaborative Designing (LCD) has been developed to guide and facilitate students’ collaborative knowledge building processes in technology enhanced learning environments (Seitamaa-Hakkarainen et al., 2010). It guides all participants to take part in deliberate advancement of ideas, and highlights the role of physical artifacts, material objects, and abstract models as essential aspects of the design process. The LCD model represents designing as a spiral and iterative process. The model consists of the following partially overlapping phases: 1) creating design context, 2) defining design task and related design constraints, 3) creating conceptual and visual design ideas, 4) evaluating design ideas and constraints, 5) experimenting and testing design ideas by sketching, modeling, and prototyping, 6) evaluating functions of prototypes, and 7) elaborating design ideas and redesigning. The LCD model have be applied to collaborative designing to facilitate participants’ interaction processes in developing design ideas and sharing their expertise through technology-enhanced learning environments (Seitamaa-Hakkarainen et al., 2010). Through technology enhanced designing, even elementary level students can become acquainted with the tools and advanced practices of designing already in their early education (Seitamaa-Hakkarainen et al., 2010).

2. Method

2.1. Participants and the setting of the study

The architecture project was designed in collaboration with a class teacher, and it took place in her classroom in an elementary school, located in a middle-class suburb in Helsinki, Finland. The students (N=29) were 6th graders, 12 years old, and it was their final year of elementary school. The project lasted 19 weeks and took approximately 45 lessons, about 2-3 hours a week, and it was integrated with normal school subjects. Figure 1 presents the main phases and activities during the project.

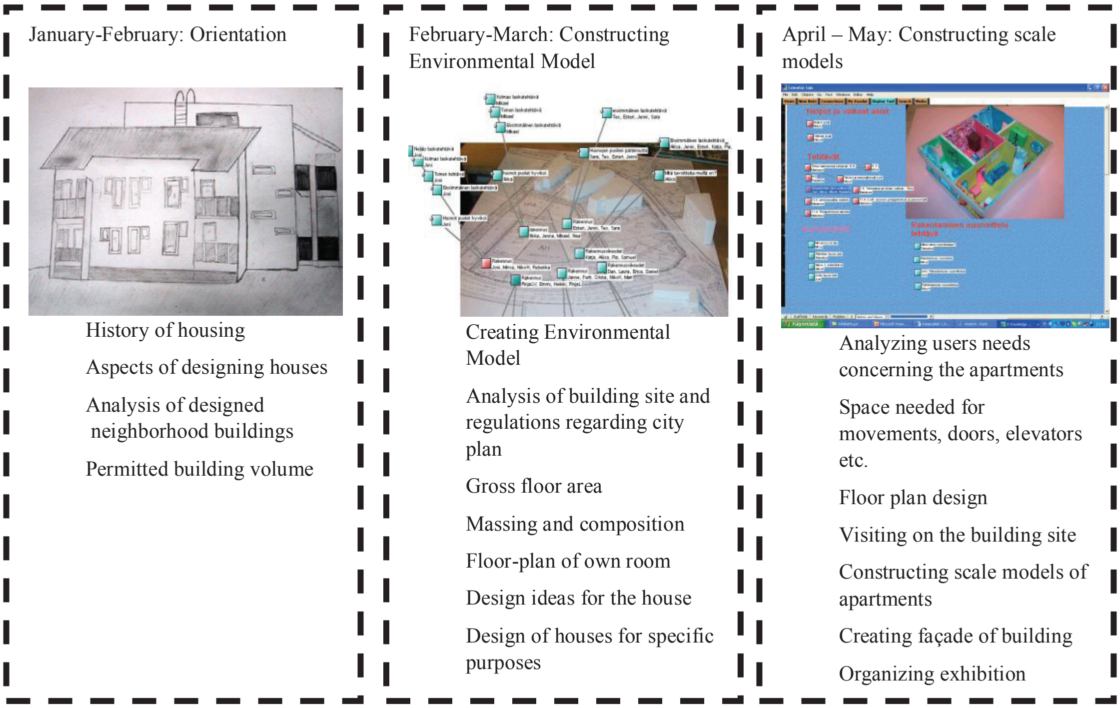

Fig. 1. The main phases and activities during the Architecture Project.

During the project, the students worked in 7 teams (4-5 students in each) and designed 7 apartment buildings of varying types for an actual building site planned by the City of Helsinki. The teacher has been very committed to developing the pedagogy of knowledge building, and she has extensive experience as an elementary school teacher. The teacher and researchers planned the general phases of the project, and the interior designer functioned as an expert of architecture. He commented on students' work and provided different kind of tasks for assisting the students in advancement of their collaborative process. Expert-like working familiarized the students with planning regulations, requirements of the building site and different kinds of scale models that architects work with.

The technical infrastructure for the project was provided by Knowledge Forum (KF), a networked learning environment based on knowledge building pedagogy (Bereiter, 2002; Bereiter and Scardamalia, 2003). The central aspect of KF is a common working space for the students; a database that consists of knowledge (texts and graphics) produced by the students and teachers. The database was organized around views. A view is a kind of visually organized representation of a selected part of the database, and it may contain thematically connected textual notes, drawings, photographs, and links to other views.

2.2. Method of data analysis

The analysis of the Architecture project relies only on the project's KF database, consisting of notes, pictures, sketches and photos posted by participants. The participants' quantitative contributions to the database were analyzed using Analytic ToolKit, which underlies Knowledge Forum. It reveals the frequency of computer posting (i.e., notes, views, rise aboves, build-ons), the time when the note was created, and note-reading activity. Firstly, in order to analyze how the project was actualized in practice and how Knowledge Forum supported the project work, we analyzed the number and contents of students' notes in each view. The notes collected within the rise-above notes, copied notes (i.e., notes created in one view and copied later on to support activities in another view) were not included in the analysis. Also notes related to studies of habitats of different animals, housing in different historical phases and geographical areas (i.e., integration of other subjects) were excluded from the analysis. Secondly, to analyze the main content of the notes produced by the student teams, we employed a theory and data-driven approach for categorizing the content of the notes. The analysis produced the following five main categories: 1) design context and design constraints, 2) design ideas and visualizations (the number of pictures, sketches, photos, models were counted manually), 3) calculations related to buildings, and 4) reflections on the project. The analysis was performed with standard procedures of qualitative content analysis (Chi, 1997) with the help of ATLAS.ti software.

In the present investigation, we were interested in what kind of design learning processes and outcomes would emerge during the project. We focused on our analysis on examining what kind of environmental competence students developed during the project. For this analysis, we selected those notes that were related to 1) analysis of the neighborhood and 2) construction of design context. First, we analyzed what kind of contents and environmental issues these notes consisted of, and further, we categorized these notes as 1) declaratory notes i.e., students only were listing or simply stating things or aspects shortly without explication and 2) explanatory notes. In explanatory notes students gave explanations, reasons or provided more details that explicated their ideas.

At the end of the project, each student was asked to write a note about their architectural design process. The final analysis was conducted on the individual students' 3) reflection of the project –notes and we considered those notes as representing participants' "learning outcome". We analyzed the nature of descriptions and how the students were using correct architectural concepts (for example, site and space) and, further, how these concepts were related within each other. We categorized these notes representing three levels of 1) basic, 2) progressive, and 3) advanced environmental competence. We considered the description as the basic environmental competence when the students expressed various architectural design phases, used accurate design concepts and introduced at least one important architectural concept. Progressive competence refers to the notes where student were able to explicate, at a more detailed level, some of the architectural concepts such as site, space or utility of the building and showed how these concept were related to each other. In more advanced descriptions, more elaborated architectural concepts were provided and these concepts were related to each other.

3. Results

3.1. Summary of the project

The starting point of the Architecture Project was an authentic and real problem: to design apartment buildings for various user groups at a building site planned by the City of Helsinki. The students were requested to analyze and to draw the neighborhood building and to give, according to their point of view, justifications related to pleasant or unpleasant properties of the houses. The actual architectural designing started with all participants performing a joint analysis of the design context. The students were given orientation material about city planning, and they reflected on how to investigate and study the building or construction processes. The student teams also reflected on what issues need to be taken into consideration in the construction design.

During massing and composition, the students needed to consider, together with their team members, various constraints and specific characteristics of the building site: traffic, effects of sun, accessibility, and so on. All of these issues were authentic, important constraints related to the real-life architectural design context and requirements for permitted buildings. When reflecting upon on the effects of sun, wind, traffic, sounds, and accessibility, it was decided that each team would adopt one of these as a special design challenge or theme. The teams' proposed buildings were named according to their design challenges. Further, the student teams were asked to self-organize their activities and create their own team views for their design ideas.

The total number of KF views created during the Architecture Project was 9, and the total number of notes was 490. The teacher created two shared views, the Welcome view and the Environmental Model view, used by all the teams. As stated above, each team had its own view, named according to the special design challenge. Correspondingly, the team views were named, Eco House (considering especially ecological aspects), Sound House (special attention to acoustics), Water and Wind House, Green House, Community House, Small Apartment House (consisting of only two apartments), and Accessibility House (for disabled people).

Table 1. The quantitative contributions of the Architecture Project's KF database

	Name of the view	Student teams' notes	Teacher's notes	TOTAL
Shared views	Welcome	26	11	37
	Environmental model	185	32	217
Team views	Eco House	32	2	34
	Sound House	29	1	30
	Water and Wind House	30	1	31
	Green House	25	0	25
	Community House	57	3	60
	Small Apartment House	25	1	26
	Accessibility House	26	4	30
TOTAL		435	55	490

Table 1 shows the number of students' notes in the team views varied from 25 notes to 32, except for the Community House view, where the number of notes was 57. The Welcome view (f= 37) and the

Environmental Model view (f=217) were constructed collaboratively by the whole class. The teacher's notes (f= 55) were mainly organizational instructions. The students' notes were mainly written in teams. Half of the notes were linked to other notes, indicating that the students built on each other's notes, especially on the team views.

The qualitative content analysis of the student teams' notes (f= 435) revealed that the main content of student teams' notes was, as expected, related to design ideas and visualizations (f=141; 32%). The analysis of the design context and the design constraints accounted for approximately 24% (f=106) of the contents of the notes. During the course of the project, it was essential also to master calculations of area and various measures regarding buildings, and thus, the calculations related to building volume played an important role in the design process (f=50; 12%). Moreover, the students reflected on their design processes (f=138; 32%), considering aspects that were easy or difficult for them in designing. In the following, we will describe how the environmental competence regarding the architectural principles and domain concept were developed during the process, with examples from the project's database.

3.2. Developing the environmental awareness and competence in the architectural design process

In order to get the students toward design mode, they were engaged to investigate building design of their neighborhood. The task was intended to anchor their personal architectural experiences (i.e., personal awareness and attitudes) of the residence buildings. Students were asked to select a well- or badly designed apartment building from their neighborhood, justify their selection (why the house was interesting to them), and make their assessment concerning its design characteristics. Working towards that end, students drew pictures of the building as well as constructed written explanations justifying their design evaluations.

The students' notes (f=27) related to analysis of the neighborhood were examined. In general, these notes and drawings depicted how young students perceive their environment and concerns about appearance and properties of the buildings. The students assessed their neighborhood buildings as pleasant (f=16) or unpleasant (f=11). The main properties associated to neighborhood were distance (f=20), nature (f=18), size (f=14) and safety (f=7). Justifications related to distance were connected to location and services; building was for example near the shopping center, near by the sea or too far from sport field. The nature was associated with the location; for example, "the house is locating in nice place because there is sea view from the balcony" or the size of the backyard and landscape. The students evaluated that aesthetics (f=6) and general quality (f=9) of the buildings were either good or bad. These statements were very general: "The house is ugly especially the balcony" or "The house is beautiful from outside". They also considered maintenance (how clean the house or yard was) (f=7), utensils and technology (such as elevator, parking garages) (f=19) and community (f=5) that were related either to good or bad properties of the houses. The pleasant properties that were mentioned were privacy, tranquility, location, and ownership of the house, whereas disturbance was seen as unpleasant property. The analysis of the task revealed that student had already developed environmental competence related to architectural appreciation; they had some knowledge about space utilization, and they were able to assess, analytically, their surroundings. However, all of the students' justifications were simple declarations in nature, only listing those aspects they considered as good or bad designs without further explications.

Before starting actual architectural designing, the student teams also reflected on what issues need to be taken into consideration in the construction design. These notes were written in teams, and we analyzed the contents of these constructing-of-design-context notes. The students considered, in their team notes, the size and location of the building site (f=15), construction and pile work (f=11), water plumbing and electric wiring (f=8), users (f=7), type of the building (f=6) and budget (f=3). However, four of the teams only listed their considerations (for example environment and soil, size of the house and site) whereas three of the teams explicated their considerations in a more detailed manner. Below is an example of the Community House team's explanatory note:

> *When starting the planning of the construction, you have to keep in mind is the building site near the sea, what kind of land it's on and whether it's on flat land or on an hill. Because during the design phase it's important to know which side has the best view (a view towards the sea is obviously the best). The land the house is important because if it's on a ridge a part of the building has to be build under the ground. Electrical wiring and water pipes also need to be dragged to the house. Access to the house is also important as usually they are important if the owner plans to move at some point. The yard has to be well taken care of and there should be plenty of trees and brushes so there are places for children to play. The most important element is of course who lives in the area and whom the house is made for as a house made for a grandmother and a family moves in, the family may not enjoy it nearly as much.*

The previous analysis of the KF data-base revealed that the students mainly provided declaratory notes and only a small portion of the notes was classified as explanatory notes. Though the students listed "individual items" without deeper explication these issues, the notes still represented very relevant environmental knowledge. In other words, the students had the capacity to identify various and accurate aspects related to buildings and construction processes. Furthermore, during the Architecture project, they were able to design sophisticated apartment buildings and consider various aspects related to user needs or ecological aspects of the buildings.

At the end of the Architecture project, each student described his or her design processes, and we analyzed those notes as reflecting the "learning outcome". We analyzed the nature of students' description, how the students were using correct architectural concepts in general and how the main concepts and aspects were related or connected within each other. The notes were seen to represent three levels of 1) basic, 2) progressive, and 3) advanced environmental competence. The results revealed that all students (f= 28) provided accurate descriptions of the architectural process and all of them used correct domain-specific vocabulary; i.e., building volume, gross-floor area, building permit and so on. Typically all notes started, "First you need to select the site where the building will be constructed. Then you need to work out the building permit." However, about half of the notes (f= 16) were seen to represent the basic level of environmental competence: they described the design process stating different design activities and mentioning only the importance of site, type of building, and building permit. Below is an example of Sara's basic- level-competence note:

> *First you need to introduce for yourself to building construction (net or literature). Then, you need to select a building site and investigate the soil. Do the environmental plan 1:500. Then you study the building permit and select the type of the apartment building; the city plan affects selection of building type. Calculate building volume and building gross-floor area for each floor. Decide placement for elevators and stairs. Now design the house on paper by using pen; now it is good to think how to locate the house. Then you draw the floor plans, sections and facades. Scale model 1:20. Then glue all drawings on the board, so that you can make, for example, an exhibition (Sara note 2678).*

At the progressive environmental competence level, the students (f=8) considered, besides the accurate project description and vocabulary, either the site or the space or both by explicating how these have an effect on designing. Amy's note is an example of the progressive environmental competence:

> *First we thought what kind of building it could be. We needed to calculate size of building site, because we needed to take in to the consideration how the house will fit on the site and what direction the external doors will be. So that it is not too near of the road. When we had decided what kind of*

building it will be, we got a permit to start to design. Then we started to think what kind of community space there will be. And what kind of apartments we wanted. We started to think what kind of rooms there will be in the house, and we decided where the room will located. We started to make drawings of community spaces and apartments. Then we started to think about where windows will be located and what size the windows will have. We made facades 1:200. And we made a scale model of one apartment (Amy note: 2672).

At the more advanced environmental competence (f=4) level, the descriptions involved more elaborated architectural concepts and furthermore, explicated, for example, the importance of space planning (i.e., interior spaces), utility or function of the designed spaces and mentioned the users of the building. Moreover, these concepts were related to each other. Part of the Gemma's note represented advanced competence:

You need to take into the consideration building permit and gross-floor area. You need to consider what kind of people (families, elderly people, adolescent) and what will be devoted in the design. We decided to make community house, so we thought about all the suitable spaces that will be common in the house. We decided to design for the young athletic adolescents…. (Gemma note:2673)

To summarize, the results revealed that students clearly learned to use accurate architectural vocabulary; they learned to name various architectural design phases, and moreover, they had acquired practical environmental skills to designing the environment during the project.

4. Conclusion

The purpose of the Architecture project was to examine how practices of collaborative designing with the help of a technology-enhanced learning environment may be implemented in an upper elementary classroom. Toward that end, elementary-school students were engaged in an architectural project involving a variety of knowledge practices, working with conceptual and material tools and artifacts. To provide students with an authentic experience of architectural designing, we created a learning environment that simulated architectural practices. Thus, the project included the use of KF software, hands-on drawing and modeling activities to support students' design inquiries.

The aim of the project was to develop students' understanding of architectural design principles and domain specific concepts. The students learned to understand various design constraints related to construction requirements, utilities of the space and users' needs. During the project, they learned to consider the effects of traffic (roads) and light for the location of the buildings. The designer had an important role in familiarizing the students with planning regulations, requirements of the building site, and different kinds of scale models used by architects.

Students worked in teams and went through many of practices involved in actual architectural design. The previous sections described what kinds of learning process emerged during the project. The quantitative analysis of the KF views and notes revealed some of the characteristics of the technology-supported collaborative learning process. The analysis showed that students were able to take various aspects into consideration while designing a house. The participants engaged in learning by collaborative designing by carrying out various concrete and material as well as epistemic and conceptual activities, such as taking measurements, doing calculations, reading and writing, sketching and drawing, and prototyping and testing scale models. To conclude, the participants engaged in design inquiry across a long period of time and deepened their understanding of architecture.

The results depicted some examples of the students' environmental competence. Environmental competence means a capacity to deal with one's environment in effective manner; the development of environmental competence is an informal process that continues the whole life span (Pedersen, 1999).

Educational settings, especially those that involve active participation, some environmental competences can also be facilitated (Pedersen, 1999). In this study, we sought to operationalize the environmental competence at three levels in order to reveal student learning outcomes. The results revealed that students had developed environmental competence related to architectural appreciation; they had some knowledge about space utilization, and they were able to assess, analytically, their surroundings. Further, at the end of the project, all students were able to provide accurate descriptions of the architectural design phases; they realized, in varying degrees, the importance of the size and location of the building site, the requirements for building site and planning regulations (city plan). Only a few of the students were able to explicate more elaborated architectural concepts, such as the importance of space planning or functions of the designed spaces. To conclude, the architectural project helped inculcate useful, design skills for students as well as enhanced their environmental awareness and competence.

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